The Influence of a Values Affirmation Intervention on Students' Mathematical, Social, and Epistemological Empowerment

Carrie Olson Bala
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THE INFLUENCE OF A VALUES AFFIRMATION INTERVENTION ON STUDENTS’ 
MATHEMATICAL, SOCIAL, AND EPISTEMOLOGICAL EMPOWERMENT 

by 

Carrie Olson Bala 

A dissertation submitted in partial fulfillment 
of the requirement for the degree 
of 

DOCTOR OF PHILOSOPHY 
in 

Education 

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Logan, Utah 

2022
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ABSTRACT

The Influence of a Values Affirmation Intervention on Students’ Mathematical, Social, and Epistemological Empowerment

by

Carrie Olson Bala, Doctor of Philosophy

Utah State University, 2022

Major Professor: Dr. Beth MacDonald
Department: Mathematics Education and Leadership

The purpose of this study was to better understand the varying impacts of educators’ attention to identity construction as tenth grade Emergent Bilinguals and native English-speaking students develop mathematical, social, and epistemological empowerment in a mathematics classroom. Within the transformative paradigm, I incorporated a framework detailing critical consciousness as a mediator between students’ identity construction and their empowerment development. I employed a mixed methods transformative design, utilizing quantitative and qualitative methods to analyze the influence of a values affirmation intervention on students’ critical consciousness and empowerment. To follow, I incorporated integrated analysis to highlight emerging and differing patterns in the empowerment data, the specific characteristics which may have contributed to these themes, and the need for multiple measures. Approximately 80 tenth-grade Emergent Bilingual and native English-speaking students were recruited from a western high school to participate in the study. Results suggest that students of different identities experience empowerment differently in the mathematics classroom. Findings provide a foundation suggesting that efforts to attend to students’ identities may positively contribute to
their empowerment. In particular, values affirmation interventions correspond with improved mathematical empowerment outcomes, particularly for Emergent Bilingual students, but are associated with limited or negative influences on students’ social and epistemological empowerment outcomes. Findings also suggest that both reflection and traditional assessments are necessary to adequately capture students’ development in the mathematics classroom. I recommend further research to develop techniques which highlight students’ empowerment, specific to their language and gender identities.

(160 pages)
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Carrie Olson Bala

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students’ development in the mathematics classroom. I recommend further research to develop techniques which highlight students’ empowerment, specific to their language and gender identities.
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CHAPTER I

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM, 2018) defines the goal of high school mathematics to include empowerment, specifically empowerment to “expand professional opportunity; understand and critique the world; and experience wonder, joy, and beauty” (p.9). This transformative goal represents a broad definition of mathematics learning, one that includes gaining content knowledge, developing disciplinary practices, constructing positive perceptions, and using mathematics to confront inequity (Cai et al., 2019). In keeping with such a transformative paradigm, researchers evoke critical theories to investigate characteristics of students’ mathematics success. Critical theorists within a transformative paradigm acknowledge the social, political, and cultural influences on knowledge and identity construction, highlight the resulting inherent inequities in students’ opportunities to construct mathematical knowledge and identities, and engage students in a process of social change (Mertens, 2009). Through critical reflection and positive identity construction, students develop an awareness of their positioning in the mathematics classroom community, and the competencies and confidence to work for such social change (Gutstein, 2006). However, it is not yet known how students’ critical reflection and identity construction can be utilized to promote their academic mathematics achievement and their positive perceptions of mathematics. Therefore, the focus for this research was to better understand the varying impacts of educators’ attention to identity construction as high school students develop mathematical, social, and epistemological empowerment.
Background of the Problem

A growing body of literature exists on the benefits of promoting positive identities in the mathematics classroom (Gutiérrez, 2013; Gutstein, 2006; Moreno & Rutledge, 2018; Mycyk, 2019; Wood, 2013; Wright, 2016). By attending to student identity construction, educators must also recognize students hold multiple identities. Varelas et al. (2012) suggest the development of positive disciplinary, cultural, and academic identities as essential to learning mathematics. Research findings on developing positive disciplinary identities in the classroom suggest that when educators build mathematical competencies (Gutstein, 2006), foster students’ sense of belonging in the field of mathematics (Mycyk, 2019), and purposefully locate students in positions of mathematical authority (Wood, 2013), students are more apt to contribute to collaborative mathematical tasks and evidence the behaviors of a professional mathematician. Similarly, when educators develop positive cultural identities in the mathematics classroom, and by extension, racial, language, class, and gender identities, they highlight students’ contributions, develop understandings of group members’ schooling experiences, and align school requirements with students’ personal and cultural strengths (Moreno & Rutledge, 2018; Oppland-Cordell & Martin, 2015; Pennell, 2016). To develop positive academic identities in the classroom, educators need to structure students’ academic involvement, allowing for equitable participation in classroom discussion and access to social justice mathematics investigations (Gutiérrez, 2013; Wright, 2016). Exploration of students’ identity construction along disciplinary, cultural, and academic themes frames a burgeoning understanding of the complex and varied influences on students’ mathematical development. Additionally, investigations involving students’ identity construction recommend pedagogical strategies to enhance students’ engagement with mathematical tasks and practices.
Researchers have begun to investigate the intersection of students’ mathematical, racial, gender, class, and language identities as they navigate challenging mathematics schooling experiences (Leyva, 2016a; Zavala, 2014). When exploring the academic impact these identities have with mathematics school experiences, findings evidenced counterstories, explaining historically underrepresented students’ experiences, particularly for Latin* students. While aware of terms such as LatinX, Latin@, and Latino/a, I have chosen the term Latin* for this study. Latin* is an inclusive term intended to support the intersection of students’ fluid identities (Salinas, 2020). Counterstories, or opposing explanations, challenge stereotypical narratives of minoritized students’ academic experiences, including that of Emergent Bilingual students. In particular, these experiences are often evidenced through performance gaps on national and international assessments (U.S. Department of Education, 2019; OECD, 2019) rather than specific students’ stories and perceptions around their success and growth. As individuals encounter personally relevant stereotypes in the mathematics classroom, Emergent Bilingual students experience threats to their identities and subsequent impairment on mathematical challenges and assessments (Steele & Liu, 1983). Some researchers attempt to remedy these performance gaps by attending to students’ positive identity construction through research-driven, values affirmation interventions. To design and utilize a values affirmation intervention, educators promote students’ construction of positive identities through their reflection, recognition, and affirmation of personal and cultural values and strengths (Cohen et al., 2006; Harackiewicz et al., 2014; Rapa et al., 2020). However, few studies focus on bolstering students’ identity construction in the high school mathematics classroom. By focusing on high school students, educators are more equipped to leverage students’ nascent awareness of the connections between their personal and cultural identities and their community’s social
structures (Godfrey & Grayman, 2014; Thomas et al., 2014). Further, critical consciousness, where students critically reflect on their own experiences with school mathematics, provides a mechanism for researchers to examine the relations between students’ growing awareness and their efforts to achieve mathematics success, broadly defined.

When examining critical consciousness of students, findings suggest students develop a sense of agency to work towards improvement in their classrooms and society (Banda & Flowers, 2018). Gutstein (2006) also found that students’ critical consciousness development related to their self-perception and personal connection to their community. Thus, as researchers examine students’ critical consciousness, results indicate positive relations between students’ identity construction and specific, social aspects of their success. However, few studies investigate high school students’ critical consciousness development in conjunction with mathematics achievement in school and attitudes towards mathematics. Moreover, researchers have yet to utilize phases of critical consciousness development to better understand the impact that values affirmation interventions have with students’ empowerment.

Studies attempting to assess relations between students’ empowerment and their school achievement, found these relations could be explained by their traditional school accomplishments (Buenrostro, 2016; Dunleavy, 2015; Sims, 2016), social connections and awareness of social inequities (Pennell, 2016; Kokka, 2019; Raygoza, 2016), and positive attitudes towards mathematics (Braathe & Solomon, 2015; Gutierrez, 2013). Ernest (2002) broadly defines these themes as mathematical, social, and epistemological empowerment. Findings from studies incorporating values affirmation interventions or students’ engagement with social justice mathematical tasks suggest that when students feel more empowered, they do so among one or some of these three types of empowerment. Researchers have yet to broadly
characterize high school students’ mathematical success with all three aspects of empowerment. Further, studies do not yet explicitly examine connections between students’ empowered success and pedagogical efforts to bolster their identity development.

**Problem Statement**

Given the limited nature of national and international assessment results (U.S. Department of Education, 2019; OECD, 2019), it is not yet known how students’ identity development could be leveraged to promote students’ mathematics achievement, or more broadly, students’ feelings of empowerment. Additionally, even though values affirmation interventions have been shown to be effective in supporting mathematics students’ identity development and academic achievement in mathematics courses, it is not yet known how long these interventions should be implemented, how the impact varies with the nuances of high school students’ identity development, or how the interventions influence students’ social, mathematical, and epistemological empowerment. Educational reports rarely include measured students’ success according to these three standards of empowerment (Ernest, 2002). In particular, studies continue to narrowly measure mathematics achievement and success, reporting growth trends for historically underrepresented students, but rarely incorporate particular student voices and perceptions. By incorporating students’ voices and perceptions, educators will gain insight into how and why students feel more or less empowered in particular school mathematics experiences.

**Significance of the Study**

This study focused on how high school mathematics students’ identity construction influenced their empowerment. In particular, study results add to the literature by providing a deeper understanding of how Emergent Bilinguals’ and native English speakers’ identity
development explains different and/or similar social, mathematical, and epistemological empowerment in the mathematics classroom. Furthermore, results inform future research designs, which seek to examine how high school mathematics students’ success and empowerment relate. For instance, the nuanced measures of this study can inform how future studies can more fully capture the diversity in particular rural, high school student populations. Finally, results from this study have the potential to add to the literature examining the use of values affirmation interventions in rural high school mathematics classrooms.

**Research Purpose and Questions**

To address these problems, the purpose of this study was to better understand the varying impacts of educators’ attention to identity construction as tenth grade Emergent Bilinguals and native English-speaking students develop mathematical, social, and epistemological empowerment in a mathematics classroom. To meet this purpose, this study sought to answer the following three research questions.

1. When controlling for language identity and gender identity, to what degree does a values affirmation intervention predict students’ mathematical, social, and epistemological empowerment?
   a. How do varying levels of intervention implementation influence this prediction?

2. Following a values affirmation intervention, how do the perceptions of students with differing language and gender identities relate to their mathematical, social, and epistemological empowerment?
3. Following a values affirmation intervention, how do students’ mathematical, social, and epistemological empowerment profiles differ between outcome measures and personal survey responses?

   a. How do differences in empowerment profiles relate to differences in language and gender identities?

   b. How do differences in empowerment profiles relate to phases of critical consciousness development?

**Summary of Research Design**

To examine these phenomena, I used a mixed methods transformative design wherein critical theory provided an overarching framework for the study and contributed to participant empowerment (Creswell & Plano-Clark, 2018; Mertens, 2009). In the study, I concurrently gathered quantitative and qualitative data to obtain a more complete understanding of student empowerment, identity development, and the effects a values affirmation intervention has on these constructs. Moreover, this design better determined the degree of effectiveness some of these predetermined scales have in comparison to students’ open-ended responses. The five classroom sections of participating students were enrolled in tenth grade in the same mathematics course with the same teacher. School demographics suggested that these classrooms included both Emergent Bilingual students (10%) and native English-speaking students (90%).

This study design included a quantitative data analysis phase to answer research question 1, a qualitative data analysis phase to respond to research question 2, and an integrated data analysis phase to answer research question 3. In particular, I utilized quantitative data to investigate how critical consciousness develops through a values affirmation intervention. Additionally, I examined how these data explain changes in a variety of tenth grade students’
mathematical, social, and epistemological empowerment. The qualitative data explored connections between identity, critical consciousness, and empowerment for tenth grade students enrolled in the same classroom section. By integrating these two forms of data, I established a more complete understanding of how students develop positive identities, critical consciousness, and empowerment. This integrated analysis challenged the use of a single measure of student success while, simultaneously, contributed positive counterstories of mathematical, social, and epistemological empowerment for Emergent Bilinguals.

**Assumptions, Positionality, and Scope of the Study**

In this particular study, I utilized critical theory; a theory assuming that individuals have unique and unequal experiences in the mathematics classroom. By taking up this theoretical lens, I also assumed that social and cultural artifacts mediate and inequitably influence students’ mathematics knowledge construction, mathematical practices, and attitudes towards mathematics.

As a white, cis researcher, I was positioned as a participating teacher in the school community with my own particular assumptions and biases. I recognized that I inhabited a position of privilege and had access to resources that are not available in all studies. With such privilege, I felt responsible to seek ways to improve my own teaching, to enable all students to fully participate in empowering mathematical practices, and to highlight all students’ mathematical successes. Every effort was made to connect with the community of Emergent Bilinguals and encourage participation in this study, including informal focus groups with previous Emergent Bilingual students for fine-tuning and translation of materials and instruments. Moreover, I more formally collaborated with the school’s Latin* family liaison to ensure that I was communicating and translating study materials and data accurately for bilingual
families. With wide participation in this study, I hoped to inform my own teaching, honor students’ perceptions, and broadly illustrate the successes of mathematics students.

This study took place in a rural western high school in five sections of a tenth-grade mathematics classroom. Students at this particular age are beginning to develop connections to their social world and constructing personal and civic identities in a relatively new and potentially threatening school environment (Godfrey & Grayman, 2014; Thomas et al., 2014). Because this study focused on students’ critical consciousness development with high school-aged participants, extending this investigation to other stereotypically threatening contexts, such as junior high school and undergraduate mathematics and science classes, was beyond the scope of this study.

**Definition of Terms**

*Critical Consciousness*: an understanding of the inequalities of power and resources that exist both in the personal life and the broader community, as well as the capacities to make specific social transformations based on conceptual understanding (Freire, 1972/1978; Gutstein, 2006)

*Emergent Bilingual*: a strength-based term describing a student developing along multiple continua of language proficiency (Garcia, 2009)

*Empowerment*: the gaining of power in particular fields by individuals or the processes that facilitate those gains in power (Ernest, 2002)

*Identity*: the changeable, contextual collection of stories that an individual tells about the self or the stories that others tell about an individual (Langer-Osuna & Esmonde, 2017)
CHAPTER II

LITERATURE REVIEW

The purpose of this study was to better understand the varying impacts of educators’ attention to identity construction as tenth grade Emergent Bilinguals and native English-speaking students develop mathematical, social, and epistemological empowerment in a mathematics classroom. To outline proposed relationships between these concepts, this chapter first explains the theoretical and conceptual framework used to interpret results. To follow, a literature review details a synthesis of findings along themes of student identity construction, critical consciousness, and empowerment. A summary concludes the chapter.

Theoretical and Conceptual Frameworks

In this study, I adopted a transformative paradigm to frame the findings and explicate the (in)effective design aspects for the research intervention. Within this paradigm, critical theory explains how students develop identity and how this relates to their sense of empowerment in the study. The following subsections detail the transformative paradigm, critical theory, and the connecting conceptual framework of the research design.

Transformative Worldview

Within a transformative paradigm, a researcher focuses on “culturally appropriate strategies to facilitate understandings that will create sustainable social change” (Mertens, 2009, p. 10). In particular, there is an emphasis on the social, political, and cultural influences on knowledge and identity construction. Researchers within the transformative worldview recognize inherent social inequalities and desire to use research to engage with those social conflicts and empower often-neglected community members (Jewiss, 2018). “As these issues are studied and
exposed, the researchers provide a voice for these participants, raising their consciousness and improving their lives” (Creswell & Poth, 2018, p. 25). Given this worldview, I examined how the Emergent Bilingual students’ critical perceptions relate to their sense of empowerment. Additionally, I incorporated student voices into the study’s analysis of achievement, awareness, and attitudinal data for a more nuanced understanding of the influences of a values affirmation intervention on student empowerment. The transformative paradigm provides a structure for the application of various social theories to understanding specific social phenomenon while also giving voice to minoritized individuals. Critical theory explains details of how Emergent Bilingual students’ critical perceptions may relate to their sense of empowerment within the transformative paradigm.

**Critical Theory in Mathematics Education**

Critical theory provides the foundation for critical mathematics education. Framed by Marx, Kant, Freud, and Habermas in the 1920’s, *critical theory* is any theory which develops an awareness of social inequalities and the capacity to work for change. In keeping, critical theorists emphasize both ones’ reflection, to understand the social world, and their critique, to act towards emancipation from these inequalities (Ewert, 1991).

Notably first in the field of education, Freire employed critical theory, utilizing the experiences and ideas of his students to motivate social action and emphasize the development of their critical consciousness through literacy (Frankenstein, 1983). Watts et al. (2011) succinctly capture the essence of critical consciousness by characterizing critical reflection, political efficacy, and transformative action. Applying these same themes of critique and action to mathematics education, Gutstein (2006) examined student development of critical consciousness and capacity for social change in classes of mathematics for social justice. In his research,
Gutstein developed pedagogical and mathematical content goals which highlighted the necessity for positive student identity construction and mathematical content learning for empowered social action. However, it is not yet known how students’ identity construction and sense of empowerment relate.

**Proposed Conceptual Relationships Between Identity Construction and Empowerment**

In the context of the mathematics classroom with inherent inequalities, students may develop a state of awareness or critical consciousness, resulting in a better understanding of their own positioning in the classroom and their cognizance of the strengths they bring to mathematics class. To examine the influence of a values affirmation intervention on students’ empowerment, I posit that high school students’ identity construction is associated with the construction of their critical consciousness. In particular, I sought to investigate students’ identities as the intersection of their cultural identity (the narratives students tell about the beliefs, customs, and practices of their family and community) and their language identity (the language(s) students use to tell their stories). To follow, I argue that when students develop critical consciousness, they become more positively empowered mathematically, socially, and epistemologically.

The conceptual framework used in this study, displayed in Figure (2.1), details how students’ identity construction may be mediated by their critical consciousness development and predicts how students’ sense of empowerment develops.
Figure 2.1

The Critical Identity Construction and Empowerment Framework

This framework informed the study design which incorporates a values affirmation intervention intended to bolster positive student identity construction. Students’ identity construction develops through critical reflection on their personal strengths, values, and social positions. Critical consciousness development is the mechanism through which students’ identity construction expands to their own motivation, action, and empowerment in the mathematics classroom. The following sections review the literature of these themes described in the conceptual framework: student identity construction, critical consciousness, and empowerment.

**Student Identity Construction**

Varelas et al. (2012) outline the importance of constructing positive disciplinary, racial, and academic identities when identifying as a mathematics learner. In the mathematics classroom, this definition of learning is characterized by students’ collaborative engagement with mathematical tasks, students’ confident persistence in working through mathematical challenges, and students’ recognition of the personal strengths brought to the task. To examine this importance further, the following subsections contain a synthesis of research on (1) disciplinary identity construction, (2) cultural, language, and gender identity construction, and (3) academic identity construction. To follow, I describe how values affirmation interventions bolster students’ identities.
**Disciplinary Identity Construction**

Varelas et al. (2012) describe mathematics *disciplinary identity* as the positions and characteristics of one who does mathematics professionally. For example, students with strong disciplinary identities take on positions of authority and belonging through their justification of mathematical claims and academic choices, create questions when investigating patterns, and express curiosity and appreciation for the mathematics field. Given these features, in the literature, I explain how students’ positions and characteristics of their disciplinary identity are constructed in school mathematics.

Students construct disciplinary identity in the classroom as they position themselves or are positioned with a perceived sense of mathematical competence. Some studies which attended to disciplinary identity focused on the student’s feelings of belonging in the mathematics field, as described in their narratives (Andersson, 2010; Bartholomew et al., 2011; Braathe & Solomon, 2015; Mycyk, 2019). For example, Braathe and Solomon (2015) interviewed five female graduate students in mathematics education, investigating their purposeful choice of mathematics study. Close analysis of interview responses suggests that a student’s personal recounting of experiences choosing mathematics, despite anxiety and trepidation, may influence their disciplinary identity as a mathematician.

Other researchers highlighted how student shifting from menial positions in the classroom to authoritative positions, such as a shift from note-taker to explainer, in mathematical practices enables positive shifts in identity with respect to mathematics (Black et al., 2010; Solomon et al., 2011; Tisch, 2014; Wood, 2013). Wood (2013) analyzed collaborating students’ discourse in one fourth-grade classroom and highlighted the changing positions of one particular student throughout the course of the lesson. Findings suggest that student positions such as
explainer allow for more mathematics learning opportunities than worker positions and that multiple authoritative positions should be enacted for students to develop as mathematics learners.

Still other studies integrated the sociopolitical aspects of mathematics (Kokka, 2019; Unfried & Canner, 2019). For example, Kokka (2019) described the process of humanizing mathematics through a middle school class with a social justice focus. Outcomes from the case study suggest that as students reflect on personal trauma from social inequities through a social justice mathematical lens; mathematics mediated student healing, enabling a changing view of themselves within the field. Disciplinary identity studies illustrated identity construction with respect to the disciplinary field of professional mathematics and accounted for students’ sense of belonging, authoritative positioning, and sociopolitical awareness.

**Cultural, Racial, Gender, and Language Identity Construction**

Similarly, studies which highlighted students’ cultural, racial, gender, and language identity construction in mathematics education attempted to investigate the experiences of mathematics learners in relation to their particular group membership and to investigate the experiences of a particular group member in relation to mathematics. For example, Oppland-Cordell and Martin (2015) utilized an exploratory case study with eight undergraduate Calculus students to investigate what it means to be a successful Latin* mathematics student. Findings suggest students strengthen their participation in mathematical tasks as they negotiate their intersecting cultural, language, and academic identities through culturally relevant mathematics classroom experiences.

In fact, all of the reviewed literature focused on student participants from historically underrepresented populations in mathematics. Some researchers hoped to shed light on
inequitable practices which these students experience in the classroom (François & Stathopoulou, 2012; Harper, 2017; Langer-Osuna, 2011). Langer-Osuna (2011) investigated the identity trajectories and mathematical engagement of two group leaders of different genders in a project-based Algebra classroom. Despite the students’ equal positioning as leaders, group members deemed the female student’s displays of authority as inappropriate and her engagement in mathematics tasks faltered over the course of the study. These findings suggest that students’ gender identities intersect with academic identities and impact participation in collaborative mathematics tasks.

Other studies incorporated pedagogical practices to specifically attend to student’s cultural, language, and gender identities and improve participation in the mathematics education experiences (Moreno & Rutledge, 2018; Pennell, 2016; Tanko, 2012; Turner et al., 2013; Varelas et al., 2012). Moreno and Rutledge (2018) explored how participatory action research could further engage Latin* community college students in a developmental mathematics course. Results suggest that aligning school requirements with the cultural capital of students and incorporating student concerns into course content increases students’ engagement in mathematical practices in the classroom.

Research investigating students’ identities reveals an influence of culture, language, and gender on participation in mathematical tasks. Findings suggest that providing students opportunities to reflect on and incorporate these identities into their mathematics learning enhances participation in mathematical practices. Additionally, results demonstrate that some minoritized students may require support when enacting authoritative mathematical positions and demonstrating that mathematical authority. Student participation in mathematical tasks and authoritative positioning in the classroom evidence academic identity construction.
Academic Identity Construction

Varelas et al. (2012) describe academic identity as the positions and characteristics a student takes up in academic mathematics classrooms. While attention to students’ cultural, language, and gender identities has been found to impact classroom participation, some researchers have focused specifically on the patterns of participation as a way to describe the students’ academic identity. As observable phenomenon, changes in positions and characteristics of these positions can explain students’ mathematics learning (Raygoza, 2016).

Most studies examining academic identity found students had increased opportunities to learn when they enacted positions of authority in the classroom (Dunleavy, 2015; Esmonde, 2009; Turner et al., 2013). Some studies found that when educators created a specific classroom environment that attempted to provide equal opportunities for students, these students took up positive positions of authority (Balasubramanian, 2012; Dunleavy, 2015; Gutiérrez, 2013; Tisch, 2014; Wright, 2016). Balasubramanian (2012) investigated the students’ interactions and relationships established within an urban high school mathematics classroom wherein the teacher attempted to interweave mathematics and sociopolitical content. Findings from this longitudinal study propose that when teachers attempt to balance students’ mathematical strategies with their mathematical investigation of social contradictions, more students take on positions of authority in classroom discourse. Moreover, relationships among students and teachers are strengthened.

Through these studies, unique methods of analysis of students’ academic identity were also established (Brantlinger, 2014; Esmonde, 2014; Langer-Osuna, 2011; Zavala, 2014). For example, Esmonde (2014) investigated affluent students’ positioning in a social justice mathematics class by analyzing figured worlds. Incorporating sociocultural and critical theories, figured worlds are a theoretical framework used to interpret a complex context like a
mathematics classroom with specific student participants enacting unequal authoritative roles in alignment with or misalignment with normative storylines (Urrieta, 2007). Figured worlds provides a framework to examine students’ academic identity by comparing students’ patterns of participation and power in the classroom setting in comparison to expectations of their participation and power. Utilizing this framework, Esmonde’s study examines the relationship between students’ mathematical argumentation in the classroom, their individual and family background, and students’ expected behaviors in a collaborative mathematics with a social justice focus. Findings suggested that the way students interpreted their mathematical results and the conclusions they drew aligned with their individual experiences and values, but not with the typical outcomes from students’ engagement with social justice mathematics tasks. In particular, without established norms guiding discussion and justification, some affluent students justified their mathematical results with narratives of neighborhood poverty that reinforced stereotypes. Research focusing on students’ academic identity advances the ideas that specific dialogic classroom contexts enable more students to participate in mathematical practices and that these practices are influenced by students’ multiple identities.

An analysis of the literature on student identity construction in mathematics education reveals the importance of identifying intersections of different types of identity. Disciplinary, cultural, language, gender, and academic identities intersect to provide a robust explanation of the students’ experiences when learning mathematics. With efforts to bolster positive construction of these identities, students may develop an awareness of self and community and progress toward empowerment. The following subsection details findings on a specific effort to bolster students’ identities: the values affirmation intervention.
Values Affirmation Interventions

Values affirmation interventions incorporate student reflection and writing in order to focus attention on positive values and identity characteristics. Steele and Liu (1983) assert that students’ self-affirmation is developed when they engage in reflection and writing exercises. To test this hypothesis, Cohen et al. (2006) first investigated the effects of a written values affirmation exercise on the academic achievement of 7th grade students, creating a protocol that was employed in subsequent investigations. Findings from these investigations indicate that values affirmation interventions in educational settings have been shown to bolster the academic identities and academic achievements of historically underrepresented students in particular (Brady et al., 2016; Çetinkaya et al., 2020; Cohen et al., 2006; Cook et al., 2012; Harackiewicz et al., 2014; Jordt et al., 2017; Miyake et al., 2010; Rapa et al., 2020; Salles et al., 2016; Shnabel et al., 2013; Steele & Liu, 1983; Tibbets et al., 2016).

For example, Harackiewicz et al. (2014) randomly assigned students in a university introductory biology course to either a values affirmation treatment group or a control group. As part of early coursework, those in the treatment group completed reflective writing exercises which focused participants’ attention on personal values and the importance of those values in their own lives; those in the control group completed writing exercises which did not connect participants’ values to their personal lives. Harackiewicz et al. analyzed grades and program data, finding improved course grades and biology program retention, specifically for first-generation college students that participated in the values affirmation writing exercises, as compared to those in the control group. Researchers have shown that short writing exercises which focus on positive and meaningful characteristics of students’ identities encourage
academic engagement and achievement, particularly for those in minoritized student groups (Shnabel et al., 2013; Tibbets et al., 2016).

Conversely, other values affirmation studies present few or no positive impacts for students of minority groups (Bayly & Bumpus, 2019; Borman et al., 2016; de Jong et al., 2016). Bayly and Bumpus (2019) investigated the impacts of an online values affirmation intervention on first-generation undergraduate students’ academic achievement. This particular study utilized an online intervention outside of a particular class activity to compare the effects on treatment and control groups. Lower grade point averages for students in the treatment group indicated that the intervention had no positive impact on students’ ability to combat stereotype threat. Findings also suggest that to bolster positive student identities for minority groups, researchers need to attend to several contextual factors (e.g., timing of intervention in relation to an academic stressor, online completion of the intervention activity) when implementing a values affirmation intervention in the classroom (Bayly & Bumpus, 2019). Given these findings, I included in this study particular contextual factors, such as, the course content, classroom environment, primary language, and age level of participating students.

Studies utilizing values affirmation interventions are typically implemented in middle school or undergraduate mathematics and science classes, with authors citing these contexts as particularly rife with threats to positive identity development (Brady et al., 2016; Çetinkaya et al., 2020; Cohen et al., 2006). However, 9th and 10th grade students’ identity development is not often examined in the literature. This specific high school context is important because students at this age are constructing personal, academic, and civic identities and developing connections to their social world (Godfrey & Grayman, 2014; Thomas et al., 2014). The impact of a values
affirmation intervention has yet to be implemented in the context of a mathematics course at the 10th grade level.

Through these quantitative, quasi-experimental studies, researchers examined value affirmation intervention’s impact primarily on students’ academic achievement, collecting evidence of grade point averages, course grades, and subsequent course selection. Several of these studies additionally highlighted the intervention’s influence on characteristics of students’ sense of empowerment. For example, Cook et al. (2012) integrated measures of belonging into a values affirmation study with African American middle school students. Findings suggested a brief values affirmation intervention improved minority students’ sense of belonging and allowed these students to maintain this sense of belonging over several years. Similarly, Rapa et al. (2020) incorporated measures of critical consciousness into a values affirmation study with 9th and 10th grade students. Results suggested the intervention may raise a particular characteristic of students’ critical consciousness, critical motivation. As critical motivation is the individual’s feeling of responsibility to become involved and work for change, these findings indicate a broader, positive influence of the values affirmation on students’ sense of empowerment. By utilizing additional measures of students’ growth and achievement, some studies revealed supplementary benefits of a values affirmation intervention.

However, even within these reports of a broader sense of achievement, the voices of particular students are minimal. As in one example, Brady et al. (2016) usefully incorporated the written reflections of Latin* students to explain quantitative findings that suggested the values affirmation intervention increased students’ spontaneous self-affirmation when faced with subsequent stressors (e.g., final examinations, task deadlines). The inclusion of student voices
provided insight to the findings of the study by adding “more texture to our understanding of the psychology of the affirmed learner” (Brady et al., 2016, p.360).

In values affirmation studies, researchers hypothesized that “by diminishing psychological threats in an active-learning classroom, we may be able to reduce barriers to achievement and empower a student's sense of self-value” (Jordt et al., 2017, p.9). These findings explain effective means educators can use to bolster positive student identities and to benefit students’ critical consciousness and achievement through a values affirmation intervention. The following section contains a review of the literature centered on the theme of critical consciousness in mathematics education.

**Critical Consciousness in Mathematics Education**

*Critical consciousness* is a term created by Paulo Freire in his critical literacy work with Brazilian agricultural workers. Freire (1972/1978) describes critical consciousness as individuals’ development of perceptions centered on social and political contradictions (Godfrey & Grayman, 2014; Kokka, 2020; Martinez & Yeong, 2019). By developing perceptions of these contradictions, individuals become self-aware of how to work for societal and political change. Thomas et al. (2014) expand on critical consciousness by also including the skills of critical reflection and social perspective-taking. For instance, as students reflect on their own social positioning and the cultural influences that act on that positioning, they may simultaneously become more aware of their own categorization of others and may develop the ability to take on the perspectives of those individuals (Quintana et al., 1999). The review of the literature yielded two significant themes: operationalization of critical consciousness and critical consciousness in mathematics education.
Operationalizing Critical Consciousness

These same Freirean themes of critique and action serve as a basis for recent attempts to operationalize and assess critical consciousness in the classroom. Critical consciousness has framed qualitative studies where the narratives of specific students from historically underrepresented populations challenge stereotypical accounts (Banda & Flowers, 2018; Martinez & Yeong, 2019). For example, Banda and Flowers (2018) utilize critical consciousness to explain Latin* undergraduate students’ counterstories as they persisted to successfully complete engineering degrees. These findings defined specific cultural and gender boundaries that exist in the engineering field and the students’ characteristics of critical consciousness that allowed them to persist through their program. Additionally, findings resulted in policy recommendations for engineering institutions to provide opportunities for critical dialogue and to advocate for Latin* students enrolled in undergraduate STEM programs. These policy initiatives emphasized the development of Latin*s’ critical consciousness to better prepare them to counter both cultural and gender oppression in the field.

Critical consciousness has also been articulated as a path of experiences leading to individual growth. Serrano et al. (2019) map Latin* undergraduate student narratives from a semester course through stages of **conocimiento**, which are internal ways of knowing and understanding oneself from an Anzaldúan framework informed by indigenous, Chican*, feminist, and queer theories. According to this Anzaldúan framework, students progress nonlinearly through seven phases of critical consciousness: (1) a jolt (for example, a student successfully collaborates and completes a mathematical task with a partner previously perceived as incapable), (2) an in-between space of seeing new perspectives (a student simultaneously holds old and new perceptions of their partner’s capabilities), (3) a period of hopelessness (a
student realizes they need to change their perception of their partner’s capabilities), (4) a call to action (a student makes attempts to position their partner as more mathematically capable), (5) a desire for order (a student explores the perceptions of their partner), (6) a clash of realities (a student develops a broader social perspective and shares their new ideas with others), and (7) spiritual activism (a student recognizes that cooperation and success can result from negotiating conflicting perspectives) (Martinez & Yeong, 2019; Serrano et al., 2019).

Results from the Serrano et al. (2019) study explained how individual students transitioned from one phase to another phase. For example, one student expressed a (4) new desire or a call to action to be a role model for her family and community after reflecting on her own educational experiences and the underrepresentation of Latin* students in higher education. Both the Serrano et al. and the Banda and Flowers (2018) studies highlight the process of critical consciousness development for Latin* students in contexts particularly rife with stereotype threat. As a result, this research contributes a thick description of the experiences of students (i.e., narratives which counter stereotypes, and policy recommendations for social change).

Recent quantitative studies developed and validated five surveys: the Critical Consciousness Scale (Diemer, 2017), the Critical Consciousness Inventory (Thomas et al., 2014), the Contemporary Critical Consciousness Scale (Shin et al., 2016), the Short Critical Consciousness Scale (ShoCCS) (Diemer et al., 2020) and the Short Critical Consciousness Scale (CCS-S) (Rapa et al., 2020). All of these surveys are designed for use with adolescents, an age when students begin to develop personal and civic identities (Godfrey & Grayman, 2014). Based on the theoretical research, these surveys characterize critical consciousness along similar themes of critical reflection, socio-political efficacy, and critical action, thereby increasing the comparability across studies that utilize critical consciousness (Poteat et al., 2020; Watts et al.,
2011). Critical reflection is defined as a student’s recognition that different students experience dissimilar and unequal opportunities to learn. Socio-political efficacy is defined as a student’s motivation and sense of responsibility to work for change. Critical action is defined as a student’s participation in social action groups or protests. Survey results evidenced that students’ critical consciousness explained continua of growth within these three themes. Additionally, survey results indicate that critical reflection precedes development of socio-political efficacy, which, in turn, motivates critical action. Diemer (2017) recommends utilizing a mixed methods study by combining data from quantitative survey results and students’ narratives to provide a more meaningful way to understand Latin* students’ critical consciousness development.

**Critical Consciousness in Mathematics Education**

These same themes of critical reflection, socio-political efficacy, and critical action frame the few empirical studies on students’ critical consciousness related to mathematics education. Researchers utilized interventions that took up specific pedagogical strategies to assess changes in the critical consciousness of students (Gutstein, 2006; Kokka, 2020; Martinez & Yeong, 2019). For example, Kokka (2020) investigated the influence that a social justice mathematics curriculum had on sixth-grade students’ social awareness and empowered action. Students’ narratives evidenced the development of their critical reflection through phrases such as “I used to think, now I think.” Results indicate a substantial increase in awareness of sociopolitical conditions and critical civic empathy within participating mathematics students.

Over a two-year time frame, Gutstein (2006) investigated students’ critical consciousness development in an urban junior high school mathematics class with a social justice focus. This study expanded on the construct that utilized students’ sociopolitical efficacy as consisting of the developments of mathematical competencies, social agency, and positive cultural and social
identities. Through analyses of open-ended surveys, observation notes, textual artifacts from class projects, and dialogue, Gutstein noted growth in students’ sociopolitical efficacy. Findings suggest students participating in mathematics for social justice class may develop mathematical competencies to investigate social inequities, as evidenced by creative methods to solve problems and reinvention of important mathematics. In short, students may develop social agency and strengthen their cultural and social identities by raising questions important to them and using mathematics to investigate these questions.

Martinez and Yeong (2019) also incorporated social justice mathematics tasks into research with preservice teachers. The authors analyzed preservice teachers’ written reflections and transcripts of the class discussion after participation in a collaborative task centered on the wages of men and women in different occupations. The phases of conocimiento framed the coding of the data and revealed students’ dynamic, circular pathways through critical consciousness growth. Findings suggest that through engagement with mathematical tasks centered on issues of social justice, preservice teachers may reach developed stages of critical consciousness, such as spiritual activism or critical action (Diemer, 2017; Serrano et al., 2019).

While few in number, these studies incorporate classroom strategies and interventions targeting the development of individuals’ critical consciousness, with the intent of empowering students. The following section synthesizes the literature on the theme of empowerment within the field of mathematics education.

**Empowerment Through Mathematics Education**

In mathematics education literature, *empowerment*, or the process of personal and political power development for individual growth, is evidenced by improved student achievement, increased student participation, as well as changes in students’ views of
mathematics. While much empowerment theory research was developed in the fields of social work and community organizing (Gutiérrez, 1990; Speer & Peterson, 2000), the following sections include a synthesis of mathematics education research on the theme of student empowerment through mathematics, with subsections of mathematical empowerment, social empowerment, and epistemological empowerment, as defined by Ernest (2002).

**Mathematical Empowerment**

Ernest (2002) uses the term *mathematical empowerment* to denote the establishment of the students’ competencies around their school mathematics skills and practices. A manifestation of these competencies can be evidenced through students’ traditional achievement and success in mathematics classes (Buenrostro, 2016), on high-stakes tests (Mitescu et al., 2011), and increased participation and engagement with opportunities to learn in the mathematics classroom (Dunleavy, 2015).

**Mathematical Empowerment Through Traditional Achievement and Success**

Several studies incorporating reflective and active mathematics classroom practices have highlighted gains for historically underrepresented students, referencing attempts to close achievement gaps and engage with college preparatory mathematics (Buenrostro, 2016; Farber, 2010; Sims, 2016). For example, Farber (2010) documented the efforts of participants in the Young People’s Project to address gaps in students’ mathematical understanding by connecting math literacy workers with young, struggling students. Findings suggest the project’s positive impact on youth mathematical empowerment through students’ gains in mathematical literacy and academic achievement in school. In addition to gains in mathematical literacy, mathematical empowerment is evidenced through students’ achievement in grade-level mathematics courses.
Through critical pedagogical efforts, both Sims (2016) and Buenrostro (2016) highlighted mathematical empowerment as students’ productive and successful engagement with college-preparatory mathematics. Sims specifically cited substantial performance growth on mathematics assessments for students of low socio-economic levels, promoted by participation in a year-long social justice STEM class. Buenrostro’s study contributed counterstories of the academic success of Black and Latin* middle school students, stemming from engagement in an elective math for social justice class. These studies suggest engagement with reflective and active mathematics opportunities can mathematically empower minoritized students as they improve their particular, grade-level skills.

However, studies by Gutstein (2016), Gutierrez (2013), and Johnson (2020) found not all efforts to engage with mathematics for social justice are effective in increasing students’ mathematical empowerment to desired levels. Gutstein declared that not all participants met the study’s middle school mathematical goals and Johnson reported that mathematics assessment results did not provide clear evidence of students’ mathematical growth in an Algebra 1 class. Gutierrez (2013) suggested students fully engaged only in tasks where the mathematical concepts were clearly highlighted within a social justice task. However, students from all these studies described that they felt they developed new mathematical skills and made mathematical progress. These findings suggest that students’ participation in reflective mathematics classes may not effectively improve their mathematical empowerment or that assessment results, as a one-time snapshot, do not fully capture the nuances of students’ mathematical empowerment development.

In contrast, findings of positive academic results from additional studies in reflective mathematics classrooms suggest students’ participation in relevant mathematics tasks may
develop their mathematical empowerment (Kokka, 2019; Leonard et al., 2010; Mitescu et al., 2011, Tanko, 2012). As part of a mathematics class with a social justice curriculum, Mitescu et al. (2011) reported a positive, statistically significant association between the students’ participation with the curriculum and their mathematics achievement on the district unit assessment. Similarly, Leonard et al. (2010) and Tanko (2012) described deep and lasting conceptual understanding of percentages, perimeter and area, and reasoning skills, for student participants. Additionally, Kokka (2019) used passing course grades as evidence of mathematical empowerment for participants but recommended including standardized test results for future studies. With some exception, findings suggest that participation in social justice mathematics curriculum or other reflective classroom practices may improve students’ mathematical empowerment, as evidenced by assessment results and course grades.

Much of the literature focused on developing students’ mathematical empowerment incorporated findings on students’ acquisition of grade-level mathematics skills and practices (Farber, 2010; Sims, 2016; Tanko, 2012). One study suggested participation in reflective practices contributes to improved achievement levels for historically underrepresented groups of students (Buenrostro, 2016). Some studies reported positive but insignificant gains in student achievement (Gutstein, 2016; Johnson, 2020). Another found student participation in these mathematics courses results in positive gains on mathematics assessments (Mitescu et al., 2011).

**Mathematical Empowerment Through Opportunities to Participate**

However, when examining how mathematical empowerment relates to students’ participation, studies tend to focus on students’ participation in classroom activities and discussions. In particular, these studies focused more on the successful and productive behaviors and practices of students in the classroom than on assessment results. Findings tend to explain
both student participation in generating relevant problems for study, as well as student
positioning as mathematical authorities in classroom discussion.

Many studies incorporating mathematics for social justice suggested encouraging
students to voice personal concerns about their own communities and using those concerns to
establish engaging problems for mathematical study (Esmonde, 2014; Lam, 2012; Moreno &
Rutledge, 2018; Wright, 2016). Authors found increased mathematical empowerment as
evidenced by students’ generative themes, by students’ dialogic exploration of these themes, and
by students’ participation in rich mathematical practices of inquiry. Moreno and Rutledge (2018)
highlighted that community college students in a remedial mathematics class constructed
mathematical knowledge and empowerment through explicit conversations about relevant
community issues and mathematical investigation of existing conditions. In addition to increased
engagement in classroom discussion, Andersson (2010) suggested students also choose a
personal mode of communication and assessment as a way to clearly demonstrate their
mathematical understanding of complex situations. Wright (2016) suggested “student agency can
be developed by adopting collaborative, problem-solving approaches to teaching, and
encouraging students to choose which issues to explore and which mathematical procedures to
apply” (p. 114). Findings suggest that as students generate ideas for study, their mathematical
empowerment develops, as evidenced by improved collaborative, mathematical inquiry practices
and clear communication of their mathematical understanding.

Other findings suggest student mathematical empowerment through improved positioning
in classroom discussions and activities, as well as the redefinition of the classroom space into a
collaborative, rather than competitive, environment (Dunleavy, 2015; Harper, 2017; Turner et
al., 2013). Both Dunleavy (2015) and Turner et al. (2013) found student positioning in
mathematically authoritative spaces as crucial in accessing greater opportunities to learn. Harper (2017) reported that in a mathematics classroom with a social justice focus, students begin to challenge “power structures that perpetuate inequity in the classroom” (p. 179). These studies suggest that as students take up authoritative positions in collaborative classroom tasks, their mathematical empowerment improves through engagement with productive mathematical practices. However, these studies seem to assume that all mathematics classroom spaces are established as a place of discourse and collaborative problem-solving.

Given this assumption, several researchers suggested the emphasis should be on creating these collaborative workspaces for students in order to encourage empowered participation in mathematics practices. Solomon et al. (2011) and Tisch (2014) studied student groups at the college level and found the need for support spaces or classrooms which help students engage in productive mathematical discourse and establish authority over their own learning. Specifically, Solomon et al. suggested that specific support centers “provide a context in which all students can take up empowered positions with respect to mathematics” (p. 582). Results of analysis implied that more students may engage in mathematical exploration and dialogue when provided with supportive environments. Echoing these findings, Raygoza (2016) encouraged youth participatory action research within the mathematics classroom in order to redefine “what it means to do mathematics” (p. 143). Outcomes from this study suggest that participation in the scientific inquiry of a research project may enable students to engage with authentic mathematical strategies. Thus, findings indicate that by encouraging students to participate in reform-oriented mathematics classroom tasks, students may develop strategies for mathematical discovery, justification, and discourse, which are successful and productive behaviors of mathematical empowerment. While mathematics empowerment attends to capabilities for
success in school mathematics, social empowerment extends the capabilities to a broader community by highlighting control over educational and employment opportunities and to civic action for social change.

**Social Empowerment**

Ernest (2002) defines *social empowerment* as both the gain in control over academic and professional opportunities and the development of critical, mathematical citizenship. Often the control over educational and employment prospects takes the form of a critical awareness of limited opportunities, barriers, and contradictions based on culture, language, or gender. As part of a mathematics curricula that incorporates reflection, the students’ awareness is coupled with a willingness to engage with those same barriers to advanced coursework, fields of study, and employment opportunity. The following section contains a review of literature with a social empowerment focus, with subsections of empowerment through social awareness and cultural competence and empowerment through civic engagement or social action.

**Empowerment Through Social Awareness and Cultural Competence**

Several mathematics education studies found students developed social empowerment by connecting the relevance of the mathematics that they studied with their own local community cultures (Balasubramanian, 2012; Kokka, 2019; Lam, 2012). For example, when participating in an extra-curricular Social Issues Club, Lam (2012) found that both secondary students and teachers became more socially empowered when they valued the improved connections between mathematically relevant community challenges and collaborative approaches to mathematics problem-solving.

Moreover, in multiple studies, students developed social empowerment when their mathematical investigation revealed evidence of particular lived disadvantages (Buenrostro,
2016; Gutstein, 2016; Pennell, 2016). For example, Pennell (2016) found that students shifted their thinking around social norms in middle school mathematics when exploring social justice tasks designed with a combined critical and queer pedagogical lens. In one particular task, students investigated social media data to question and eventually challenge claims about a professional baseball franchise’s support of lesbian, gay, bisexual, transgender, and queer (LGBTQ+) organizations. Findings suggest that students are socially empowered when they begin to question public claims and social norms.

In addition to engagement, Esmonde (2014) and Balasubramanian (2012) cited the need to connect mathematical learning with sociopolitical content as a means to increase social and cultural awareness of student community life. In particular, Balasubramanian (2012) emphasized the inclusion of politically taboo topics, such as local gentrification, racial profiling, and incarceration rates, in a mathematics class as a way to normalize the discussion of sociopolitical complexities in school mathematics. Upon students’ analysis of incarceration rates and subsequent discussion, students were socially empowered to publicly present their findings at two town meetings. Kokka (2019) reported that student analysis of local housing affordability resulted in an awareness of inequities and suggested students’ proposals for improvement in their community. Similarly, Wright (2016) stated that participation in relevant mathematics tasks enabled “students to gain an appreciation of how mathematics can be used to better understand a situation and to argue for a change” (p. 114). These studies on social empowerment reveal improved social awareness and cultural competence when students participate in mathematics projects relevant to their particular community.

*Empowerment Through Civic Engagement or Social Action*
Several research studies highlight student social empowerment through civic participation. Interestingly, in her study, Johnson (2020) utilized a questionnaire to report the positive degree to which six 9th grade students felt civic responsibility after engaging in a mathematics for social justice algebra course. Other researchers recruited the participating students in the research process through participatory action studies (Farber, 2010; Raygoza, 2016; Unffried & Canner, 2019). Findings from these studies suggest that community service and reflection socially empowered students through an increased awareness of social injustice and the increased capacity to work towards systemic improvements.

Findings also suggest the importance of local, cultural considerations as possible limiting factors to students’ civic engagement (Oh & Kwon, 2014; Tanko, 2012). Specifically, after participation in a social justice mathematics class, Oh and Kwon (2014) described South Korean students’ sense of reserved agency, an increased awareness of local injustice but an unwillingness to cross cultural barriers on public questioning practices. Tanko (2012) reported on the experiences of female college mathematics students in the United Arab Emirates. However, despite the cultural limitations placed on these students, the participants publicly presented results of their mathematical analysis and their recommendations for improvements in student transportation issues. While these two studies reported different results, they evidence the need for consideration of local customs and expectations for the participants when promoting students’ social empowerment development.

Findings focusing on students’ social empowerment after participation in relevant mathematics experiences evidenced an improved awareness and control over opportunities, while also showcasing civic actions by students. In combination, the participation in these experiences resulted in the development of critical mathematics citizenship. As Freire
(1972/1978) predicts, “students, as they are increasingly posed with problems relating to themselves in the world and with the world, will feel increasingly challenged and obliged to respond to that challenge” (p. 70). Along with students’ development of critical citizenship, students often reframe their views about mathematics. Participants in reflective and active mathematics experiences reported changes in their confidence, changes in their perceptions of mathematics, and changes in their sense of control over mathematics knowledge. The following section contains a review of literature detailing these changes in student views, or the sense of epistemological empowerment.

**Epistemological Empowerment**

Ernest (2002) defines *epistemological empowerment* as a growth in confidence when applying mathematics, a view of the mathematics field as dynamic and creative, and a personal assuredness in validating mathematical knowledge. Researchers of mathematics education document students’ epistemological empowerment in each of these areas.

**Empowerment Through Confident Mathematics Application**

Epistemological empowerment explained an improved sense of student confidence or perceptions of their own mathematical abilities. While Tisch (2014) noted a class dependence on explicit teacher presentation of information, through collaborative work on relevant projects, students developed an increased view of their own math abilities. Gutierrez (2013), Johnson (2020), and Sims (2016) reported an increase in students’ confidence when enrolled in mathematics programs with a social justice focus. Through mathematical modeling of global issues and tasks that involved finances, Baron (2015) and Schell-Straub (2013) found improved student confidence and increasingly positive views of the utility of mathematics. These studies
all found that productive mathematical engagement with important issues were followed by increases in students’ mathematical confidence and positive mathematics attitudes.

**Empowerment Through Changing Views of Mathematics and Mathematical Knowledge**

Studies reporting on student perceptions of mathematics presented mixed results, hinting that deeply entrenched students’ views from previous classroom experiences impacted these perceptions (Brantlinger, 2013; Unfried & Canner, 2019; Wright, 2016). For example, in Brantlinger’s (2013) study, students’ prior enrollment in traditional classrooms affected their ability to change their perceptions of mathematics while enrolled in a remedial social justice-focused geometry class; students explained that the reform-oriented mathematics they were currently learning was not real mathematics. Some studies reported that students began to view mathematics as a human-developed field, affected by individual contribution, after students participated in mathematics classes centered on investigation of social issues (Brelia, 2014; Kokka, 2019; Lam, 2012; Moreno & Rutledge, 2018; Wright, 2016). Additionally, Braathe and Solomon (2015) reported that despite students’ anxiety and cultural reservations, they made intentional choices to engage with mathematics. In many cases, the improved connection of mathematics to relevant issues led to students’ epistemological empowerment as evidenced by changing perceptions of the field of mathematics.

**Summary**

In this literature review, I presented a theoretical and conceptual framework to outline proposed relationships between students’ identity construction, critical consciousness, and empowerment. In summary, research evidences the importance of recognizing and developing intersections of different types of student identity. With efforts to bolster students’ disciplinary identities, cultural, language, and gender identities, and academic identities, students develop
self-awareness, strengthen their participation in mathematical practices and classroom discussions, and establish a sense of belonging in the mathematical field and the classroom community. These efforts are particularly beneficial to minoritized students, such as Emergent Bilinguals. Studies that incorporate students’ critical consciousness provide a mechanism to investigate students’ progression from identity construction to social, mathematical, and epistemological empowerment. Findings suggest that as students participate in reflective and active mathematics education, they may develop a more abstract view of knowledge which enables further critical inquiry in future mathematics experiences (Pennell, 2016). Further, research centering on student empowerment provides evidence that reflective practices connect students more closely to their own communities and community issues, and improve traditional academic achievement, social awareness, engagement, and attitudes towards mathematics. The current study investigated the empowering impacts of these reflective practices through a values affirmation intervention in secondary mathematics classes.
CHAPTER III

METHODS

The purpose of this study was to better understand the varying impacts of educators’ attention to identity construction as tenth grade Emergent Bilinguals and native English-speaking students develop mathematical, social, and epistemological empowerment in a mathematics classroom. To meet this purpose, I used a transformative mixed methods research design, with quantitative and qualitative data collected concurrently (Creswell & Plano-Clark, 2018; Mertens, 2009). A transformative mixed methods research design aims to pinpoint and challenge social issues in collaboration with all stakeholders. Given the socio-cultural aspects of this study and critical theoretical lens, this research design was best suited to provide insight when evoking social change in mathematics education. The following chapter describes the methods that were used in this study, including the research design, sampling and site selection, data sources and instruments, data collection procedures, and analysis.

Research Design

Researchers utilizing a transformative mixed methods research design seek to highlight the views and positions of historically underrepresented groups and work to positively impact communities (Creswell & Plano-Clark, 2018). A transformative mixed methods design fulfills the transformative design need “to integrate community perspectives into the inquiry process” (Mertens, 2009, p. 165). For this study, this meant that the cooperating school Latin* family liaison and non-participating Emergent Bilingual students assisted in improving instrument design, intervention implementation, data collection and analysis.
Additionally, the constructs of the study, student identity, critical consciousness, and empowerment, are situated in the particular experiences of high school mathematics students, and which are complex and multifaceted, requiring a research design that examines “real-life context understandings, multilevel perspectives, and cultural influences” (University of Southern California, 2020). A transformative mixed methods research design also allowed my attention to the complexity of these constructs, both giving “voice to participants” and reporting “statistical trends” in data evidencing high school students’ identity, critical consciousness, and empowerment data (Creswell & Poth, 2018, p.72). For this study, I sought to elicit both quantitative survey results and qualitative responses from all participants, but particularly from Emergent Bilingual students. By integrating the quantitative and qualitative data, I was able to gain a more complete understanding of students’ development of identity, critical consciousness, and empowerment, and to provide an opportunity to create storylines challenging stereotypes that are often framed with low student achievement.

The conceptual framework informed the design of the study, incorporating a values affirmation intervention intended to bolster students’ identities. The affirmation intervention also provided students an opportunity for critical reflection, a phase in the development of critical consciousness. I examined aspects of students’ critical consciousness as mediators between their identity construction and their mathematical, social, and epistemological empowerment. As outlined in Table 3.1, the study included both quantitative and qualitative data collection and analysis. The table presents each research question with the associated instruments, data sources, and analysis.
### Table 3.1

**A Summary of the Research Design.**

<table>
<thead>
<tr>
<th>Research Question</th>
<th>Instrument/Data Source</th>
<th>Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ#1: When controlling for language identity and gender identities, to what degree does a values affirmation intervention predict students’ mathematical, social, and epistemological empowerment?</td>
<td>Short Critical Consciousness Scale ShoCCS (Diemer et al., 2020)</td>
<td>Hierarchical linear and Poisson regression, controlling for language identity and gender identity</td>
</tr>
<tr>
<td>a. How do varying levels of intervention implementation influence this prediction?</td>
<td>Common departmental mathematics quiz scores</td>
<td></td>
</tr>
<tr>
<td>RQ#2: Following a values affirmation intervention, how do the perceptions of students with differing language and gender identities relate to their mathematical, social, and epistemological empowerment?</td>
<td>Social, Mathematical, and Epistemological Empowerment Survey</td>
<td>A priori codes from ShoCCS (Diemer et al., 2020) and Ernest (2002)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>In vivo coding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pattern coding</td>
</tr>
<tr>
<td>RQ#3: Following a values affirmation intervention, how do students’ mathematical, social, and epistemological empowerment profiles differ between outcome measures and personal survey responses?</td>
<td>ShoCCS, MAPS, Mathematics quiz scores, Social and Mathematical Empowerment Survey</td>
<td>Comparison and synthesis of qualitative themes with quantitative scores to create empowerment profiles for select participants.</td>
</tr>
<tr>
<td>a. How do differences in empowerment profiles relate to differences in language and gender identities?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. How do differences in empowerment profiles relate to phases of critical consciousness development?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Therefore, to best respond to the research questions, this transformative mixed methods research design included both quantitative and qualitative data analysis, as well as an integrated analysis to build a richer understanding of the constructs and to evaluate the effectiveness of the measures (Creswell & Poth, 2018). In particular, this transformative mixed methods research design took up a multiple-baseline approach to better allow for inferences on the efficacy of the values affirmation intervention (Johnson & Christensen, 2017).

**Participant Sampling, Roles, Setting, and Intervention Activities**

To best inform this study’s findings about student empowerment in this context, I purposefully sampled the selected school population by recruiting approximately 180 tenth-grade students enrolled in one of five regular non-honors Integrated Mathematics II classes taught by the same teacher/researcher (Creswell & Poth, 2018). All students enrolled in these classes ranged in age (14-17 years old) and included a subset of this population who have been identified as exhibiting low English language World-Class Instructional Design and Assessment levels (WIDA levels 1 and 2). While rarely utilized to investigate students’ mathematics attitudes and achievements, research incorporating measures of critical consciousness focus on students in this age range because these individuals are beginning to develop social awareness and civic identities (Godfrey & Grayman, 2014; Thomas et al., 2014). I obtained school district approval to recruit these students for the study (see Appendix J). Recruitment efforts resulted in 81 participants.

I invited all enrolled tenth-grade students who met the aforementioned criteria to participate and provided additional support for students identified as Emergent Bilinguals to access the study (Mertens, 2009). Following previous school registration protocols, students identified as Emergent Bilinguals were enrolled in the teacher/researcher’s class sections. I
provided incentives for all returning consent forms to assure that all parents received and read the study opportunities. The data custodian randomly assigned participants of both subsets to the control and treatment groups based on the order of consent form return.

In addition to the participants, there were three main roles undertaken in this study: the teacher/researcher, the school’s Latin* family liaison, and the data custodian. I managed the study as the teacher/researcher, preparing materials, conducting intervention activities and daily lessons quizzes, analyzing data, and interpreting results. The Latin* family liaison, a school employee charged with establishing connections between the school and Spanish-speaking families, collaborated with the teacher/researcher to assist with document and response translation, provided information to and requested permission from parents, and generally encouraged participation of Emergent Bilingual students. The data custodian, Dr. MacDonald, managed the IRB consent process through the dissemination, collection, and storage of consent materials. The data custodian also assisted the teacher/researcher in establishing the data sample for analysis (explained in the following paragraph).

The study was set in five tenth-grade non-honors Integrated Mathematics II classes located in a rural, western U.S. high school with reported demographics of 23% as economically disadvantaged, 6% as English Learners (primarily native Spanish speakers), and 78.5% as Caucasian. In keeping with the transformative paradigm, this study sought to include a “broad range of people who are generally excluded from mainstream society” (Mertens, 2009, p.14). To meet this aim, I worked with the data custodian to recruit a sample population that mirrors the overall population of the school, placing particular emphasis on the inclusion of Emergent Bilinguals in the study. As explained earlier, the data custodian attended to the number of
participants enrolled in each of the control and treatment groups by randomly assigning students in the order the consent forms return.

Participants of the study included 81 students from five sections of an Integrated Mathematics II course with the same teacher. Most students (84%) reported English as the home language, while 16% reported Spanish as the home language. The sample included 46 individuals who identified as male, 34 students who identified as female, and 1 student who identified as nonbinary.

The materials used in this study included three online intervention activities for the VA Groups and three Control Group activities. These varying activities differed by intent and mode of expression. For example, the intervention activities for the VA Groups intended to elicit students’ reflection on the importance of personal values in their lives through various modes of expression, while the activities for the C Group did not intend to connect personal values to students’ own lived experiences. To improve student access, all intervention activities displayed an English language, Spanish language, and braille option. Samples of these activities can be found in Appendices A through F, and were originally designed by Cohen et al. (2006) and adapted by Rapa et al. (2020). As shown in Appendix A, the first VA intervention activity contained a list of nine values, two writing prompts and four survey items for students to select and describe their three most important values. Each writing prompt was followed by a text entry box with no maximum character limit. The secondary VA intervention activity contained a list of nine values and a prompt for students to create and/or select a personal photograph for each of the three most important values (Appendix B). The third VA intervention activity contained a list of nine values and a prompt for students to create a personal video to select and orally describe the three most important values (Appendix C). The second and third VA intervention activities
were amended to include a poem option for a visually impaired student that could not access photographs.

As designed by Cohen et al. (2006), the activities for the C Group were similar to the first VA group intervention activity but were not designed to elicit students’ reflection on the importance of personal values in their lives. The first activity contained the same list of nine values. As displayed in Appendix D, the activity included two writings prompts and four survey items for students to select and describe the three least important values. A text entry box with no maximum character limit followed each writing prompt. The second C intervention activity contained a list of nine values and a prompt for students to select a non-personal photograph for each of the three least important values (Appendix E). The third C intervention activity contained a list of nine values and a prompt for students to select and orally describe the least important value (Appendix F). The control activities were specifically designed to restrict students from connecting with personal strengths and values.

**Data Sources and Instruments**

To examine students’ social empowerment, mathematical empowerment, and epistemological empowerment, this study used three quantitative data sources: The Short Critical Consciousness Scale (ShoCCS) (Diemer et al., 2020), daily mathematics content quizzes centered on specific learning targets, and the Mathematics Attitudes and Perceptions Survey (MAPS) (Code et al., 2016). Additionally, each mathematics content quiz contained one qualitative reflection question. To further examine these same empowerment constructs with qualitative sources, this study included the Social, Mathematical, and Epistemological Empowerment Survey.
The Short Critical Consciousness Scale

The first quantitative instrument used to assess student social empowerment was the ShoCCS (Diemer et al., 2020) (see Appendix G). The scale consisted of 13 items, distributed among three subscales measuring critical reflection, critical motivation, and critical action. Each item measured one of these subscales with a six-point Likert scale. Diemer et al. investigated the internal consistency of this streamlined scale using an Item Response Theory analytic approach and reported reliability measures > 0.7 for all subscales. When analyzing data from the ShoCCS, I kept the three subscales distinct, so that the sub-scores for each subconstruct remained distinct (Diemer et al.). Additionally, the subscales strongly correlated with the previously validated Critical Consciousness Scale (CCS) (Diemer et al., 2017) (0.93≤r≤ 0.98), as evidenced by “similar theta coverage and reliable information patterns between the ShoCCS and the CCS” (Diemer et al., 2020).

Common Mathematics Content Quizzes

A second quantitative instrument, a daily lesson quiz, was used to assess aspects of mathematical empowerment. To more comprehensively examine students’ mathematical empowerment, I utilized 15 common departmental quizzes, each with four items (see a sample quiz in Appendix H). Each lesson quiz assessed one specific learning target for the term (outlined in Appendix I), based on specific state standards for the course. Teachers specified the 15 learning target proficiency levels to be evidenced when students correctly answered three questions. An example of a quiz item is a problem that asks students to draw from their understanding of parallelogram properties to set up and solve an algebraic equation (see Figure 3.1). Additionally, each quiz contained one reflection question for students to express how well they understand the learning target.
Figure 3.1

A Sample Common Mathematics Content Quiz Item

![Parallelogram ABCD with equations](image)

Parallelogram ABCD is shown above.
AB = 8x + 3
BC = 4x + 4
CD = 3x + 5
Find x.
Round your answer to the nearest hundredth.

The Mathematics Attitudes and Perceptions Survey

The third quantitative instrument to assess epistemological empowerment was the Mathematics Attitudes and Perceptions Survey (MAPS) (Code et al., 2016) (see Appendix J). The scale consisted of 31 items with a five-point Likert scale, distributed among seven subscales measuring confidence, persistence, growth mindset, interest, views of mathematics, sense-making, and the nature of answers. Through statistical analyses grounded in the literature, Code et al. present these subscales to be “representative of the large set of epistemological beliefs, perceptions, and attitudes known to affect students’ academic outcomes in mathematics” (p. 932). Findings report a Cronbach’s alpha value of 0.87, indicating strong internal consistency.

The Social, Mathematical, and Epistemological Empowerment Survey

The Social, Mathematical, and Epistemological Empowerment Survey is a qualitative survey developed by this researcher and designed to assess the three empowerment subconstructs, social, mathematical, and epistemological (see Appendix K). I created and piloted the survey questions to elicit participant insight on the characteristics of the ShoCCS subsets.
(Diemer et al., 2020) and the three types of empowerment described by Ernest (2002). The pilot project did not include any current study participants. Responses to these piloted survey questions provided personal narratives of students’ developing sense of empowerment in the mathematics classroom, with detail and description far more specific than what was provided from the quantitative survey responses. Additionally, at times, these responses did not align with quantitative results. The survey contained three open-ended questions, prompting participants to reflect on their opportunities (Esmonde, 2014), mathematical progress (Gutstein, 2006; Sims, 2016), attitudes towards and perceptions of mathematics (Kokka, 2019; Moreno & Rutledge, 2018), and social contributions (Diemer et al., 2020; Rapa et al., 2020).

Given the purpose of this study, both the pilot project and the current study only considered these survey outcomes of social, mathematical, and epistemological empowerment, rather than students’ personal reflections on their identities. In short, the purpose of the current study was to evaluate the influences of a values affirmation on student empowerment. It was beyond the scope of this study to consider what students were doing in the values affirmation intervention activities.

Data Collection Procedures

The study included six months of preparatory work, translating materials and instruments and developing strategies to encourage participation. The data collection procedures spanned a nine-week term of the fall academic year. In particular, the data collection of the investigation contained three phases: the recruitment phase, the intervention activities phase, and the follow-up surveys phase. In the intervention activities phase, I utilized a multiple-baseline design, with VA intervention activities staggered throughout the term. I chose this time period (see Figure 3.2)
because previous values affirmation studies typically use this time period (Harackiewicz et al., 2014; Rapa et al., 2020).

**Figure 3.2**

*Study Timeline*

<table>
<thead>
<tr>
<th>Study Phases</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation Phase</td>
<td></td>
</tr>
<tr>
<td>6 Months Prior to Study</td>
<td>Translate intervention materials and surveys</td>
</tr>
<tr>
<td></td>
<td>Develop strategies to encourage participation of at least 30 students per course section.</td>
</tr>
<tr>
<td>Recruitment Phase</td>
<td></td>
</tr>
<tr>
<td>3 Weeks Prior to Study</td>
<td>Email/Disseminate consent forms to parents/assent forms to students</td>
</tr>
<tr>
<td></td>
<td>Random, sequential assignment of participants to C, VA1, VA2, VA3, and VA4 groups</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Intervention Activities Phase</td>
<td>C Group</td>
</tr>
<tr>
<td>Week 1</td>
<td>1st control activity</td>
</tr>
<tr>
<td>Week 2</td>
<td>Regular class instruction continues with daily quiz administration</td>
</tr>
<tr>
<td>Week 3</td>
<td>2nd control activity</td>
</tr>
<tr>
<td>Week 4</td>
<td>Regular class instruction continues with daily quiz administration</td>
</tr>
<tr>
<td>Week 5</td>
<td></td>
</tr>
<tr>
<td>Week 6</td>
<td>3rd control activity</td>
</tr>
<tr>
<td>Week 7</td>
<td>Regular class instruction continues with daily quiz administration</td>
</tr>
<tr>
<td>Week 8</td>
<td></td>
</tr>
<tr>
<td>Follow-Up Surveys Phase</td>
<td>Surveys: ShoCCS, MAPS, Social, Mathematical, and Epistemological Empowerment Survey</td>
</tr>
<tr>
<td>Week 9</td>
<td>Collect content quiz scores</td>
</tr>
</tbody>
</table>
Preparation and Recruitment Phases

Prior to the study’s onset, I garnered school district consent to conduct the investigation (see Appendix J). Upon receipt of this approval, I began meeting with the school’s Latin* family liaison to produce usable and valid translations of the intervention materials and study instruments. Additionally, we continued to generate strategies to communicate the study’s purpose to parents of Emergent Bilinguals and to encourage participation in the study.

The data custodian emailed a link for the informed consent document and sent a paper copy to parents of students in these course sections three weeks prior to the study’s onset. Consent documents were stored in Qualtrics and managed by the data custodian. In class, the data custodian presented students with an assent form, which was stored in Qualtrics and managed by the data custodian.

Also prior to the study’s onset, the data custodian randomly assigned participants to either a control group (C) or a Values Affirmation treatment group (VA1, VA2, VA3, and VA4) in the sequential order of received consent forms. Balance was maintained across these five conditions by sequentially but separately assigning Emergent Bilinguals and native English speakers to these groups. Students without consent were assigned to VA1, VA2, VA3, and VA4 groups to provide structure for the classroom activities. I did not utilize data from non-participants in this study.

Intervention Activities Phase

The intervention activity phase began when the teacher explained how to complete the first exercise in the project and directed participants to the assignment on the Canvas learning platform. Many students then completed the online intervention activity. Those in the treatment groups completed the first VA intervention activity (see Appendix A), while those in the control
group completed the C Group intervention activity (see Appendix D). Each exercise was approximately 10 minutes in duration, with responses collected via the Canvas learning platform.

During each of the next 12 class sections, many students completed one online mathematics content quiz. Students completed each quiz after a ten-minute warm-up activity at the start of the class. The researcher recorded proficiency scores on the Canvas learning platform each day.

At the start of week 3 of the term, students in VA2 and VA3 Groups completed the 2nd VA intervention activity (see Appendix B), and students in the C and VA1 Groups completed the 2nd control activity (see Appendix E). To control for learning effects, students in the VA4 Group completed the 3rd VA intervention activity (see Appendix C). Each of these exercises was approximately 10 minutes in duration, with responses collected through the Canvas learning platform. Students completed these activities during class time or, alternatively, outside of school.

At the start of week 6 of the term, students in the VA3 Group completed the 3rd VA intervention activity, students in the VA4 Group completed the 2nd VA intervention activity, and students in the C, VA1, and VA2 Groups completed the 3rd control activity (see Appendix F). As before, these exercises were each approximately 10 minutes in duration, with responses collected through the Canvas learning platform. Students completed these activities during class time or outside of school.

**Follow-up Surveys Phase**

At the end of the term, in week 9, the teacher/researcher invited students to participate in a study activity. The teacher explained how to complete the ShoCCS survey (Diemer et al., 2020), the MAPS survey (Code et al., 2016) and The Social, Mathematical, and Epistemological...
Empowerment Survey and directed participants to the surveys on the Canvas learning platform. Many students then completed the ShoCCS, MAPS and the Social, Mathematical, and Epistemic Empowerment survey online, in class. The students’ completion of these surveys was approximately 20 minutes in duration, with responses collected through the Canvas learning platform. I did not utilize data of non-participating students in this study.

Additionally, at this point in the study, I collected all mathematics content quiz scores and reflection data for the mathematics class sessions.

**Data Analysis**

After data collection, I analyzed data in three stages: quantitative data analysis, qualitative data analysis, and integrated data analysis, in alignment with the three research questions. Each set of analyses incorporated data on the social, mathematical, and epistemological empowerment constructs. Additionally, each set of student responses from the surveys and mathematical content quizzes received an assigned number, to remove identifying characteristics from the data segment. The following sections outline the analytic methods in each stage.

**Quantitative Data Analysis**

To answer the first research question, I evaluated the degree of impact of a values affirmation intervention on students’ empowerment via quantitative data analysis. To begin, I organized the data by uploading the quantitative data on social, mathematical, and epistemological empowerment, including participant information, ShoCCS response, MAPS responses, and mathematics content quiz scores into SPSS. I categorized mathematics content quiz data as mathematical empowerment data, with higher quiz scores as evidence of stronger mathematical empowerment. I categorized ShoCCS responses as social empowerment data, with
higher scores of critical reflection, critical motivation, and critical action indicating higher levels of social empowerment. I categorized MAPS responses as epistemological empowerment data, with higher scores along seven characteristics as evidence of stronger epistemological empowerment.

To identify errors in the data, I ran a frequency distribution on each variable and ensured responses fell within the range of each instrument’s design (Empire State College, 2020). I did not encounter an error. I incorporated listwise deletion, maintaining missing data but omitting missing values from computation.

For each set of empowerment data, analytic procedures were similar. I created and reported basic descriptive statistics to explain each set of data. Controlling for language identity and gender identity, I performed hierarchical linear regression and Poisson regression analyses to assess the degree to which the values affirmation intervention predicted social, mathematical, or epistemological empowerment and, if possible, to determine whether the intervention positively impacted Emergent Bilinguals. Hierarchical linear regression is a useful model to describe the relationship between two or more predictor variables, such as intervention level and language identity, and outcome variables, such as mathematical empowerment (Field, 2018; Johnson & Christensen, 2017). This type of regression also allows for evaluation of incremental changes in outcome variation, with different levels of predictor variables. I incorporated intervention level as the primary predictor variable in the models, with language and gender identities as secondary predictor variables. Regression also helps to mitigate issues associated with unbalanced groups. In particular, Emergent Bilingual students accounted for approximately 10% of each treatment group. While controlling for language identity, I did not achieve the same level of precision in comparison as would be possible with equally balanced groups. However, by identifying
language identity as a control variable, I still gained useful comparison information. Similar to the analysis in Salles et al. (2016) and Schnabel et al. (2013), regression of quiz scores, ShoCCS scores, and MAPS scores from the VA and C Groups explained intervention effects on students’ empowerment outcomes. Prior to this analysis, I tested assumptions of linearity between independent and dependent variables, normality of variables using the Kolmogorov-Smirnov Test, multicollinearity of the independent variables, and homoscedasticity (https://www.statisticssolutions.com/assumptions-of-linear-regression/).

**Qualitative Data Analysis**

To answer the second research question, I measured the perceptions of students with differing language and gender identities via qualitative analysis of empowerment data. Utilizing an a priori coding scheme stemming from the review of relevant literature (Miles et al., 2014), I followed a four-step process to analyze participant responses from the qualitative sources.

In the first step, I highlighted sentiments, attitudes, and statements that evidenced characteristics of critical consciousness in connection with the ShoCCS. A priori codes in this phase included critical reflection, critical motivation, and critical action (Diemer et al., 2020). Critical reflection, defined as the recognition of unequal opportunities for all students, may have been evidenced by students’ phrases such as in the general example, “I might be limited in a few things because I am a girl”. Critical motivation, defined as the feeling of responsibility to become involved and work for change, may have been evidenced by students’ phrases such as in the general example, “I know I should speak up when I see something unfair”. Critical action, defined as participation in social or political change, may have been evidenced by students’ stories of participation in social-action groups or protests.
In the second step, I highlighted sentiments, attitudes, and statements that evidenced characteristics of mathematical empowerment in connection with Ernest’s (2002) theory. A priori codes in this phase included improved participation and academic success (Buenrostro, 2016; Dunleavy, 2015; Moreno & Rutledge, 2018). Improved participation, defined as engagement with relevant mathematics tasks and improved classroom positioning, may have been evidenced in such students’ responses as “I think I have something to add to my group math work and I think my group members listen to what I have to say”. Academic success, defined as achievement in grade-level mathematics classes and on standardized mathematics tests, may have been demonstrated in students’ responses, such as “I aced the quizzes and the unit test this time”.

In the third step, I highlighted attitudes and perceptions that evidenced epistemological empowerment. A priori codes in this phase included confidence in mathematics application and positive views of mathematics (Gutierrez, 2013; Kokka, 2019; Sims, 2016). Confidence in mathematics application, defined as improved perception of personal capabilities, may have been evidenced by such students’ responses as “I feel like I can handle difficult problems now, or at least know how to start”. Positive views of mathematics, defined as an opinion of mathematics as dynamic and relevant, may have been evidenced by students’ responses, such as “Math is something I can use to understand my life more clearly”.

In the fourth step, I utilized in vivo coding, similar to my previous examples, to particularly honor participants’ voices in describing empowerment (Miles et al., 2014). From the responses with a priori coding, I selected specific phrases that evidenced the characteristics of social, mathematical, and epistemological empowerment, thereby highlighting the personal narratives of students’ experiences. To follow, I employed pattern coding to elicit more general
empowerment themes from the coded survey data (Miles et al.). In particular, I identified themes from phrases or codes that were repeated in the responses of a particular identity group.

**Integrated Data Analysis**

To answer research question three, centering on differences between quantitative outcome measures and qualitative survey data, I utilized integrated data analysis in two phases: comparing themes and creating empowerment profiles. The purpose of the integrated analysis in this transformative mixed methods design was to merge the quantitative and qualitative aspects of the study, expanding understanding of empowerment constructs through interpretation of confirming or disconfirming results (Creswell & Plano-Clark, 2018; Mertens, 2009). For this integrated data analysis, I incorporated both the quantitative patterns and qualitative themes from the separate data sets. In particular, the analysis included a comparison of individual qualitative themes with the relative scores from the ShoCCS and MAPS surveys, and mathematical content quizzes.

A final tool of integrated analysis was the creation of empowerment profiles for five participants, two Emergent Bilinguals, two native English speakers, and one gender nonbinary student. In particular, I constructed profiles for one Emergent Bilingual and one native English speaker whose quantitative and qualitative outcomes aligned, and one Emergent Bilingual and one native English speaker whose quantitative and qualitative outcomes did not align. Additionally, I constructed a profile for a gender nonbinary student to highlight the unique empowerment experiences of students with this gender identity. These profiles merged quantitative results with responses from the Social, Mathematical, and Empowerment Survey and intervention activities. I framed these profiles using the conceptual framework as a guide, illustrating student identities, critical consciousness characteristics, and empowerment
constructs. The purpose in creating these profiles was to highlight emerging and differing patterns in the empowerment data, the specific characteristics which may have contributed to these themes, and the need for multiple measures. In keeping with a transformative design, the integrated analysis provided opportunity for Emergent Bilinguals to tell their counterstories of empowerment (Mertens, 2009).
CHAPTER IV

RESULTS

In this study, I investigated students’ experiences of empowerment with participation in values affirmation interventions, mediated by their critical consciousness development. Specifically, I measured outcomes of students’ mathematical, social, and epistemological empowerment, dependent on intervention treatment level, language identity, and gender identity. As part of this measurement, I examined students’ critical reflection, critical motivation, and critical action, all facets of critical consciousness. The results that follow are presented in three major sections, according to research question. The first section presents quantitative results by discussing differences in empowerment between the three different values affirmation (VA) Groups and the control (C) Group. These results stem from analysis of the quiz totals, the Short Critical Consciousness Survey (ShoCCS) responses, and the Mathematics Attitudes and Perceptions Survey (MAPS) responses. Additionally, I report variances in these results according to home language identity and gender identity. The second section provides qualitative results, wherein thematic findings on empowerment in the Social, Mathematical, and Epistemological Empowerment Survey responses are discussed. To identify subtle differences in perceptions of student experiences of empowerment, I further categorize these themes by home language and gender identities. The third section presents a comparison of quantitative results and qualitative themes, deconstructed by home language and gender identities. Further, I describe student characteristics, evidenced in five empowerment profiles, two with convergent results, two with divergent results, and one of the unique results of a gender nonbinary student.
Results of Quantitative Analysis of Empowerment Data

The first research question asked: *When controlling for language identity and gender identity, to what degree does a values affirmation intervention predict students’ mathematical, social, and epistemological empowerment? How do varying levels of implementation influence this prediction?* I attempted to incorporate different variables into the statistical models to illuminate and control for the experiences of participants with various identities. For statistical models of mathematical empowerment, I used completed treatment levels, gender identity, and language identity as independent variables and summed quiz totals as a dependent variable. I utilized completed treatment levels, gender identity, and language identity as independent variables and critical reflection, critical motivation, and critical action scores as dependent variables for statistical models of social empowerment. For models of epistemological empowerment, I used completed treatment levels, gender identity, and language identity as independent variables and MAPS scores as a dependent variable.

To highlight the experiences of empowerment of Emergent Bilingual students, I collected data from participants exhibiting emergent English language levels, as measured by World-Class Instructional Design and Assessment levels (WIDA levels 1 and 2). However, the number of these participants with WIDA levels 1 and 2 was limited to two. I alternatively utilized home language data as a method of coding language identity. With this alternative language identity coding, the data set contained 13 participant responses coded as Spanish home language and 68 coded as English home language.

I also collected data on the number of absences from mathematics class to measure students’ willingness to participate in classroom mathematical practices. However, because of the Covid-19 pandemic, absences were not indicative of students’ willingness to participate in
classroom mathematics activities. Therefore, I determined students’ participation in classroom practices would be better measured through proficiency on the daily mathematics quizzes which could be taken in the classroom or virtually.

The data custodian assigned all participants to one of five treatment groups: C, VA1, VA2, VA3, and VA4. Throughout the nine weeks of the study, the participants completed varying numbers of allocated values affirmation interventions. Increased student absences negatively impacted the completion rate of the intervention activities, prompting a reorganization of treatment types. While all interventions were available online, many students remained absent virtually, as well. As such, I utilized the number of completed interventions as a Completed Treatment Level code and reassigned participants to one of four groups: C, VA1, VA2, and VA3, based on those codes. These final four treatment groups were balanced with approximately 20 participants in each; 3 students with identified Spanish home language in each of the treatment groups.

Statistical analysis revealed some significant differences in mathematical, social, and epistemological empowerment between VA and C Groups. Results of hierarchical linear regression and Poisson regression included a statistically significant predictive model for one aspect of social empowerment, critical motivation. These findings will be delineated by how these different types of empowerment were explained in relation to completed treatment levels, gender identity, and language identity.

**Mathematical Empowerment Findings**

I measured mathematical empowerment through the summation of quiz scores data. As a measure of both traditional academic achievement and participation in classroom practices, the sum of quiz scores data provided a gauge of participants’ mathematical empowerment. The
highest quiz score per individual quiz was 20 points. I listwise deleted five outliers from the data set to prevent the mean from being skewed. These data, from four students with female gender and Spanish language identities and one student with male gender and English language identities, were at least two standard deviations below the mean. The mean summed quiz score for the remaining sample (N=76) was 228 with standard deviation of 47.

To first assess whether participation in a values affirmation intervention predicted students’ mathematical empowerment, I compared the means of summed quiz scores of students in the control group with those of students in all treatment groups. Figure 4.1 displays the comparison of the means of summed quiz scores of C and VA Groups for both English home language and Spanish home language students. The means of summed quiz scores of students in VA groups were greater than the means of summed quiz scores of students in the C group, for both English home language and Spanish home language students, indicating a higher level of mathematics empowerment. The means of summed quiz scores for English home language students were higher than those for Spanish home language students, regardless of participation in interventions. These findings, while displaying similar trends in higher summed quiz scores with treatment, highlight a potential difference in student experiences of mathematical empowerment corresponding to differences in home language identity.
Figure 4.1

Means of Summed Quiz Scores of C and VA Groups for English and Spanish Home Language Students

Note: Maximum summed quiz score=300; English home language N=17 C Group, N=50 VA Groups; Spanish home language N=1 C Group, N=8 VA Groups

To examine the details of the patterns of these findings more and to assess the influence of varying levels of treatment, Table 4.1 presents the descriptive statistics for summed quiz scores, evidencing mathematical empowerment. I display the means of summed quiz scores and standard deviations for the C Group and each of the VA Groups, disaggregated by home language and gender. Specifically, Table 4.1 exhibits the variation in means of summed quiz scores with increased treatment levels for English home language and Spanish home language students. This table also presents the variation in means of summed quiz scores with increased treatment levels for students of male, female, and nonbinary gender identities. For comparison,
Table 4.1 displays the overall means of summed quiz totals for participants in the C Group and each VA Group.

**Table 4.1**

*Means of Summed Quiz Scores and Standard Deviations of C and VA Student Groups*

<table>
<thead>
<tr>
<th>Means of Summed Quiz Scores</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>English Home Language</td>
<td>218(48)</td>
</tr>
<tr>
<td>Spanish Home Language</td>
<td>191(*)</td>
</tr>
<tr>
<td>Male</td>
<td>206(42)</td>
</tr>
<tr>
<td>Female</td>
<td>223(51)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>225(*)</td>
</tr>
<tr>
<td>Overall Mean (SD)</td>
<td>216(47)</td>
</tr>
</tbody>
</table>

*Note: N = 18 C Group, N = 20 VA1, N = 19 VA2, N = 19 VA3; *No standard deviation for N=1*

As presented in Table 4.1, I uncovered minor differences between the group means for the summed quiz scores data. With one exception (VA1 Spanish home language), means of summed quiz scores were higher for the treatment groups, as compared with those of the control, suggesting a positive influence on the mathematics empowerment of participation in values affirmation interventions. Additionally, increased treatment levels corresponded to higher summed quiz scores for students of different male and female gender identities. However, increased treatment levels did not necessarily correspond to higher summed quiz scores for
students of different language identities. Interestingly, the mean of summed quiz scores for English home language students in the VA2 group was lower than the mean of summed quiz scores for English home language students in the VA1 and VA3 groups. The mean of summed quiz scores for Spanish home language students in the VA3 group was lower than the mean of summed quiz scores for Spanish home language students in the VA2 group. To further investigate these differences in group means with increased treatment levels, I incorporated additional analysis of summed quiz scores data.

I used hierarchical linear regression analysis to test if the completed treatment levels significantly predicted participant’s summed quiz scores, controlling for home language and gender identities. Results were not significant and indicated that the completed treatment levels only explained 6.4% of the variance in summed quiz scores ($R^2=.064$, $F(3,72)=1.636$, $p=.189$) and predicted all students’ summed quiz scores ($\beta=0.217$, $p=.069$). Further, even though the model was insignificant, it described lower summed quiz scores for those in the Spanish home language group as compared with those in the English home language group ($\beta=-.158$, $p=.177$), suggesting lower mathematics empowerment. The model also detailed higher summed quiz scores for participants identifying as female or non-binary as compared with those identifying as male ($\beta=.059$, $p=.617$), suggesting greater mathematics empowerment for these students. While not statistically significant, findings from the regression analysis align with the observed differences in group mean quiz totals data.

**Social Empowerment Findings**

I analyzed social empowerment data from the ShoCCS responses along three subconstructs of critical consciousness: critical reflection, critical motivation, and critical action. Results of these analyses are presented in the following subsections.
Critical Reflection Findings

The mean critical reflection score was 13.3 out of a possible 24, with standard deviation of 5.5. The 81 complete participant data were included in analysis. To first assess whether participation in a values affirmation intervention could predict this aspect of students’ social empowerment, I compared mean critical reflection scores of students in the control group with those of students in all treatment groups. Further, Figure 4.2 displays the comparison of mean critical reflection scores of C and VA Groups for both English home language and Spanish home language students. The mean critical reflection score of students in VA groups was lower than the mean critical reflection score of students in the C group for English home language students, suggesting a corresponding lower level of social awareness. The mean critical reflection score of Spanish home language students in VA groups was slightly higher than the mean critical reflection score of those in the C group, suggesting a higher level of social awareness for these students. These results highlight a potential difference in student experiences of critical reflection corresponding to differences in home language identity.
Figure 4.2

Mean Critical Reflection Scores of C and VA Groups for English and Spanish Home Language Students

Note: Maximum critical reflection score=24; English home language N=17 C Group, N=51 VA Groups; Spanish home language N=3 C Group, N=10 VA Groups

To further detail the influence of varying levels of treatment, Table 4.2 presents the descriptive statistics for critical reflection, a subcomponent of social empowerment. I display the critical reflection scores and standard deviations for the C Group and each of the VA Groups, disaggregated by home language and gender. Specifically, Table 4.2 exhibits the variation in mean critical reflection scores with increased treatment levels for English home language and Spanish home language students. This table also presents the variation in mean critical reflection scores with increased treatment levels for students of male, female, and nonbinary gender.
identities. For comparison, Table 4.1 displays the overall mean critical reflection scores for participants in the C Group and each VA Group.

**Table 4.2**

*Mean Critical Reflection Scores and Standard Deviations from ShoCCS of C and VA Student Groups*

<table>
<thead>
<tr>
<th>Mean Critical Reflection Scores</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>English Home Language</td>
<td>15(5.8)</td>
</tr>
<tr>
<td>Spanish Home Language</td>
<td>11.7(5.5)</td>
</tr>
<tr>
<td>Male</td>
<td>12.3(5.4)</td>
</tr>
<tr>
<td>Female</td>
<td>15.7(5.7)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>9(*)</td>
</tr>
<tr>
<td>Overall Mean (SD)</td>
<td>14.5(5.7)</td>
</tr>
</tbody>
</table>

*Note:* N = 20 C Group, N = 21 VA1, N = 20 VA2, N = 20 VA3; *No standard deviation for N=1

Table 4.2 presents minor differences between the group means for critical reflection data. For female students, the mean critical reflection scores for those in the treatment groups were lower than the control group mean. However, for female students increased treatment level did not correspond with lowered critical reflection scores. For example, critical reflection scores of female students in the VA2 group were higher than critical reflection scores of female students in the VA1 group, suggesting higher levels of social awareness. All other groups displayed mixed
results in critical reflection data with increased treatment levels. For male students and for English home language students, the VA1 and VA3 groups displayed lower mean critical reflection scores than the means of the control groups, while the VA2 group means were greater than those of the control groups. It is interesting to note that this second level of intervention corresponded with higher levels of social awareness for some students. For Spanish home language students, the VA1 and VA2 groups displayed higher mean critical reflection scores than the mean of the control group, suggesting greater social awareness. The critical reflection score for the gender nonbinary student was lower than any group mean score, indicating a lower level of social awareness. To further investigate these differences in group means, I incorporated additional analysis of critical reflection data.

I used hierarchical linear regression analysis to test if the completed treatment levels significantly predicted participant’s critical reflection score, controlling for home language and gender identities. Results were not significant and indicated that completed treatment levels only explain 4.3% of the variance in critical reflection scores ($R^2=.043$, $F(1,77)=1.165$, $p=.328$). The model was an insufficient predictor of all participant’s critical reflection scores.

**Critical Motivation Findings**

The mean critical motivation score was 17.4 with standard deviation of 4.6. I listwise deleted three outliers from the data set to prevent the mean from being skewed. These data, from two students with male gender and English language identities and one student with female gender and English language identities, were at least two standard deviations below the mean. The mean critical motivation score for the remaining sample ($N=78$) was 17.8 with standard deviation of 4.1.
To first assess whether participation in a values affirmation intervention could predict this aspect of students’ social empowerment, I compared mean critical motivation scores of students in the control group with those of students in all treatment groups. Figure 4.3 displays the comparison of mean critical motivation scores of C and VA Groups for both English home language and Spanish home language students. The mean critical motivation scores of students in VA groups were lower than the mean critical motivation scores of students in the C group, for both English home language and Spanish home language students, suggesting less motivation to challenge social inequities. Mean critical motivation scores for Spanish home language students were higher than those for English home language students, regardless of participation in interventions, corresponding to a greater willingness to engage with social barriers. These results, while displaying similar negative relations between treatment and critical motivation scores, highlight a potential difference in student experiences of critical motivation corresponding to differences in home language identity.
**Figure 4.3**

*Mean Critical Motivation Scores of C and VA Groups for English and Spanish Home Language Students*

![Bar chart showing mean critical motivation scores for C and VA groups for English and Spanish home language students.]

*Note:* Maximum critical motivation score = 24; English home language N = 17 C Group, N = 49 VA Groups; Spanish home language N = 3 C Group, N = 9 VA Groups

To further detail the influence of varying levels of treatment, Table 4.3 presents the descriptive statistics for critical motivation, a subcomponent of social empowerment. I display the mean critical motivation scores and standard deviations for the C Group and each of the VA Groups, disaggregated by home language and gender. Specifically, Table 4.3 exhibits the variation in mean critical motivation scores with increased treatment levels for English home language and Spanish home language students. This table also presents the variation in mean critical motivation scores with increased treatment levels for students of male, female, and
nonbinary gender identities. For comparison, Table 4.3 displays the overall mean critical motivation scores for participants in the C Group and each VA Group.

Table 4.3

*Mean Critical Motivation Scores and Standard Deviations from ShoCCS of C and VA Student Groups*

<table>
<thead>
<tr>
<th>Mean Critical Motivation Scores</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>English Home Language</td>
<td>18.6(4.2)</td>
</tr>
<tr>
<td>Spanish Home Language</td>
<td>19.7(1.5)</td>
</tr>
<tr>
<td>Male</td>
<td>17.3(4.2)</td>
</tr>
<tr>
<td>Female</td>
<td>19.5(3.7)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>19(*)</td>
</tr>
<tr>
<td>Overall Mean (SD)</td>
<td>18.8(3.9)</td>
</tr>
</tbody>
</table>

*Note: N = 20 C Group, N = 21 VA1, N = 20 VA2, N = 20 VA3; *No standard deviation for N=1

As presented in Table 4.3, I uncovered minor differences between the group means for the critical motivation scores. Groups displayed mixed results in critical motivation scores with increased treatment levels. For students in both language groups, VA1 and VA3 group means were lower than those of the control groups, corresponding to lower motivation levels. Critical motivation mean scores for male students in VA1 and VA3 groups were also lower than the control group mean score. Interesting to note is for the second level of intervention, mean critical
motivation scores were higher than those of the control groups, highlighting a greater willingness to challenge social inequalities. To further investigate these differences in group means, I incorporated additional analysis of critical motivation data.

I used hierarchical linear regression analysis to test if the completed treatment levels significantly predicted participants’ critical motivation scores, controlling for home language and gender identities. The results of the regression indicated that the predictors explained 11.7% of the variance in critical motivation score ($R^2=0.116$, $F(3,74)=3.224$, $p=0.027$). The model highlighted gender as the significant predictor of all students’ critical motivation scores ($\beta=0.276$, $p=0.016$), emphasizing higher critical motivation scores for female or non-binary students regardless of participation in values affirmation interventions or home language identity. These results indicate a greater willingness to engage with and challenge social barriers. Further, the model detailed insignificantly higher critical motivation scores for Spanish home language students ($\beta=0.150$, $p=0.175$) and insignificantly lower critical motivation scores for all students with increased treatment levels ($\beta=-0.075$, $p=0.509$). Findings from the regression analysis align with the observed differences in group mean critical motivation data.

**Critical Action Findings**

The mean critical action score was 7.8 with standard deviation of 4.2. I listwise deleted two outliers from the data set to prevent the mean from being skewed. These data, from two students with male gender and English language identities, were at least two standard deviations above the mean. The mean critical action score for the remaining sample (N=79) was 7.4 with standard deviation of 3.4.

To first assess whether participation in a values affirmation intervention could predict this aspect of students’ social empowerment, I compared mean critical action scores of students in
the control group with those of students in all treatment groups. Figure 4.4 displays the comparison of mean critical action scores of C and VA Groups for both English home language and Spanish home language students. The mean critical action score of students in VA groups was higher than the mean critical action score of students in the C group for English home language students, corresponding with more participation in social action events. The mean critical action score of Spanish home language students in VA groups was lower than the mean critical action score of those in the C group, suggesting less participation in social action activities. Students of both language identity groups displayed mean critical action scores far below the maximum possible score of 30, with little variation, suggesting little participation in events to work for social change. While displaying similarly low critical action scores, these results do highlight a potential difference in student experiences of critical action corresponding to differences in home language identity.
**Figure 4.4**

*Mean Critical Action Scores of C and VA Groups for English and Spanish Home Language Students*

Note: Maximum critical action score=30; English home language N=17 C Group, N=50 VA Groups; Spanish home language N=3 C Group, N=9 VA Groups

To further detail the influence of varying levels of treatment, Table 4.4 presents the descriptive statistics for critical action, a subcomponent of social empowerment. I display the critical action scores and standard deviations for the C Group and each of the VA Groups, disaggregated by home language and gender. Specifically, Table 4.4 exhibits the variation in mean critical action scores with increased treatment levels for English home language and Spanish home language students. This table also presents the variation in mean critical action scores with increased treatment levels for students of male, female, and nonbinary gender.
identities. For comparison, Table 4.4 displays the overall mean critical action scores for participants in the C Group and each VA Group.

Table 4.4

*Mean Critical Action Scores and Standard Deviations from ShoCCS of C and VA Student Groups*

<table>
<thead>
<tr>
<th>Mean Critical Action Scores</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>English Home Language</td>
<td>7.4(2.9)</td>
</tr>
<tr>
<td>Spanish Home Language</td>
<td>7.7(3.8)</td>
</tr>
<tr>
<td>Male</td>
<td>7.6(2.8)</td>
</tr>
<tr>
<td>Female</td>
<td>7.4(3.2)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td>19(*)</td>
</tr>
<tr>
<td>Overall Mean (SD)</td>
<td>7.5(3.0)</td>
</tr>
</tbody>
</table>

*Note: N = 20 C Group, N = 21 VA1, N = 20 VA2, N = 20 VA3; *No standard deviation for N=1*

Table 4.4 presents minor differences between the group means for critical action. Groups displayed mixed results in critical action scores with increased treatment levels. For students in the English home language group, VA1 and VA3 groups displayed higher mean scores than the mean of the control group, corresponding with some participation in social action events. For Spanish home language students, VA1 and VA2 group means were lower than the control group mean, suggesting little participation in social action activities. The critical action score for the
nonbinary student was far greater than any group mean, corresponding to more participation in events for social change. For male students, VA2 and VA3 group means were lower than the control group mean, suggesting low participation in social action events. For female students, VA1 and VA2 group means were lower than the control group mean, evidencing low participation in social change activities. To further investigate these differences in group means, I incorporated additional analysis of critical motivation data.

As displayed in Figure 4.5, critical action data were skewed. With corrective action of logarithmic, square root, and inverse data transformations and outlier removal, the critical action data still did not meet assumptions of normality (see Appendix M). I encountered no missing critical action data. Because of the skewed shape of the distribution, I used Poisson regression to test if the completed treatment levels significantly predicted participants’ critical action scores, controlling for home language and gender identities (Hox et al., 2018). Tests of model effects indicated insignificant relations between gender (p=.549), home language (p=.342), and treatment level (p=.435) variables and critical action scores. As such, the model was an insufficient predictor of participants’ critical action scores.
Epistemological Empowerment Findings

I measured epistemological empowerment through the Mathematics Attitudes and Perceptions Survey (MAPS) scores. The mean MAPS score was 2.8 with standard deviation of 4.3. I removed two outliers from the data set to prevent the mean from being skewed. These data, from two students with female gender and English language identities, were at least two standard deviations above the mean. The mean MAPS score for the remaining sample (N=79) was 2.3 with standard deviation of 2.9.

To first assess whether participation in a values affirmation intervention could predict students’ epistemological empowerment, I compared mean MAPS scores of students in the control group with those of students in all treatment groups. Figure 4.6 displays the comparison of mean MAPS scores of C and VA Groups for both English home language and Spanish home language students. The mean MAPS score of students in VA groups was lower than the mean
MAPS score of students in the C group for English home language students, corresponding with less confidence and less positive attitudes towards mathematics. The mean MAPS score of Spanish home language students in VA groups was the same as the mean MAPS score of those in the C group, suggesting no difference in confidence or attitudes with treatment. Students of both language identity groups displayed mean MAPS scores far below the maximum possible score of 28, with little variation, corresponding with low confidence and less positive perceptions of mathematics. Despite displaying similarly low MAPS scores, these results highlight a potential difference in student experiences of epistemological empowerment corresponding to differences in home language identity.

**Figure 4.6**

*Mean MAPS Scores of C and VA Groups for English and Spanish Home Language Students*

![Bar chart showing MAPS scores for English and Spanish home language students in C and VA groups.](chart.png)

*Note:* Maximum MAPS score=28; English home language N=16 C Group, N=50 VA Groups; Spanish home language N=3 C Group, N=10 VA Groups
To further detail the influence of varying levels of treatment, Table 4.5 presents the descriptive statistics for epistemological empowerment. I display the MAPS scores and standard deviations for the C Group and each of the VA Groups, disaggregated by home language and gender. Specifically, Table 4.5 exhibits the variation in mean MAPS scores with increased treatment levels for English home language and Spanish home language students. This table also presents the variation in mean MAPS scores with increased treatment levels for students of male, female, and nonbinary gender identities. For comparison, Table 4.5 displays the overall mean MAPS scores for participants in the C Group and each VA Group.

Table 4.5

Mean MAPS scores and Standard Deviations of C and VA Student Groups

<table>
<thead>
<tr>
<th>MAPS Scores</th>
<th>Treatment Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>English Home Language</td>
<td>2.4(2.2)</td>
</tr>
<tr>
<td>Spanish Home Language</td>
<td>3.0(3.5)</td>
</tr>
<tr>
<td>Male</td>
<td>2.4(2.3)</td>
</tr>
<tr>
<td>Female</td>
<td>2.5(2.5)</td>
</tr>
<tr>
<td>Nonbinary</td>
<td></td>
</tr>
<tr>
<td>Overall Mean (SD)</td>
<td>2.5(2.3)</td>
</tr>
</tbody>
</table>

*Note: N = 20 C Group, N = 21 VA1, N = 20 VA2, N = 20 VA3; *No standard deviation for N=1

As presented in Table 4.5, I uncovered minor differences between the group means for the MAPS scores. Groups displayed mixed results in MAPS scores with increased treatment
levels. For students in the English home language group, VA1 and VA2 groups displayed lower mean scores than the mean of the control group, while the VA3 group displayed greater confidence and positive attitudes. For Spanish home language students, VA1 and VA2 groups displayed higher mean scores than the mean of the control group, corresponding with higher levels of confidence and more positive perceptions of mathematics. VA2 and VA3 groups of male students displayed equal or lower mean scores than that of the control group, suggesting lower confidence and less positive attitudes. For female students, VA1 and VA2 groups displayed lower mean scores than that of the control group, while the VA3 group displayed greater confidence and more positive perceptions towards mathematics. The MAPS score for the gender nonbinary student was lower than any group mean except the Spanish home language VA3 group, suggesting low confidence and less positive attitudes towards mathematics. To further investigate these differences in group means, I incorporated additional analysis of MAPS data.

As displayed in Figure 4.7, MAPS data were skewed. With corrective action of logarithmic, square root, and inverse data transformations and outlier removal, the MAPS data still did not meet assumptions of normality (see Appendix N). I encountered no missing MAPS data. Because of the shape of the distribution, I used Poisson regression to test if the completed treatment levels significantly predicted participants’ MAPS scores, controlling for home language and gender identities. Tests of model effects indicated insignificant relations between gender (p=.373), home language (p=.084), and treatment level (p=.997) variables and MAPS scores. As such, the model was an insufficient predictor of participant’s critical action scores.
Quantitative analysis of empowerment data revealed differences in students’ mathematical, social, and epistemological scores with participation in values affirmation interventions. Model results of hierarchical linear regression incorporating completed treatment levels, gender, and home language variables significantly explained the variance in critical motivation scores. However, for outcomes of summed quiz scores, critical reflection scores, critical action scores, and MAPS scores, findings were insignificant, perhaps due to the small sample size. Observed differences in group means were rendered insignificant with the introduction of increased parameters to each regression model. This result suggests that the small sample skewed the data sets, preventing the models from having enough power to explain the complex relationships between variables.
Results of Qualitative Analysis of Empowerment Data

The second research question asked: Following a values affirmation intervention, how do perceptions of students with differing language and gender identities relate to their mathematical, social, and epistemological empowerment? Analysis of the Social, Mathematical, and Epistemological Empowerment Survey data revealed differences in perceptions of empowerment for students with different home language and gender identities. I present results of this analysis in the following subsections of Social Empowerment Data, Mathematical Empowerment Data, and Epistemological Empowerment Data.

Social Empowerment Findings

In stage one, I coded student responses according to characteristics of critical consciousness, including critical reflection, critical motivation, and critical action. I coded student responses in two categories of critical reflection: recognition of unequal opportunities or lack of recognition of unequal opportunities. Because the empowerment survey did not contain questions specifically targeting students’ willingness to challenge social inequalities or participate in social action events, I coded no student responses evidencing critical motivation or critical action. I then selected exemplary phrases that represented the majority of responses in each home language group. Further, I investigated themes that emerged in all responses evidencing recognition of social inequality. I also categorized student responses evidencing critical reflection by gender.

English home language students expressed recognition of social limitations in response to the prompt Do you have the same opportunities as others? Some participants recognized financial limitations, as evidenced in the response, “I do, and maybe even better chances because of … my financial status (which isn’t fair at all)”. Others expressed awareness of limitations due
to gender, such as in the response, “since i am a female some chances for me may be more
difficult than for a white male”. Several English home language students recognized limitations
due to disabilities, as evidenced in the response, “I would say that there are some limitations for
people like me who have disabilities”. Other students expressed awareness of social or racial
inequalities, such as in the response, “I can understand how a student from a minority group
could face oppression in the school”. English home langue students expressed recognition of
social inequality along themes of finances, gender, disability, race, and social status.

Spanish home language students shared recognition of financial barriers and additionally
acknowledged limitations in the educational system. In response to the same prompt Do you
have the same opportunities as others?, a Spanish home language student expressed awareness
of financial limitations by stating, “No because club can cost a lot of money and some people
might not have that money”. Other students recognized limitations to educational opportunity,
such as in the response, “no, because in some classes you need some requirements”. Spanish
home language students expressed recognition of social inequality along themes of finances and
education.

Table 4.6 presents social empowerment findings from the survey responses, separated by
home language identity and treatment groups. The table shows the percentage of student
responses coded as recognition of unequal opportunity and an exemplary quote representing the
group majority. I applied a blue color to the table cells with a majority of student responses
coded as recognition of unequal opportunity (percentages greater than 50%) and an orange color
to the cells with a majority of responses coded as lack of recognition of unequal opportunity
(percentages less than 50%).
Table 4.6

Findings on Social Empowerment

<table>
<thead>
<tr>
<th>Social Empowerment</th>
<th>English Home Language</th>
<th>Spanish Home Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical Reflection</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Do you have the same opportunities as others?</em></td>
<td>59%</td>
<td>33%</td>
</tr>
<tr>
<td>“Yes, I have great opportunities but I understand others don’t.”</td>
<td>“yes i do”</td>
<td></td>
</tr>
<tr>
<td>VA Groups</td>
<td>25%</td>
<td>30%</td>
</tr>
<tr>
<td>“[Y]es we all have the same opportunities”</td>
<td>“[I] do feel as if i have the same opportunities as everyone else”</td>
<td></td>
</tr>
</tbody>
</table>

As displayed in Table 4.6, English home language students in VA Groups presented fewer perceptions of social inequality than those in the C Group. Spanish home language students shared a similar number of perceptions of unequal opportunity in both the C and VA Groups. Most students in the English home language C Group responded in recognition of social inequality. A similar, low percentage of English home language and Spanish home language students in the VA Groups shared comments recognizing social inequality, as evidenced in the exemplary quotes.

Additionally, analysis of qualitative social empowerment data revealed that the proportion of student’s perceptions of social inequality varied with gender identity and participation in values affirmation interventions. Responses of critical reflection from male students in the treatment groups (25%) were similar to the proportion of responses in the control group (29%). Responses evidencing social awareness from female students in treatment groups (29%), however, were far fewer than those in the control group (69%). This data suggests variation in social empowerment based on differences in gender identity.
Mathematical Empowerment Findings

In stage two, I coded student responses according to characteristics of mathematical empowerment, including evidence of academic success and valued participation in mathematics class. I coded sentiments of academic success as opinions of improvement or opinions of lack of improvement. I coded sentiments of valued participation as feelings that one’s voice matters or feelings that one’s voice does not matter. I then selected exemplary phrases representing the majority of responses in each home language group. I also categorized student responses evidencing mathematical empowerment by gender.

Many English home language students shared perceptions of mathematical empowerment through sentiments of success in mathematics class. For example, one student stated, “I think I am making improvements”. Additionally, some English home language students expressed mathematical empowerment through sentiments of valued participation in mathematics class. Evidencing this theme, a student responded, “I think I'm still valued and understood in the classroom”.

Similarly, many Spanish home language students shared perceptions of success in mathematics class. For example, a student stated, “Yes, i believe i am improving”. Many Spanish home language students expressed mathematical empowerment through opinions of valued participation in mathematics class, as evidenced in the response, “I think my voice definitely matters”. Spanish and English home language students shared perceptions of success and feelings that their voice matters in mathematics class.

Table 4.7 presents mathematical empowerment thematic findings from the survey responses, separated by home language identity. The table shows the mathematical empowerment theme, the percentage of responses evidencing opinions of improvement or
feelings that voice matters, and an exemplary quote for the majority of each C and VA Groups. I applied a blue color to the table cells with a majority of student responses coded as opinions of improvement or feelings that voice matters (percentages greater than 50%) and an orange color to the cells with a majority of responses coded as lacking opinions of improvement or feelings that voice matters (percentages less than 50%).

Table 4.7

*Thematic Findings on Mathematical Empowerment in English and Spanish Home Language Groups*

<table>
<thead>
<tr>
<th>Mathematical Empowerment</th>
<th>English Home Language</th>
<th>Spanish Home Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Success in Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Group</td>
<td>71%</td>
<td>67%</td>
</tr>
<tr>
<td>“[I] feel that i am making improvements in math and that class is helping me.”</td>
<td>“[S]iento que sigo igual que siempre aveces entiendo y aveces no (I feel like I'm still the same as always sometimes I understand and sometimes I don’t).”</td>
<td></td>
</tr>
<tr>
<td>VA Groups</td>
<td>86%</td>
<td>60% (71% with 2+ VAs)</td>
</tr>
<tr>
<td>“I feel like i am excelling.”</td>
<td>“I think I am improving and understanding.”</td>
<td></td>
</tr>
<tr>
<td>My Voice Matters in Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Group</td>
<td>53%</td>
<td>0%</td>
</tr>
<tr>
<td>“Yeah, my voice matters. Even if other people don't think my opinion matters, I say it anyways.”</td>
<td>“[N]o i feel like my voice isnt mattered in my class.”</td>
<td></td>
</tr>
<tr>
<td>V Groups</td>
<td>45%</td>
<td>70%</td>
</tr>
<tr>
<td>“Yes I feel comfortable and feel like I matter.”</td>
<td>“[Y]es, because our opinion is important.”</td>
<td></td>
</tr>
</tbody>
</table>
As displayed in the table, a greater percentage of English home language students shared perceptions of success in the mathematics classroom, as compared with Spanish home language students. Similar statements of improvement in mathematics class were shared by those in the English home language control group and the Spanish home language intervention groups. As compared with those in the control group, Spanish home language students in the intervention groups presented more perceptions of mathematical empowerment through valued participation in class. Approximately half of all English home language students shared perceptions of mathematical empowerment through valued participation, regardless of treatment group.

Further analysis of the data revealed differences in perceptions mathematical empowerment for students in different gender identity groups. All students, regardless of gender identity, shared responses evidencing success in the mathematics classroom. However, students in male gender identity treatment groups shared fewer responses of valued class participation (45%) than those in the control group (57%). Conversely, students in female gender identity treatment groups shared more responses of valued class participation (52%) than those in the control group. This data suggests variation in mathematical empowerment based on differences in gender identity.

**Epistemic Empowerment Findings**

In stage three, I coded student responses according to characteristics of epistemic empowerment, including confidence in mathematics application and positive views of mathematics. I coded sentiments of confidence as self-assurance or lack of self-assurance. One participant out of the total shared personal views of mathematics. I coded this response as a positive perception of the field of mathematics. I then selected exemplary phrases representing the majority of responses in each home language group. Further, I identified patterns that
emerged in those participant responses coded as evidencing self-assurance. I also categorized student responses evidencing epistemological empowerment by gender.

English home language students expressed epistemological empowerment along two themes, confidence in mathematical understanding and positive views of mathematics. Some students expressed self-assurance in their mathematical application, such as in the response, “I’ve understood mostly everything and felt pretty confident about it”. Additionally, one student expressed positive views of the field of mathematics in the response, “In math if you can do difficult problems you can do lots of stuff in life”.

Spanish home language students expressed epistemological empowerment distinct from the responses of English home language students. In survey response, Spanish home language students expressed a conditional confidence in mathematical understanding. For example, one student stated, “I can participate and be successful if I put the effort into it”. Another student responded, “I think that if I put in enough effort I will be able to understand more”. Spanish home language students expressed epistemological empowerment as conditional on personal effort.

A greater percentage of English home language students shared perceptions of self-assurance in the mathematics classroom (59% C Group, 55% VA Groups), as compared with Spanish home language students (0% C Group, 40% VA Group). Approximately half of English home language students presented similar perceptions of epistemological empowerment, regardless of treatment level. As compared with those in the control group, Spanish home language students in the intervention groups presented more perceptions of epistemological empowerment through confidence in mathematics.
Additionally, analysis of qualitative data revealed that the proportion of student’s perceptions of epistemological empowerment varied with gender identity and participation in values affirmation interventions. Responses evidencing self-assurance from male students in the treatment groups (40%) were similar to the proportion of responses in the control group (43%). Responses evidencing self-assurance from female students in treatment groups (71%), however, were far greater than those in the control group (54%). This data suggests variation in epistemological empowerment based on differences in gender identity.

**Results of Integrated Analysis of Empowerment Data**

The third research question asked: *How do students’ empowerment profiles differ between outcome measures and personal survey responses? How do profile differences relate to differences in language and gender identities? How do profile differences relate to phases of critical consciousness development?* Integrated analysis of quantitative results with qualitative themes of empowerment revealed a mixture of convergence and divergence.

Findings from quantitative analysis of empowerment data include influence of a values affirmation on students’ empowerment with differences attributed to language and gender identities. As a measure of mathematical empowerment, students’ summed quiz scores were higher for all student groups with increased treatment level. Students in the English home language group displayed higher summed quiz scores than those in the Spanish home language group. Female and non-binary students displayed higher summed quiz scores than male students. As a measure of social empowerment, critical reflection, critical motivation, and critical action scores provided indication of mixed influences of participation in values affirmation interventions. I detected significant differences in critical motivation scores associated with differences in gender identity. Similarly, analysis of MAPS data indicated mixed epistemological
empowerment results influenced by values affirmation interventions. I uncovered differences in MAPS scores associated with differences in language identity.

Qualitative data revealed themes of social empowerment, mathematical empowerment, and epistemological empowerment with differences corresponding to differences in home language and gender identities. Student responses evidenced social empowerment through themes in recognition of social inequalities, such as limitations due to finances, gender, disability, education, race, and social status. Student responses also evidenced mathematical empowerment through sentiments of improvement and valued participation in mathematics class. Additionally, student survey responses evidenced epistemological empowerment through confidence in mathematics application and positive views of mathematics.

Within the conceptual framework, I created five empowerment profiles to highlight patterns of convergence and divergence. Two empowerment profiles display characteristics of those from each home language group with convergent quantitative and qualitative outcomes. Two other empowerment profiles display characteristics of those from each home language group with divergent quantitative and qualitative outcomes. One empowerment profile displays characteristics of a gender nonbinary student. I present these findings in subsections of Convergent Results, Divergent Results, and Empowerment Profiles.

**Convergent Results**

Table 4.8 presents results with convergent quantitative findings and qualitative patterns in mathematical, social, and epistemological empowerment data, separated by home language and gender identities.
Table 4.8

*Convergent Quantitative Results and Qualitative Patterns*

<table>
<thead>
<tr>
<th>Empowerment Type</th>
<th>Quantitative Results</th>
<th>Qualitative Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematical Empowerment</strong></td>
<td>Higher summed quiz scores with increased treatments ($R^2=.064$, $F(3,72)=1.636$, $p=.189$); completed treatment level predicted students’ summed quiz scores ($\beta=.217$, $p=.069$) for all identity groups.</td>
<td>More perceptions of success in class with increased treatment level for all language and gender identity groups. More perceptions of valued participation with increased treatment level for Spanish home language groups. More perceptions of valued participation with treatment for female gender groups.</td>
</tr>
<tr>
<td><strong>Social Empowerment</strong></td>
<td>Mixed results of critical reflection scores with increased treatment level for all identity groups</td>
<td>No change in perceptions of social inequality with increased treatment for Spanish language groups. No change in perceptions of social inequality with increased treatment for male gender groups.</td>
</tr>
<tr>
<td><strong>Epistemological Empowerment</strong></td>
<td>Mixed results with increased treatment level for English home language students</td>
<td>No change in perceptions of epistemological empowerment for English home language groups.</td>
</tr>
<tr>
<td></td>
<td>Higher MAPS score with increased treatment level for Spanish home language students (not significant)</td>
<td>More perceptions of epistemological empowerment with increased treatment level for Spanish home language groups.</td>
</tr>
<tr>
<td></td>
<td>Mixed results with increased treatment level for all gender identity groups</td>
<td>No change in perceptions of epistemological empowerment for male gender groups.</td>
</tr>
</tbody>
</table>

As shown in Table 4.8, increased treatment levels resulted in greater evidence of mathematical empowerment. Higher mathematics summed quiz scores corresponded with qualitative themes of academic success for students of both home language identity groups.
Consistent with academic measures of achievement, students of the Spanish home language group also shared perceptions of valued participation in mathematics class. Similarly, students of female gender groups shared increased perceptions of valued participation in class. Student perceptions added nuanced description of the mathematical empowerment development based on language and gender identities. These results suggest quantitative measures alone are insufficient to capture themes of mathematical empowerment that students of different identities experience.

Table 4.8 also presents convergent findings in social empowerment data. Varied quantitative critical reflection scores resulted from participation in values affirmation interventions. In correspondence, shared perceptions of social awareness were inconclusive for Spanish home language groups and male gender groups. This data suggests complex influences of the intervention on students’ social empowerment. Additionally, the results imply that students are in early, but changeable stages of critical consciousness development.

Table 4.8 also presents convergent quantitative results and qualitative patterns in epistemological empowerment data. Varied quantitative evidence of epistemological empowerment followed increased treatment for English home language students. In correspondence, unchanged perceptions of self-assurance in qualitative data from English home language students suggested little influence of the values affirmation intervention. Increased treatment levels resulted in increased MAPS scores for Spanish home language students with a corresponding increase in perceptions of self-assurance. This data suggests that the values affirmation intervention influences students’ epistemological empowerment different for students of different language identities.
Divergent Results

Table 4.9 presents results divergent quantitative results and qualitative patterns in empowerment data, separated by home language and gender identities.

Table 4.9

*Divergent Quantitative Results and Qualitative Patterns*

<table>
<thead>
<tr>
<th>Empowerment Type</th>
<th>Quantitative Results</th>
<th>Qualitative Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mathematical Empowerment</td>
<td>Higher summed quiz scores with increased treatments</td>
<td>Fewer perceptions of valued participation with increased treatment level for English home language groups</td>
</tr>
<tr>
<td></td>
<td>Spanish home language (lower quiz scores)</td>
<td>Fewer perceptions of valued participation with increased treatments for male gender groups</td>
</tr>
<tr>
<td>Social Empowerment</td>
<td>Mixed results of critical reflection scores with increased treatments for all identity groups</td>
<td>Fewer perceptions of social inequality with increased treatments for English home language students</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fewer perceptions of social inequality with increased treatments for female gender groups</td>
</tr>
<tr>
<td>Epistemological Empowerment</td>
<td>Mixed results with increased treatment level for all gender identity groups; Low MAPS scores</td>
<td>More perceptions of epistemological empowerment for Spanish language groups</td>
</tr>
<tr>
<td></td>
<td></td>
<td>More perceptions of epistemological empowerment for female gender groups</td>
</tr>
</tbody>
</table>

As shown in the table, quantitative results and qualitative findings diverged on aspects of mathematical, social, and epistemological empowerment. English home language students and students in male gender groups shared fewer perceptions of valued participation in mathematics class with increased treatment level, despite academic success evidenced through increased summed quiz scores. Inconsistent social empowerment levels, evidenced through increased
critical reflection scores did not align with some qualitative findings. English home language students and students in female gender groups presented decreased perceptions of social inequality with increased treatment levels. Mixed results and low MAPS scores for gender identity groups did not align with a consistent increase in perceptions of epistemological empowerment for those in female gender treatment groups.

This data again suggests the need for multiple measures to understand students’ varied experiences of empowerment in the mathematics classroom. In particular, traditional measures of mathematical empowerment appear to undervalue Spanish home language students’ valued participation in class. Similarly, quantitative measures of epistemological empowerment seem to underreport female students’ and Spanish home language students’ confidence in mathematics application.

**Empowerment Profiles**

The following empowerment profiles display typical characteristics of students from each home language identity group with convergent or divergent quantitative and qualitative outcomes. The table also displays the characteristics of a gender nonbinary student. Table 4.10 presents the characteristics for each of the five profiles (A-E), quantitative measurements of critical consciousness, and mean values for quantitative measurements. Profile A displays characteristics of an English home language student with convergent findings. Profile B displays characteristics of a Spanish home language student with convergent findings. Profile C displays characteristics of an English home language student with divergent findings. Profile D displays characteristics of a Spanish home language student with divergent findings. Profile E displays the characteristics of one particular gender nonbinary student, distinct from the characteristics and themes that emerged from other identity groups.
Table 4.10

*Characteristics of Empowerment Profiles*

<table>
<thead>
<tr>
<th>Alignment</th>
<th>Home Language</th>
<th>Gender</th>
<th>Absence</th>
<th>Transience</th>
<th>Critical Reflection</th>
<th>Critical Motivation</th>
<th>Critical Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Convergent</td>
<td>English</td>
<td>Male</td>
<td>No</td>
<td>16</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>Convergent</td>
<td>Spanish</td>
<td>Female</td>
<td>Yes</td>
<td>9</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>C</td>
<td>Divergent</td>
<td>English</td>
<td>Female</td>
<td>Yes</td>
<td>20</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>D</td>
<td>Divergent</td>
<td>Spanish</td>
<td>Male</td>
<td>No</td>
<td>4</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>N/A</td>
<td>English</td>
<td>Nonbinary</td>
<td>Yes</td>
<td>24</td>
<td>19</td>
<td>7</td>
</tr>
</tbody>
</table>

| Mean Values | 2.7          | 13.3    | 17.7    | 7.4        |

*Note:* Profile E displays the characteristics of a gender nonbinary student, distinct from the characteristics and emergent themes of other identity groups.

As displayed in the table, profiles for English home language and Spanish home language contain opposite gender and transiency characteristics for convergence and divergence. The convergent profile with English home language identity presents a male gender identity with no transiency, while the convergent profile with Spanish home language identity presents a female gender identity with transiency. In particular, transiency describes at least one change in school districts over the last four school years. The divergent profile with English home language identity presents a female gender identity with transiency, while the divergent profile with Spanish home language identity presents a male gender with no transiency. The profile with nonbinary gender identity presents low absence (1 absence) but transiency. Profiles with the same gender identity report similar numbers of absences and transiency.
Also presented in Table 4.10, all five profiles contain differences in critical consciousness subconstruct scores. Profiles with Spanish home language identity present Critical Reflection scores below the mean while profiles with English home language present Critical Reflection scores above the mean. The nonbinary gender profile presents a Critical Reflection score above the mean. All five profiles present Critical Motivation scores above the mean value. Profile A with English home language identity reflected a Critical Action score above the mean, while all other profiles presented Critical Action scores below the mean.

These characteristics suggest that students of different language and gender identities experience empowerment differently in the mathematics classroom. In particular, characteristics of profile A align with the dominant language and gender identities of the school. This profile highlights the stability of these students’ social status with no transience and few absences reported. Above average critical reflection scores and personal reflections of social awareness illustrate critical consciousness development. This convergent data suggests current measures of empowerment are aligned with the dominant language and gender identities of the school.

Conversely, the characteristics of profile D correspond to the historically underrepresented language and gender identities of the school. This profile also illustrates the solidity of these students’ social status with no transience and few absences reported. However, below average critical reflection scores compared with responses of social inequality awareness, illustrate students’ critical consciousness development despite inadequate assessment. This divergent data suggests current measures of empowerment are not aligned with the language and gender identities of these students.

Characteristics of profile B, while reflecting convergent data, also suggest a misalignment of assessments with language and gender identities. This profile highlights the
instability of these students’ social status, with some transience and high number of absences. Additionally, below average critical reflection scores compared with responses of social inequality awareness, illustrate students’ critical consciousness development despite inadequate assessment. This profile data suggests current measures of empowerment are not aligned with the language and gender identities of Spanish home language, female students.

Characteristics of profile C correspond to the non-dominant gender identity of the school. This profile highlights the instability of these students’ social status, with some transience and high number of absences. Above average quiz scores, critical reflection scores, and MAPS scores did not correspond with personal reflections. This profile data suggests current measures of empowerment are not aligned with the identities of English home language female students.

Characteristics of profile E represent a student who identifies as a non-dominant gender identity and evidence an indeterminate social stability. With some transience and low absence, this student’s social status stability is difficult to characterize. Further, this student evidenced a below average summed quiz score aligned with negative perceptions of mathematics and valued participation. Additionally, this student’s critical reflection and critical motivation scores were above the mean, which explained they were aware of unequal opportunities. This profile suggests that current measures may align with the identities of gender nonbinary students.

Summary

Analysis of results suggests mixed influences of values affirmation interventions on students’ empowerment. Participation in interventions correspond to increased levels of mathematical empowerment, as evidenced through higher summed quiz scores. Results suggest statistically significant positive effects of the interventions on summed quiz scores for Spanish home language students. In correspondence, students’ personal survey responses detail an
increase in mathematical empowerment within themes of success in the mathematics classroom and valued participation in the class. Participation in intervention activities corresponds to a mixture of social and epistemological empowerment outcomes. Personal survey responses highlight the nuanced differences in students’ experiences of empowerment in the mathematics classroom. In the following chapter, I present a more complete presentation and discussion of these complex findings on student empowerment in the context of the literature.
CHAPTER V

DISCUSSION

The purpose of this study was to better understand the varying impacts of educators’ attention to identity construction as tenth grade Emergent Bilinguals and native English-speaking students develop mathematical, social, and epistemological empowerment in a mathematics classroom. In this chapter, I present a summary of the study and a discussion of the results, limitations, conclusions, and recommendations for further research.

Study Overview

This study sought to answer the following three research questions.

1. When controlling for language identity and gender identity to what degree does a values affirmation intervention predict students’ mathematical, social, and epistemological empowerment?
   a. How do varying levels of intervention implementation influence this prediction?

2. Following a values affirmation intervention, how do the perceptions of students with differing language and gender identities relate to their mathematical, social, and epistemological empowerment?

3. Following a values affirmation intervention, how do students’ mathematical, social, and epistemological empowerment profiles differ between outcome measures and personal survey responses?
   a. How do differences in empowerment profiles relate to differences in language and gender identities?
b. How do differences in empowerment profiles relate to phases of critical consciousness development?

To attend to these research questions, I employed a mixed methods transformative design (Creswell & Plano-Clark, 2018; Mertens, 2009), utilizing quantitative and qualitative methods to analyze the influence of a values affirmation intervention on students’ critical consciousness and empowerment. To follow, I incorporated integrated analysis to highlight emerging and differing patterns in the empowerment data. Findings inform understanding of students’ experiences of empowerment in the mathematics classroom and suggest improvements for measuring empowerment for students of different language and gender identities. Results suggest students with different language and gender identities experience empowerment differently in the mathematics classroom. Findings also suggest that existing measures of empowerment may be inadequate in capturing these experiences and may perpetuate stereotypical narratives of achievement.

**Discussion of Results**

The convergent and divergent results of this study suggest that students with different language and gender identities experience empowerment differently in the mathematics classroom and that critical consciousness development may help to explain some of these differences. The study confirmed the positive influences of a values affirmation intervention on students’ mathematical achievement. Results also support the notion that high school students are in nascent stages of critical consciousness development. Findings also suggest that existing measures of empowerment may be inadequate in capturing these experiences and may perpetuate stereotypical narratives of achievement. I include further discussion of these results in the following subsections entitled Convergent Results Suggesting Benefits and Inadequacies of
Intervention, Divergent Results Suggesting Differences in Students’ Empowerment Experiences, Participation in Values Affirmation Interventions, Critical Consciousness Development, and Existing Measures.

**Convergent Results Suggesting Benefits and Inadequacies of Intervention**

Quantitative results and qualitative findings converged to adequately describe some aspects of students’ empowerment. In particular, increased summed quiz scores with participation in values affirmation interventions echoed students’ perceptions of academic success in the classroom, evidencing greater mathematical empowerment. These findings provide a thick description of students’ experiences of mathematical empowerment in the classroom and suggest a benefit to participation in these interventions.

Both quantitative and qualitative analysis of social empowerment data provided information suggesting participation in the intervention was ineffective in improving awareness of social inequalities. Specifically, inconsistent critical reflection score improvements mirrored the static percentage of perceptions of social inequality for students of Spanish language identity and students of male gender identity. While analysis provided descriptions of students’ social empowerment, the convergent results point to some inadequacies of values affirmation interventions to improve critical awareness.

However, convergent data suggest that participation in values affirmation interventions may be effective in improving epistemological empowerment for some students. In particular, students of Spanish home language identity presented increased MAPS scores with increased treatment levels. Mediated by critical reflection, participating students’ perceptions of confidence in mathematics application support these findings. Students of English home language identity presented inconclusive MAPS scores and corresponding static responses of mathematical
confidence with increased treatment levels. These convergent results suggest that students of different language identities experience epistemological empowerment differently with values affirmation interventions.

Divergent Results Suggesting Differences in Students’ Empowerment Experiences

Conversely, some quantitative results and qualitative findings diverged to reveal subtle differences in students’ experiences of empowerment in the mathematics classroom. While students in all language and gender identity groups reported increased summed quiz scores with participation in values affirmation interventions, only certain groups shared perceptions of valued participation in the classroom. Specifically, as compared with those in the control group, students with Spanish language identity and students with female gender identity revealed higher perceptions of valued participation with increased treatment levels, mediated by their critical reflection on personal strengths and positions in the classroom. These differences suggest values affirmation interventions may provide additional benefit to the mathematical empowerment of some students, beyond traditional academic measures.

Differences in social empowerment outcomes highlight challenges associated with measuring this complex construct. Inconclusive findings from critical reflection scores suggest no correspondence between students’ participation in values affirmation interventions, language and gender identities, and their awareness of social inequalities. However, analysis of students’ survey responses revealed differences in social awareness associated with differences in language and gender identities. Specifically, participation in interventions was associated with lower percentages of perceptions of social inequality for students with English language identity and students with female gender identity. These findings suggest an inadequacy of existing measures in describing students’ social empowerment in the mathematics classroom.
Divergent quantitative and qualitative results also reveal differences in students’ epistemological empowerment experiences, dependent on participation in values affirmation interventions, and gender identity. In particular, analysis of MAPS scores suggests no treatment benefit to female students’ confidence in mathematics application. However, qualitative finding suggest that intervention participation corresponded with improved perceptions of confidence for students with female gender identity. These differences suggest values affirmation interventions may provide benefit to the epistemological empowerment of some students, beyond the scope of quantitative measures.

**Participation in Values Affirmation Interventions**

Convergent findings confirmed the beneficial impact of values affirmation interventions on students’ mathematical empowerment. In particular, descriptive statistical results evidencing small, improved quiz totals echo the findings of Farber (2010) and Sims (2016) who incorporated assessment scores and course grades as measures of mathematical empowerment. In support, qualitative reports of perceived success in the classroom evidence improved mathematical empowerment for all students participating in values affirmation interventions.

As in the works of Harackiewicz et al. (2014) and Tibbets et al. (2016), results suggest that values affirmation interventions appear to bolster the academic identities and achievements of historically underrepresented students in particular. In this study, students of Spanish language identity and students with female gender identity reported more perceptions of valued participation in the classroom with participation in the intervention activities. These findings, coupled with statistical findings, add to the results on improved mathematical empowerment with treatment. Results suggest that future research on mathematical empowerment should consider mixed measures to better understand students’ academic development in the classroom.
In particular, considering the outcomes from students’ personal and critical reflection practices may provide insight into the development of mathematical empowerment, as students share their perceptions of success and valued participation.

**Critical Consciousness Development**

After engagement in values affirmation interventions, integrated results suggest that high school students evidence different and changeable phases of critical consciousness development, many inhabiting nascent stages of social awareness (Godfrey & Grayman, 2014; Martinez & Yeong, 2019). As in the study by Rapa et al. (2020), the critical motivation subcomponent of critical consciousness development was impacted by participation in values affirmation interventions. However, unlike in the previous work, critical motivation scores decreased with participation in these interventions. These results suggest that, for some students, individual reflection, as in an intervention, may not be as effective in developing critical consciousness as collective engagement with mathematical social justice tasks (Gutstein, 2006; Kokka, 2020). Short Critical Consciousness Survey responses indicating students’ levels of critical consciousness along three subconstructs also support the notion that critical consciousness develops through phases of reflection, motivation, and action (Rapa et al.). Progressively lower subconstruct scores suggest that students at this age are in the early stages of critical consciousness development. Investigation of these outcomes, however, does allow for a more nuanced understanding of students’ empowerment development as students present perceptions of their growth from awareness to motivation to action in the mathematics classroom.

**Existing Measures**

Results of this study also suggest that, while rarely used, broad measures of students’ empowerment development should be incorporated to better understand the varied influences of
participation in values affirmation interventions. Findings support results that detail influence on students’ academic achievement as well as students’ sense of belonging, and critical consciousness (Cook et al., 2012; deJong et al., 2016; Rapa et al., 2020). Additionally, this study provides evidence that participation in values affirmation interventions may influence students’ confidence in mathematics application.

Study findings also suggest that existing measures may inadequately represent students’ experiences of empowerment in the mathematics classroom and that these measures may create or reinforce stereotypical narratives defining achievement. Results illustrate the alignment of measures with dominant gender and language identities, while divergent findings and characteristics of outlier data highlight ineffectual methods for capturing the empowerment experiences of some students (Leyva, 2016b). Traditional assessments simultaneously underrepresent Emergent Bilingual students’ mathematical empowerment and overshadow their perceptions of valued participation in mathematics class. Additionally, traditional measures of mathematical empowerment mask a low perception of valued participation for male students.

Study results also evidenced the limitations quantitative measures alone have in examining the different social empowerment experiences of students with different language and gender identities. Survey questions eliciting personal responses are needed to highlight lived and/or recognized social inequalities due to race, gender, financial status, disability, or educational status. While this study supports other quantitative results evidencing some influence of values affirmation interventions on students’ critical motivation (Rapa et al., 2020), further qualitative research is needed to determine how gender and language identities may influence students’ motivation for social change.
This study additionally suggests that measures of epistemological empowerment may be inadequate for improving understanding of students’ experiences of empowerment in the mathematics classroom. Inconclusive quantitative results and one-dimensional qualitative responses fail to describe the insight that students’ views on the field of mathematics and their place in knowledge development may have with their critical consciousness development. These findings point to a need for progress in measures to understand students’ perceptions of epistemological empowerment, particularly following participation in values affirmation interventions.

**Limitations, Validity and Reliability Considerations, Recommendations, and Conclusions**

In the following section, I describe the limitations related to this study, validity and reliability considerations, recommendations for future research, and conclusions based on the results.

**Limitations**

One limitation of this study was that I relied on demographic information to assign students to language and gender identity groups. While I made efforts to utilize school district data, identity selections were essentially made by students’ guardians. I did not collect data on students’ own perceptions of their identities. As identities are personal and complex, it may be necessary to gather and compare these two sources of data before assigning students to language and gender identity groups.

A second limitation of this study was the sample size. Given the complexity of the systems I attempted to examine, the sample size was inadequate to allow for statistical investigation of multiple parameters. Further research should necessarily increase the sample size, while still emphasizing participation of historically underrepresented students.
A third limitation related to the use of values affirmations and to assumptions of the interventions’ efficacy. While values affirmations have been implemented to bolster students’ identities and improve outcomes for historically underrepresented students, participation in these exercises does not resolve larger, systemic inequities that influence student development and require remediation. Further, I did not collect data on whether the values affirmation intervention bolstered students’ identities. While the study allowed for student reflection on personal values, these responses were not collected and analyzed. Consequently, future research should include pre and post measures of students’ sense of belonging and confidence in chosen identity groups.

Finally, I completed this study in a rural high school without much diversity in language identity. Though I made substantial effort to attend to the participation and responses of Emergent Bilingual students, I collected and analyzed data from a small sample of these students. Future research may be needed in a more diverse setting to better understand the influence of a values affirmation on the empowerment of students with different language identities.

**Validity and Reliability Considerations**

Under the transformative worldview, I looked “at validity as a unitary concept that measures the degree to which all accumulated evidence supports the intended interpretation of data for the proposed purpose” (Mertens, 2009, p. 236). To follow, I collected from a variety of data sources, both quantitative and qualitative. In seeking to improve the validity of this study, I attended to quantitative and qualitative design considerations, as well as those specific to a transformative mixed methods study, including purposeful selection of participants for the qualitative data collection, interaction between quantitative and qualitative phases, and the use of results to draw meta-inferences (Creswell & Plano-Clark, 2018). Mertens recommends
consideration of a parallel concept of credibility, seeking correspondence between community perception and researcher portrayal of the study constructs. I attempted to use a variety of data, in collaboration with participants, to support interpretations of the data collected.

I also focused on improving the reliability of measurements in the study, both quantitative and qualitative. The study includes instrument reliability reports, as well as a record of how understandings changed over the course of the study (Mertens, 2009). A special emphasis was placed on the translation of instruments and responses.

**Recommendations**

Based on the results of this study, I present three recommendations for improving the understanding of different students’ empowerment experiences in a mathematics classroom. First, findings lead to the recommendation to include an expanded set of both quantitative and qualitative measures when assessing students’ mathematical, social, and epistemological empowerment. Quantitative results illuminate student characteristics of growth but may also highlight existing school and social structures that unequally recognize students’ development. Qualitative findings can provide thick descriptions of students’ perceptions of empowerment and give voice to stories that either confirm or disconfirm quantitative outcomes. To add to a nuanced understanding of students’ identity construction and empowerment development, future research could incorporate pre- and post-measures of self-assurance, sense of belonging, and attitudes towards mathematics.

However, the mixed methods nature of this study required as large a sample as possible and, subsequently, succinct measures of data collection. Consequently, qualitative data collection was limited to short responses to survey prompts. A suggestion to improve the depth of these responses is to purposefully select students from existing school identity groups that would be
willing to participate in semi-structured interviews and potentially provide a richer description of their experiences of empowerment. These interviews would additionally create an opportunity to create counterstories of empowerment that may challenge stereotypical narratives of students in specific language and gender identity groups.

Finally, based on the findings of this study, I recommend studying the combined impacts of values affirmation interventions with participation in mathematics for social justice curriculum. As values affirmation interventions correspond to mixed results in critical consciousness development and inconclusive results in epistemological empowerment growth, future research could evaluate this development in the context of a mathematics class where social inequalities are a focused part of mathematical discourse. It is not yet understood how efforts to simultaneously bolster students’ identities and challenge social norms would contribute to empowerment development in the mathematics classroom.

**Conclusions**

This study confirmed that students of different identities experience empowerment differently in the mathematics classroom. Efforts to bolster these identities through values affirmation interventions influence students’ mathematical, social, and epistemological empowerment to varying degrees. Values affirmation interventions improve mathematical empowerment outcomes, particularly for Emergent Bilingual students, but are associated with limited or negative influences on students’ social and epistemological empowerment outcomes.

A key takeaway from this study is that multiple measures of empowerment are necessary to adequately capture students’ development in the mathematics classroom. Traditional measures of academic success may mirror students’ perceptions of improvement but do not adequately capture students’ sense of valued participation, confidence in mathematics application, or social
awareness. For secondary mathematics educators, this result implies that both reflection and traditional assessments are necessary to understand students’ progress in mathematics class. On a broader scale, this result means that school systems must incorporate measures that better align with the language and gender identities of students to better reflect their development in mathematics.

Understanding that students’ intersecting identities play a part in their mathematical development is important in the creation of classrooms and school systems that support individuals as they participate in mathematical practices. This study provides a foundation suggesting that efforts to attend to students’ identities may positively contribute to their mathematical empowerment, broadly defined. However, further research is needed to develop techniques which highlight students’ empowerment, specific to their language and gender identities.
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APPENDICES
Appendix A. The First Values Affirmation Intervention Activity

1. Below is a list of nine values that some people have identified as important to who they are. *read the entire list of values and think carefully about each one. Select the three values that are most important to you. (Although several of the values on the list may be important to you, be sure to only select the three values that you would consider to be the most important to you).

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women’s rights
- Living in the moment

2. Next, look at the three values you picked as most important to you. Think about times when these values were important to you. Then, in a few sentences, describe why these values you selected are important to you.

Focus on your thoughts and feelings, and don't worry about spelling, grammar, or writing. I'm just interested in your ideas and about why you selected as most important to you the three values that you did.

Enter your answer
3. List the top two reasons why you selected the three values that you chose as most important. Briefly reflect on what opportunities you might have to live out these values at school, in your neighborhood, or in your community during this school year.

Enter your answer

4. Indicate your level of agreement with the following statements about the values you identified.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>These values have influenced my life.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>In general, I try to live up to these values.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>These values are an important part of who I am.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I care about these values.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Appendix B. The Second Values Affirmation Intervention Activity

Below is a list of nine values that some people have identified as important to who they are.

Read the entire list of values and think carefully about each one.

Select the 3 values that are most important to you. Then create or select a personal photograph for each of the three most important values.

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women's rights
- Living in the moment

---

**Question 1**

Upload the photograph for your first important value.

Upload Choose a File

---

**Question 2**

Upload the photograph for your second important value.

Upload Choose a File

---

**Question 3**

Upload the photograph for your third important value.

Upload Choose a File
Appendix C. The Third Values Affirmation Intervention Activity

Below is a list of nine values that some people have identified as important to who they are.
Read the entire list of values and think carefully about each one.
Select the 3 values that are most important to you. Then create a personal video in which you orally describe the three most important values.

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women's rights
- Living in the moment

Question 1

Upload your personal video in which you describe the three most important values.

Upload
Choose a File
Appendix D. The First Control Group Activity

1. Below is a list of nine values that some people have identified as important to who they are. *read the entire list of values and think carefully about each one. *select the three values that are least important to you. (Although several of the values on the list may not be important to you, be sure to only select the three values that you would consider to be the least important to you).

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women’s rights
- Living in the moment
2. Next, look at the three values you picked as least important to you. Think about times when these values might be important to someone else. Then, in a few sentences, describe why these values might be important to someone else.

Focus on your thoughts and feelings, and don't worry about spelling, grammar, or writing. I'm just interested in your ideas and about why the three values you identified as least important to you might be important to someone else.

Enter your answer

3. List the top two reasons why someone else would view the values you chose as important. Remember, there are no right or wrong answers and I am just interested in hearing what you think.

Enter your answer

4. Indicate your level of agreement with the following statements about the values you identified.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>These values have influenced some people's lives.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some people try to live up to these values.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>These values are an important part of who some people are.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Some people care about these values.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E. The Second Control Group Activity

Below is a list of nine values that some people have identified as important to who they are.

Read the entire list of values and think carefully about each one.

Select the 3 values that are least important to you. Then select a non-personal image or photograph for each of the three least important values.

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women’s rights
- Living in the moment

---

**Question 1**

Upload the image for your first least important value.

Upload [Choose a File]

---

**Question 2**

Upload the image for your second least important value.

Upload [Choose a File]

---

**Question 3**

Upload the image for your third least important value.

Upload [Choose a File]
Appendix F. The Third Control Group Activity

Below is a list of nine values that some people have identified as important to who they are.

Read the entire list of values and think carefully about each one.

Select the 1 value that is least important to you. Then create a video in which you orally describe a time or reason why that value might be important to someone else.

- Expressing myself through art, music, writing, or physical activity
- Making sure all students in my schools are treated fairly, no matter their race, sex, or social class
- Being smart or getting good grades
- A sense of humor
- Talking about important social or political issues with my friends, teachers, or family
- Belonging to a social group (such as a sports team, racial group, or school club)
- Religious values
- Supporting important social or political issues like human rights, gun rights, gay rights, or women's rights
- Living in the moment

<table>
<thead>
<tr>
<th>Question 1</th>
<th>1 pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upload your video in which you describe the least important value from the list.</td>
<td></td>
</tr>
</tbody>
</table>

Upload: Choose a File
Appendix G. The Short Critical Consciousness Scale (ShoCCS)

Please respond to the following statements by selecting how much you agree or disagree with each statement. For each statement, choose “Strongly Disagree”, “Mostly Disagree”, “Slightly Disagree”, “Slightly Agree”, “Mostly Agree”, or “Strongly Agree”.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Mostly Disagree</th>
<th>Slightly Disagree</th>
<th>Slightly Agree</th>
<th>Mostly Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain racial or ethnic groups have fewer chances to get good jobs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Certain racial or ethnic groups have fewer chances to get ahead</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Women have fewer chances to get ahead</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Poor people have fewer chances to get ahead</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>It is important for young people to know what is going on in the world</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>It is important to correct social and economic inequality</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>It is my responsibility to get involved and make things better for society</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>People like me should participate in the political activity and decision making of our country</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Please respond to the following statements by selecting how often you were involved in each activity in the last year. For each statement, choose “Never did this,” “Once or twice last year,” “Once every few months,” “At least once a month,” or “At least once a week.”

<table>
<thead>
<tr>
<th>Activity</th>
<th>Never did this</th>
<th>Once or twice last year</th>
<th>Once every few months</th>
<th>At least once a month</th>
<th>At least once a week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participated in a civil rights group or organization</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Participated in a political party, club, or organization</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Contacted a public official by phone, mail, or email to tell him/her how you felt about a particular social or political issue</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Joined in a protest march, political demonstration, or political meeting</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Participated in a human rights, gay rights, or women's rights organization or group</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>
Appendix H. Sample Mathematical Content Quiz

Question 1

Given square ABCD

AB = 3x = 18
BC = 4x - 5
Find x
Round to the nearest hundredth

Question 2

Given Parallelogram ABCD

Find AC if
DE = 8
AD = 7
AE = 15
Round to the nearest tenth if necessary.

Question 3

Given rectangle ABCD

<table>
<thead>
<tr>
<th>Statement</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectangle ABCD</td>
<td>given</td>
</tr>
<tr>
<td>AD = BC</td>
<td>[Select]</td>
</tr>
<tr>
<td>DC = CD</td>
<td>reflexive property</td>
</tr>
<tr>
<td>m&lt;ADC = 90</td>
<td>[Select]</td>
</tr>
<tr>
<td>m&lt;BCD = 90</td>
<td>[Select]</td>
</tr>
<tr>
<td>m&lt;ADC = m&lt;BCD</td>
<td>substitution</td>
</tr>
<tr>
<td>(\triangle ADC \cong \triangle BCD)</td>
<td>[Select]</td>
</tr>
<tr>
<td>m\angle ACD = m\angle ABCD</td>
<td>Corresponding parts of congruent triangles are congruent</td>
</tr>
</tbody>
</table>

Question 4

Given Square ABCD

AD = 2x + 7
DC = 10
Find the perimeter of the square

Question 5

Explain how well you understand how to use quadrilateral properties to solve problems.
Appendix I. Learning Targets for the Academic Term

**Unit 1 Learning Targets**

I will understand function notation.

I will graph with functions with technology and interpret features of the graphs

I will create a table of values and write an equation from the table

I will solve multi-step equations

**Unit 2 Learning Targets**

I will use geometric notation and vocabulary

I will use angle relationships to solve problems

I will understand properties of dilation

I will use proportions to solve problems of similarity

I will solve application problems of similarity

**Unit 3 Learning Targets**

I will solve problems of distance and area on the coordinate system

I will understand properties and use appropriate vocabulary to describe

I will proportionally cut line segments on the coordinate system

I will use properties of quadrilaterals to solve problems.
Appendix J. The Mathematics Attitudes and Perceptions Survey (MAPS)

Please respond to the following statements by selecting how much you agree or disagree with each statement. For each statement, choose “Strongly Disagree”, “Disagree”, “Neutral”, “Agree”, or “Strongly Agree”.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>After I study a topic in math and feel that I understand it, I have difficulty solving problems on the same topic.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>There is usually only one correct approach to solving a math problem.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I’m satisfied if I can do the exercises for a math topic, even if I don’t understand how everything works.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I do not expect formulas to help my understanding of mathematical ideas, they are just for doing calculations.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Math ability is something about a person that cannot be changed very much.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Nearly everyone is capable of understanding math if they work at it.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Understanding math means being able to recall something you’ve read or been shown.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>If I am stuck on a math problem for more than ten minutes, I give up or get help from someone else.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>I expect the answers to math problems to be numbers.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>If I don’t remember a particular formula needed to solve a problem on a math exam, there’s nothing much I can do to come up with it.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
In math, it is important for me to make sense out of formulas and procedures before I use them.

I enjoy solving math problems.

Learning math changes my ideas about how the world works.

I often have difficulty organizing my thoughts during a math test.

Reasoning skills used to understand math can be helpful to me in my everyday life.

To learn math, the best approach for me is to memorize solutions to sample problems.

No matter how much I prepare, I am still not confident when taking math tests.

It is a waste of time to understand where math formulas come from.

We use this statement to discard the survey people who are not reading the questions. Please select Agree (not Strongly Agree) for this question.

I can usually figure out a way to solve math problems.

School mathematics has little to do with what I experience in the real world.

Being good at math requires natural (i.e. innate, inborn) intelligence in math.

When I am solving a math problem, if I can see a formula that applies then I don’t worry about the underlying concepts.

If I get stuck on a math problem, there is no chance that I will figure it out on my own.

When learning something new in math, I relate it to what I already know rather than just memorizing it the way it is presented.

I avoid solving math problems when possible.

I think it is unfair to expect me to solve a math problem that is not similar to any example given in class or the book, even if the topic has been covered in the course.

All I need to solve a math problem is to have the necessary formulas.

I get upset easily when I am stuck on a math problem.

Showing intermediate steps for a math problem is not important as long as I can find the correct answer.

For each person, there are math concepts that they would never be able to understand, even if they tried.

I only learn math when it is required.
Appendix K. The Social, Mathematical, and Epistemological Empowerment Survey

Do you feel that you are making improvements in your math understanding? Do you feel that you can participate and be successful in math class? Explain.

Do you feel that you have the same opportunities as other students in taking classes, participating in club or team organizations, and getting jobs? Explain.

Do you feel that you can ask questions both in class and outside of class? Do you feel that your voice matters? Explain.
Appendix L. School District Approval Letter

5/24/2021

Carrie Bala
Utah State University

Dear Carrie,

I am writing this letter in support of your research proposal “The Influence of a Values Affirmation Intervention on Students’ Social, Mathematical, and Epistemological Empowerment.” Wasatch County School District is pleased to support the research and recognizes the need for studies like this to inform our work.

I am confident that this research will contribute to our work in the district and have an impact on the broader field. We look forward to learning more about the project.

Tod Johnson, Director of Secondary Education, will be your research liaison with the school district. Don’t hesitate to contact Mr. Johnson with any questions or concerns at 435-654-0280 and Tod.Johnson@Wasatch.Edu. Scheduling Mr. Johnson’s calendar can be completed through his assistant, Mary Barger. Mrs. Barger contact information is 435-654-0280 and email at mary.barger@wasatch.edu

Respectfully,

Ben Springer, Ph.D., NCSP
Institutional Research Coordinator
Director of Special Education
Wasatch County School District
Appendix M. Evidence of Normality Assumption Failure for Critical Action Data
Appendix N. Evidence of Normality Assumption Failure for MAPS Data

Normal P–P Plot of Regression Standardized Residual

Dependent Variable: MAPS Total

Expected Cum Prob

Observed Cum Prob
Curriculum Vitae
Carrie O. Bala
Wasatch High School
62 Timberlakes Est., Heber City, Utah 84032
Tel: 224-715-2250 | Email: carrie.bala17@gmail.com

EDUCATION

Ph.D., Education  
Specialization: Curriculum and Instruction  
Concentration: Mathematics Education and Leadership  
Utah State University, Logan, UT  
Expected May 2022

M. Math, Mathematics  
Utah State University, Logan, UT  
2010

B.S., Civil Engineering  
University of Illinois at Urbana-Champaign  
1997

Utah Secondary Education License  
Secondary Mathematics Level 4 Endorsement  
2007

PROFESSIONAL HISTORY

Mathematics Teacher  
Wasatch High School, Heber City, UT  
2006 - present  
Responsibilities include teaching Secondary Mathematics I, II, and III courses and concurrent enrollment Mathematics 1050 and 2010 courses, serving on the school’s Guiding Coalition for school improvement, collaborating with mathematics teacher team members to build assessments, interventions, and extensions.

Adjunct Professor  
College of Science, University of Utah, Salt Lake City, UT  
2021 – present  
Responsibilities include teaching secondary mathematics courses (online and face-to-face) in the Department of Mathematics.

Adjunct Professor  
College of Science, Utah Valley University, Orem, UT  
2016-2017  
Responsibilities included teaching elementary mathematics education courses (face-to-face) in the Department of Mathematics.

Facilitator for Utah State Office of Education  
Secondary Mathematics Utah Common Core Academy  
2011-2012  
Responsibilities included designing and facilitating secondary mathematics teacher development courses.
Mathematics Teacher 2000-2006
Carmel Catholic High School, Mundelein, IL
Responsibilities included teaching Algebra I, Algebra II, Geometry, and Precalculus courses, leading student retreats, and coaching the Track team.

RESEARCH

Research Interests
- Defining the relationship between learning mathematics and student empowerment by focusing on content learning and identity construction
- Instructional practices for increasing connections between secondary student academic, social, and mathematics identities
- Instructional practices for teaching mathematics for social justice

PUBLICATIONS

Published Manuscripts

PRESENTATIONS

NATIONAL PRESENTATIONS


STATE AND REGIONAL PRESENTATIONS

Utah


**TEACHING**

**UNIVERSITY TEACHING**

*University of Utah, College of Science, Mathematics Department*

*Salt Lake City, Utah (2021-present)*

**UNDERGRADUATE COURSES**

**MATH 1210**

*Calculus I*

Taught face-to-face at Salt Lake City campus: Spring 2022

Required mathematics course for Science and Mathematics majors. This course includes conceptual development of the derivative and integral with applications of these concepts.

**MATH 3410**

*Statistics for Secondary Mathematics Teachers*

Taught online and face-to-face at Salt Lake City campus: Fall 2021

Required mathematics course for future secondary teachers. This course includes probability and statistics content from a teaching perspective, with attention to modern computational tools.

**MATH 3430**

*Algebra for Secondary Mathematics Teachers*

Taught online and face-to-face at Salt Lake City campus: Fall 2021

Required mathematics course for future secondary teachers. This course includes algebra content from a teaching perspective, with an emphasis on integrating algebraic and geometric ideas.

**Utah Valley University, College of Science, Mathematics Department**

*Orem, Utah (2016-2017)*

**UNDERGRADUATE COURSES**

**MATH 2020**

*Math for Elementary School Teachers II*

Taught face-to-face at Wasatch campus: Spring 2017
The second semester of the mathematics course for elementary teachers. This course includes topics on probability, statistics, geometry, and measurement.

**MATH 2010**

**Math for Elementary School Teachers**

Taught face-to-face at Wasatch campus: Fall 2016

The first semester of the mathematics course for elementary teachers. This course includes topics on numeration systems, elementary number theory, ratios, rational numbers, and integers.

**MAT 1000**

**Integrated Beginning and Intermediate Algebra**

Taught face-to-face Wasatch campus: Spring 2016

Beginning and intermediate algebra. This course includes topics on linear, quadratic, and functions, logarithms and exponents.

**Guest Lecture, MATH 4020 Mathematics for Elementary School Teachers (2020, February). For Amanda Cangelosi, University of Utah.**

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**CONTINUOUS LEARNING & SELF-DEVELOPMENT**

**PROFESSIONAL MEMBERSHIPS**

National Council of Teachers of Mathematics (since 2000)

Utah Council of Teachers of Mathematics (since 2006)

**WORK GROUPS**

Participated in the Gender and Sexuality Working Group at the Forty-Third Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA) 2021

Participated in Wasatch High School Sheltered Instruction Observation Protocol (SIOP) teacher work group Spring 2020-2021

Participated in the state of Utah Mathematics Pathways Task Force 2019-2020

Contributed to research program of Dr. Amanda Taggart in preparation for the University Council for Educational Administration Convention 2019-2020

Represented the Mathematics Department in the Wasatch High School Guiding Coalition 2018-2020

Facilitated CITES professional development workshops 2014-2015
Facilitated Common Core Academy, summer 2012. Participated summer 2011

Participated in Mathematical Sciences Research Institute: Critical Issues in Mathematics Education workshop, April 2013


PROFESSIONAL SERVICE

Utah Council of Teachers of Mathematics: Treasurer (2016-2021)
  Duties include maintaining and reporting financial records as a non-profit organization, facilitating registration for the annual conference.

  Duties include coordinating virtual presentation with in-person attendees.

  Duties include critiquing and offering recommendations for proposal revision.

AWARDS, PROFESSIONAL RECOGNITION, & COMPETITIVE PROGRAMS

2021  Doctoral Student Researcher of the Year Award, Utah State University, School of Teacher Education and Leadership

2016-2019  Master Teacher Fellow, Math for America

2014  ACE Teaching Award, Wasatch County School District