

# Evaluating Mathematics Curriculum from Anti-Colonial and Criticalmathematics Perspectives:

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# **BOSTON COLLEGE**

## **Lynch School of Education and Human Development**

Department of  
Teacher Education, Special Education, and Curriculum and Instruction

Curriculum and Instruction, Ph.D. Program

### **EVALUATING MATHEMATICS CURRICULUM FROM ANTI-COLONIAL AND CRITICAL MATHEMATICS PERSPECTIVES**

Dissertation  
by

**PAUL EDWARD MADDEN**

submitted in partial fulfillment  
of the requirements for the degree of  
Doctor of Philosophy

December 2019

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# EVALUATING MATHEMATICS CURRICULUM FROM ANTI-COLONIAL AND CRITICAL MATHEMATICS PERSPECTIVES

By Paul Edward Madden

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## Abstract

This study developed and then utilized an anti-colonial mathematics curriculum evaluation framework based on Grande's (2015) conceptualization of colonialist consciousness. This was done in an effort to both: a) illuminate the presence of colonial logics within mathematics curricular texts and b) re-conceptualize critical mathematics for the purpose of addressing our intertwined ecological (e.g., climate change) and human crises (e.g. systemic racism). Rather than conceptualizing mathematics as a socio-politically neutral and/or a culture-free discipline this study offers a literature review of the genealogy of Western mathematics' development in relation to British imperialism and Anglo-American settler colonialism. Working from these historical, linguistic, and philosophical perspectives the anti-colonial mathematics curriculum evaluation framework was constructed, piloted with a Common-Core-aligned 6<sup>th</sup> grade *Eureka Math* unit, and then refined. From there, two absolute criterial curriculum evaluations (Kemmis & Stake, 1988), one using the anti-colonial evaluation framework and the other using a critical mathematics evaluation framework, were completed in relation to a 7<sup>th</sup> grade *Eureka Math* unit.

Resulting from this process, this study offers two key findings. First, Grande's (2015) conceptualization of colonialist consciousness can be specified to identify concrete manifestations of colonialist consciousness, which can be meaningfully organized in relation to aspects of curriculum (i.e., goals/objectives, pedagogy, and

assessments) and curricular components (e.g., exit tickets). Second, aspects of criticalmathematics theorizations of justice may be fruitfully reconsidered to support the disruption of mathematics educations' (and its curricular texts') roles in the propagation of the metaphysical and epistemological assumptions of coloniality. Implications of this study are presented generatively as actionable suggestions for textbook developers, teacher educators, and theory-driven evaluators interested in supporting the teaching and learning mathematics from an anti-colonial stance.

## DEDICATION

This study is dedicated to

*The intergenerational, interfamilial project. To our ancestors and our progeny, familial and vocational.*

Dr. Lillie Richardson Albert  
My mentor and BC mom

Anne Vera Cruz  
My partner, best friend, and the best curriculum theorist I know

Maureen M. Madden  
Paul J. Madden  
My mom and dad for their patience, love, and sincerity.

Edward D. Driscoll  
Mary Flatley Driscoll  
Marie Desaulnier Madden  
Paul J. Madden  
My grandparents and my first mentors

Mom and Dad, Lucy and Antonio Vera Cruz  
Salamat po for embracing me as a son

The FACES Family

Ed Young Man Afraid of His Horses  
Kola and mentor. Pilimaya yelo!

C.J. Grandson  
My godson

## **ACKNOWLEDGEMENT**

This study's ideological stance was not welcomed by all. To undertake such a study I not only needed a chair willing to embrace and guide my vision, but a chair that was comfortable with the study's intertwined philosophical, historical, and qualitative social science research methodologies. Dr. Lillie Richardson Albert was that chair and more. This study would not have been possible without her thought partnership and her Vygotskian approach to guiding doctoral candidates through the dissertation process. Thank you for your intellectual generosity and partnership in this work, Dr. Albert!

To my committee members, Dr. John Wargo, Dr. Elizabeth Sparks, and Dr. Sandy Grande, thank you for your generative feedback throughout this process! Your support of this work and openness to engaging with it was refreshing and educative for me in my future labors as a professor. I sincerely thank you all! Dr. Grande I am particularly grateful to you intellectually for your conceptualization of colonialist consciousness, which is the basis of this evaluation framework.

I would also like to thank all the folks who have been on this journey with me. To my wife, Anne, I am so grateful that you not only support me, but also understand and challenge me intellectually, spiritually, and emotionally. To Josh Gresham thank you for the generative feedback and philosophical co-musing on the trail, they were invaluable to my knowledge construction, which was far from solitary. To my colleagues past and present, in particular, Charles Grandson, Sophia Boyer, Shannon Watson, and Marisa Suescun thank you for all the conversations and experiences that led me, and then, fed me during my PhD program. To my mentors, Dr. Lillie Richardson Albert, Professor Larry Watson, Paul Marcus, Dr. Leigh Patel, and Ed Young Man Afraid of His Horses thank



you for showing me how to move through this world as an educator with integrity, courage, determination, care, and grace.

Finally, I would like to thank my family, immediate and extended, in Boston, the Philippines, and the Oglala Lakota Nation for their sustained support and love. I am humbled by your collective willingness to engage with my nascent conceptualizations. To my immediate family a special thank you: mom (Maureen Driscoll Madden), dad (Paul J. Madden), Marycaitlin, Maggie; mom (Lucy Tee Vera Cruz), dad (Antonio Vera Cruz) Achie Grace, Martin, Ivan, Bellie, and Abram; and to the next generation, my niece and nephew Sammy and Theo.

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## **CHAPTER ONE: INTRODUCTION**

### **PROBLEM STATEMENT**

Given the advanced, intertwined, and existentially threatening nature of our current ecological and human crises, all human capacities, including our mathematical capacities, should be engaged to help resolve these dual crises. Currently, in the United States, mathematics and mathematics education is being dangerously under-utilized for the reconstitution of the social-political and economic systems driving these dual crises. However, mathematics education, as argued herein, has the potential to help develop students' consciousness away from the purposes of destructive and exploitative material wealth accumulation, and towards the purposes of ecological and human well-being.

In fact, rather than being merely under-utilized for these purposes, it is arguably truer that mainstream mathematics education in the United States, being driven by the Common Core State Standards, is currently contributing to these crises. First, the Common Core State Standards for Mathematics are advanced by and for the financial interests of the very corporations who profit the most from oppressive and exploitative relationships between human beings (e.g., racism, sexism), between human beings and other beings, and between human beings and our habitat (Wolfmeyer, 2014). Second, even though the Common Core State Standards have commendably reimaged a more conceptually rigorous and pedagogically-sound mathematics education in the United States, its explicit purposes, although future-oriented, lack any attentiveness to using mathematics to help understand and/or resolve the very high magnitude impacts and high probability dangers of our current and future crises.

Thankfully, criticalmathematics education researchers have, as of recent, been at the forefront of theorizing and advocating for mathematics educations' engagement with these dual crises (Wolfmeyer & Lupinacci, 2017; Gutiérrez, 2017a). This work is necessary if we are to radically shift the mathematics education community towards the purposes of ecological and human well-being. However, as this is still an emerging development within criticalmathematics there is a need for both 1) re-examining criticalmathematics ideological basis in relation to these new purposes and 2) engage in empirical research, to evidence the need for a radical shift within mainstream mathematics and, potentially, criticalmathematics curricula.

First, in order to serve these new purposes, criticalmathematics needs to examine its ideological basis from an anti-colonial stance. Historically, criticalmathematics has admirably focused on developing a mathematics education that aims to illuminate, deconstruct, and/or transform systems of human oppression and dispossession, namely, racism, sexism, classism, and capitalism for the purposes of social justice (Powell, 2012; Frankenstein, 2012; Gutstein, 2006). However, in building from this tradition, similar to other critiques of critical scholars, particularly from the perspectives of critical Indigenous and post-colonial scholars, criticalmathematics continues to advance a theory of change that is US-institution-centric, anthropocentric, Western-centric, and, often, incrementalist in its theory of change (Grande, 2015; Tuck & Yang, 2015). Further, and building from the same perspective, criticalmathematics also fails to problematize the genealogy of Western mathematics in relation to imperialism's complex web of human oppression and dispossession and ecological exploitation, which, in the case of the United States, instantiates itself as particularistic forms of settler colonialism.

As such, within criticalmathematics there needs to be a re-accounting of the history and development of both our ecological crisis and globalized systems of oppression, and dispossession as concurrent and integral, not merely topically intersecting and separate processes. It is true that our ecological crisis would be impossible without the dual global dispossession of Indigenous people from their lands and the enslavement and/or exploitation of peoples (whom were reconstituted along a continuum of human to less than human) for the purposes of extracting material wealth from said lands (Tuck & Yang, 2015; Grande, 2015; Seawright, 2014). Further, and in line with this, if we are to bring mathematics to the service of social-political and ecological justice, we must take into account the concurrent development of modern-Western imperialism and the development of Western mathematics and mathematics education from 1492 onwards (Karp, 2014). For, Western mathematics and, in particular, mathematics education, which did not exist beyond the Merchant class before the renaissance, boomed in response to the direct and explicit goals of advancing Western nation-states' military, navigational, engineering, and mining capacities (Karp, 2014; D'Ambrosio, 2014). As such, criticalmathematics education scholars cannot assume that the content and skills advanced in mainstream mathematics are sufficient, adequate, or congruent, in relation to the goals of resolving and addressing ecological and human injustices.

Further, as argued herein, although the curricular prominence of concepts, such as systems of linear equations, that directly engage consequentialist and materialistic cost-benefit-analyses is problematic, the language and logics within mathematics education itself is problematic. Rather, mathematics education's most dangerous product just may

be mathematics' impersonal, universalistic, authoritative, and amoral voice (Bishop, 1990; Semali & Kincheloe, 1999). For this discourse is often leveraged to justify wealth extractions with inseparable social, political, economic, and ecological harm for the majority of human beings, other beings, and our shared habitat (Bishop, 1990; Tuhiwai Smith, 2012). In mathematics classrooms, this discourse shapes students' consciousness towards a destructive modernist and Western imperialist way of being, what Grande (2015) has termed colonialist consciousness. This is why many postcolonial and critical Indigenous scholars have identified mathematics' projection of both a universal and seemingly boundless knowledge capacity as the most powerful cultural product of the imperial West (Semali and Kincheloe, 1999). In addition, there needs to be an examination of what is and is not taught within mathematics education, including an account of how mathematics and its applications are presented and its relationship to the production of a colonialist consciousness.

However, it may be foolhardy to categorically blame all mathematics educators. For, although there are many university teacher-education programs committed to teaching mathematics from a critical or social justice stance, there seems to be many more programs that underprepare their graduates to grapple with or, ultimately, uproot these problematic issues. However, mathematicians and mathematics education researchers, both of whom are more likely to understand the problematic nature of the knowledge and application issues of mathematics, do have a higher degree of responsibility for change. This is especially true, as both mathematicians and mathematics education researchers constitute most of the lead authors of mathematics textbooks. Within mathematics education, this is a particularly important connection, as it

has long been observed that more so than any other subject area, “teachers decide what to teach, how to teach, and what sorts of exercises to assign to their students largely on the basis of what is contained in the textbook authorized for their courses”(Robitaille and Travers, 1992, p. 706).

Second, in addition to problematizing and re-conceptualizing criticalmathematics’ ideological foundations from an anti-colonial stance, given the particular influence of textbooks on mathematics curriculum and instruction, we must understand how and where colonial constructions instantiate themselves in our mainstream and criticalmathematics curricula. If we are to address ecological and human injustices, teachers and teacher educators need concrete examples of problematic constructions to help make the familiar unfamiliar and to begin concretely imagining otherwise possibilities. Too often, criticalmathematics’ goals of illuminating all too concrete systems of oppression and dispossession are criticized as seemingly abstract. Although many may choose to view these systems as immaterial or unrelated to the core work of mathematics educators, this is a privileged position of those whose socioeconomic and/or social-cultural location do not *yet* expose them to the precarity that the majority of humanity, other beings, and our shared habitats. For the rest of us, if mathematics is to remain relevant, we must work to remove all barriers that prevent the development of mathematics educations’ capacity for grappling with these dual crises.

Further, given the relative dearth of empirical research by criticalmathematics education researchers, there is a dire need to evidence the call for a radical shift in mainstream mathematics curriculum and, potentially, criticalmathematics curriculum materials themselves. The problematics of mainstream mathematics are not obvious, nor

are they taught to most mathematics educators, nor are its particular instantiations obvious to even those who aspire to be criticalmathematics educators. If criticalmathematics is to develop as a field, it must be able to evidence and improve its theoretical claims and practical applications via systematic analysis. The dual crises we face are too large, probable, and dangerous to leave its resolution up to chance (Cook et al, 2016). Everyone, in every field must re-dedicate its intellectual and institutional resources towards its resolution. Therefore, no field is exempted, including criticalmathematics education research.

Together, the reconceptualization of criticalmathematics from an anti-colonial stance and the empirical examination of mainstream mathematics curricula are important to mathematics education's systematic efforts, in relation to our dual and intertwined human and ecological crises. In this study, questions were raised in an effort to better develop theoretical, curricular, and pedagogical guidance for mathematics teachers and teacher educators who, like all of us, will face these crises during their professional career. All of this is done from the perspective and hope that mathematics and mathematics education, as sociocultural products and deeply human activities can, as it has been in other societies, help us humans adapt, thrive, and, as hoped herein, promote well-being for human beings and other beings within a diverse array of shared habitats. As it is often said, in order to solve a problem, you must first firmly understand its challenges.

### **Purpose Statement**

The purpose of this qualitative curriculum evaluation was to specify Grande's (2015) conceptualization of colonialist consciousness into an anti-colonial mathematics

curriculum evaluations framework and apply it as a lens to Common Core curriculum to both concretize the presence of coloniality within mathematics and to help re-conceptualize criticalmathematics ideological foundations. Specifically, this study had three goals. First, this study aimed to specify Grande's (2015) conceptualization of colonialist consciousness into an anti-colonial mathematics evaluation framework using a) the results from the author's prior evaluation of his own mathematics curriculum's, b) this study's literature review, and c) the iterative process of piloting and editing drafts of an anti-colonial mathematics evaluation framework. Second, once the anti-colonial mathematics evaluation framework was refined, this study used the aforementioned evaluation framework to understand how coloniality instantiates itself in mainstream mathematics curriculum by evaluating a curricular unit from a Common Core aligned middle school mathematics curriculum. Third, this study evaluated the same Common Core aligned curricular unit using an author-created, criticalmathematics evaluation framework in order to understand: a) to what degree criticalmathematics advances and/or refuses manifestations of Grande's (2015) colonialist consciousness and b) to better understand how criticalmathematics ideological foundations may need to be reconceptualized to better serve the dual purposes of human and ecological justice.

In this study, curriculum was approached from the perspective of criticalmathematics education from an anti-colonial stance. Criticalmathematics is defined by its advancement of critical consciousness and rigorous mathematical content taught via inverted pedagogical structures within socioculturally responsive environments for the tri-fold purposes of: a) preparing students to neutralize high-stakes testing in mathematics as an institutional gate keeper, b) promoting students' critical mathematical



analysis of systems of oppression, and c) challenging students' internalization of epistemological racism (Gutstein, 2006; Frankenstein, 2012; Powell, 2012) . Further, given this study's ideological commitment to anti-colonial scholarship, additional emphasis was given to the dismantling of the shared ideological underpinnings of both globalized systems of anthro-oppression (e.g., racism, sexism, classism) and ecological devastation. This was done with the hopes of broadening criticalmathematics purposes beyond its presently US-institution-centric, anthropocentric, and Western-modernist theory of change.

### **Research Questions**

In this qualitative curriculum evaluation study, Grande's (2015) conceptualization of colonialist consciousness was specified to create the schemata for an anti-colonial mathematics curriculum evaluation framework. This anti-colonial mathematics curriculum evaluation framework was then applied to a common-core aligned mathematics curriculum in an effort to understand how coloniality instantiates itself within mathematics curriculum and to contribute to criticalmathematics' empirical-informed theoretical re-examination. Specifically, and arising from the purpose of this study, this study sought to address the following questions via the construction and application of the analytical framework:

- How can both the results of a prior mathematics curriculum evaluation based on Grande's (2015) conceptualization of colonialist consciousness and a literature review of the genealogy of Western imperialism, settler colonialism, and Western mathematics be used to specify Grande's conceptualization of colonialist consciousness to create an anti-colonial mathematics evaluation framework?

- To what extent can a Common Core mathematics curriculum be evaluated by an anti-colonial mathematics evaluation framework?
  - In what ways does the qualitative evaluation identify instantiations of coloniality within a 6-8 Common Core aligned mathematics curriculum unit (i.e., Eureka Math, grade 7, Module 3 – Expressions and Equations)?
  - How does an anti-colonial mathematics evaluation framework highlight salient curricular elements that contribute to human and ecological (in)justices within a 6-8 Common Core aligned mathematics curriculum?
- How does the curriculum evaluation help re-conceptualize criticalmathematics' ideological foundation from an anti-colonial stance to better serve the dual purposes of human and ecological justice in mathematics education?

### **Significance**

This study aimed to add to the scholarly research in both anti-colonial and criticalmathematics education, empirically and theoretically, in order to better understand the problems and possibilities related to improving practice and policy towards greater human and ecological justice via mathematics education. Theoretically, although the field of criticalmathematics in the United States has recently published a conceptually rigorous special issue in the *Philosophy of Mathematics Education Journal* (Coles & Boylan, 2017) focused on bringing mathematics education to the service of ecological and/or human justice, as implied in the introduction, the field still lacks a theoretical orientation rooted in illuminating mathematics education's relationship to the deep structures of settler colonialism and imperialism, which underlie our intertwined ecological and social crises. However, of the articles in this special issue, Gutiérrez (2017) and Wolfmeyer and

Lupinacci (2017), to date, have done the most to advance the field of criticalmathematics for the intertwined and dual purposes of social and ecological justice.

First, this study, unlike other criticalmathematics studies, theoretically aimed to connect mathematics education to the ideological and material structure of settler colonialism. Gutiérrez (2017), building from the ethnomathematics strand of criticalmathematics, pushes back on Western ways of knowing and doing mathematics that promotes human domination of the Earth, and instead privileges and builds from Indigenous ways of knowing, being, and conceptualizations of reality to imagine a *mathematx* that promotes harmony and balance for all beings. Although Gutiérrez (2017) correctly situates settler colonialism in close relationship with environmentally destructive techno-capitalism and the erasure of Indigenous ways of knowing and being, she problematically reduces settler colonialism to a metonym for a particular subset of injustices (Tuck & Yang, 2012). In this study, as argued by Tuck and Yang (2012) with respect to the term “decolonization,” the term settler colonialism was not used as a metaphoric metonym, but rather as a meta structure. As such, this study differs as it aimed to connect mathematics’ education theoretically and materially to the structure of settler colonialism, which is a physical and ideological system differentially organized in relation to place and peoples (Tuck & Yang, 2012; Grande, 2015).

Second, this study, unlike other criticalmathematics scholarship, aimed to construct an evaluation framework for identifying instantiations of settler colonialism within Common Core mathematics curriculum, while building from the perspectives of critical Indigenous scholars from the Americas. Wolfmeyer and Lupinacci (2017), in building from the critical strand of criticalmathematics and ecofeminist literature, strive

to illuminate how the hegemonic West's logic of domination and human-centric thinking has led to our singular ecological and social crisis, while forwarding ecocritical mathematics as a trans-disciplinary STEM activity focused on projects that link social and environmental issues via the "common domination/subordination themes that cut across both sectors" (p. 16). In contrast to Gutiérrez's (2017) work, although Wolfmeyer and Lupinacci (2017) placed greater attention, via their critical stance, to systems and structures of power for the purpose of wealth accumulation, they ignore, much like the ecofeminist thinkers they cite, both the more mature genealogy of critical Indigenous scholarship and the ongoing structure of settler colonialism within the United States. Further, in contrast to Gutiérrez's (2017) work, Wolfmeyer and Lupinacci (2017), rather than imagining a radically different mathematics curriculum, pragmatically illuminate how a Common Core aligned mathematics curriculum, that is EngageNY, could be used to both teach ratios and proportions and illustrate ecocritical issues, such as, our exploitative industrial agro-economical system. However, in doing so, despite the laudability of the concreteness of their example, they advance another problematic feature of ecofeminist scholarship, which tends to exploit an emotional distance and mundane orientation in White culture towards Black suffering to advance the political goals of ending animal suffering via its allusion to Black liberation struggles (Weheliye, 2014).

Building from this study's theoretical contributions, this study made three unique empirical contributions – two to critical mathematics education and the third to anti-colonial education research. First, although many critical mathematics scholars theorize from their own teaching experiences, such as Gutstein (2006), in response to the common

critique that critical mathematics lacks systematic empirical grounding for its theoretical pronouncements, this study uniquely aimed to theorize and iteratively shape an analytical framework via the analysis of digitally and freely accessible Common Core endorsed mathematics curriculum. Second, to date, other than Wolfmeyer and Lupinacci's (2017) pedagogical suggestions with respect to critical mathematics and middle school curriculum, the author is unaware of any systematic qualitative analysis of curricular texts in general, or in relation to middle school students or curricular texts from the perspective of critical mathematics from an anti-colonial stance. This is important, as although it is commonly argued by opponents of critical mathematics that sociopolitical-ecological analysis via mathematics is, at best, appropriate for older students, it is argued herein that middle school students are developmentally and socially, and, given students increasingly unbounded access to information, contextually primed for sociopolitical discussions. Finally, to date, in relation to anti-colonial education research, this study sought to uniquely and empirically illuminate instantiations of coloniality within mathematics curricular texts using Grande's (2015) conceptual framework for identifying instantiations of colonialist consciousness within educational settings and/or texts.

Collectively, the goal was that this study's theoretical and empirical contributions could help improve practice and policy for the purposes of greater ecological and human justice. As it is difficult to construct solutions without an understanding of the problem at hand, this study's theoretically enriched analytical framework and its deployment aimed to empirically help both mathematics teachers and teacher educators fully understand how mathematics education contributes to the intertwined problems of human and ecological injustice. Further, this empirically validated analytical framework can help

serve as a template for illuminating problems and possibilities in one's practice. This will hopefully complement and enhance Gutiérrez's (2013) call for the enhancement of teachers' political knowledge for teaching for social and ecological justice. Also, in relation to policy, it could help us better measure and understand how our standards and standards-based curriculums are or are not adequate to preventing our dual ecological and human crises.

### **Positionality**

As a cisgendered White male settler with an elite Western education, I have always been situated in an undeservingly privileged position within the United States. In fact, I continually learn how my beingness is deeply entangled with the sociocultural, historical, and political construction of "personal whiteness [and maleness] as a signifier of ownership/power" and how this beingness effects how I understand myself and how people understand and relate to me (Seawright, 2014, p. 563; Seidl & Hancock, 2011). However, even though I recognize my "social location relative to colonization" I write, in the spirit of Patel (2014), when she states that one's social location is not entirely "fixed by virtue of birthplace or social identity, but rather at every juncture there is constant opportunity and responsibility to identify and counter the genealogies of coloniality that continue to require oppression" (p. 358).

As a professional educator and emerging scholar, my journey in taking up an anti-colonial, ideological positionality is inscribed within this study's research purpose and three goals. Originally, this journey began with my extracurricular involvement in anti-sexist and antiracist organizing and educating in college. As a business and philosophy double major this involvement exposed me to education as a vehicle for transformative

personal and political change. Contrary to what many may assume, my decision to pursue teaching mathematics, rather than a more obviously political subject such as history, was not a departure from this path. Rather it was a decision I made during my senior year of college to embrace the ethos of Robert (Bob) Moses' work with the Algebra Project (2002), which positioned providing access to mathematical knowledge as an antiracist activity central to realizing justice as both a) the redistribution of resources and political power and b) full inclusion of people of color within the United States sociopolitical order (Moses & Cobb, 2002). This decision was further affirmed via my engagement with the works of criticalmathematicians, whom I was exposed to while pursuing my masters of education in secondary mathematics, and whose work informed my efforts as a high school mathematics educator.

Yet, my desire to develop a critical mathematics analytical framework from an anti-colonial perspective emerged, rhizomatically from my sometimes conflicting experiences and reflections as a teacher within Boston Public Schools, a teacher within an Oglala Lakota Tribally Chartered School, and as a Ph.D. student at Boston College. In particular, my experience teaching in an Oglala Lakota Tribally Chartered School exposed me to conceptualizations and calls for justice that seemed to be in radical opposition to notions of justice as articulated by both antiracist scholars and activists, such as Bob Moses, and other criticalmathematicians. First, although often lumped with other peoples of color, my elder Lakota colleagues often reminded me that American Indians, although they were sympathetic to and often engaged in the Civil Rights Movement, were attracted to the American Indian Movement because American Indians did not desire further "inclusion" within the settler colony (Deloria, 1988). Instead, they

made it clear that the Lakota people and other American Indian nations desired increased recognition as separate sovereign states with state-to-state treaty relationships with the United States (Grande, 2015). For me, realizing what seems to be the incommensurability and often contingent relationships (Tuck & Yang, 2012) between peoples of colors and American Indian liberation movements was revelatory. As such, questions such as “justice for who?” and “justice for what ends?” have arisen.

Second, although economic and sociopolitical injustices continue to affect the American Indian community I resided in, there was quite a bit of disagreement between individuals over how their sovereign state should engage with the environment to alleviate human suffering (e.g., developing a “wind farm”). In part, this tension seemed to hold the dual recognition of both the materiality of poverty and desires to maintain the Lakota ways of relating to the environment that are non-anthropocentric. Thus, my anthropocentric and commonly held antiracist position that one has to either first produce their own resources or capital, or repatriate capital from the settler colony in order to achieve economic justice, did not sit well with friends, or, even students. Instead, my forwarding of redistributive justice was correctly perceived as a part of the larger and problematic modern Western worldview that views land and fauna as resources to be transformed into fungible capital (e.g., the Gold Rush; Dakota Access Pipeline), and redistributed via colonial expansion/consumption (e.g., Louisiana purchase of 1803; General Allotment Act of 1887), which is both anthropocentric and intrinsically antithetical to American Indian sovereignty.

However, even though I have taken these insights to heart, I am also persuaded by Ta-Nehisi Coates (2014) case for reparations. In addition, I am sympathetic to the Global



South nation states' desire to balance power asymmetries between themselves and the West, via investment in Western STEM and infrastructure. These are non-reducible tensions and incommensurable histories or calls for justice (Tuck & Yang, 2012). As of yet, criticalmathematicians, like myself, have inadequately grappled with or illuminated manifestations of these incongruences using a comprehensive analytical framework, or otherwise.

My desire to engage an anti-colonial mathematics curriculum evaluation framework, in relation to a widely used and highly endorsed Common Core aligned curriculum, emerges from my desire to align my anti-colonial beliefs with my practice. Given my positionality and lived experience as a White male settler, I cannot and do not intend to speak as an Indigenous person or for Indigenous peoples. Rather, given my knowledge of mathematics education and facility with modern Western thought, I believe that I can contribute both meaningfully and authentically, by using an anti-colonial analytical framework to illuminate curricular manifestations of colonial logic, which is local to the West, within mainstream mathematics education texts.

With all of this being said, as a White person, it has been difficult striking a clear distinction between my critiques being informed by critical Indigenous and postcolonial ways of knowing and being, *versus* taking on these ways of knowing and being as my own intellectual property. This is a dangerous difference and, although certainly a personal difficulty, is not unique to me, as it has deep historical and cultural roots within White culture in the United States. Historically, the act of taking Indigenous (and other non-White peoples) ways of knowing and being as one's, personal property is connected to and parallel to the logics and institutionalization of Terra Nullius (i.e., empty land),

upon which US land claims (via the *doctrine of discovery*) are based (Wilson, 2000). Specifically, this doctrine circularly claims that land is empty and claimable up until an individual White person engages the land in a manner that another White person would consider *economically productive*. Within the social sciences, nowhere is this implicit logic more central than within the *ontological practice of the literature review*. Similar to the concept of *Terra Nullius*, the literature review, in part, positions one's work as filling a *knowledge gap* (read: empty or unclaimed intellectual terrain) within the (Western) literature. Like the doctrine of discovery, this ontological practice engages in a circular logic whereby those who wish to claim an intellectual construct as their own intellectual property may do so by first making sure that no other Western-trained researcher has already put this idea to *productive use* (i.e., publication) within Western-dominated academia.

Of course, the dissertation itself, as a single-authored intellectual process also demands a similar process and as such demands careful self-monitoring. For White researchers like myself, the erasure of both the contributions from our friends, family, colleagues, and advisors of color (Indigenous and otherwise) to our intellectual constructions mirrors the erasure of the labor and land thefts that built the United States into an imperial powerhouse. Further, out of respect for these members of my community, in addition to monitoring my over-owning of the knowledge production processes and product(s), I aimed to avoid under-owning my participation in White culture by claiming or signifying my non-participation in White culture, what Tuck and Yang (2012) may call a *move to innocence*. With this in mind, as a White male, I monitored my engagement what Maykut and Morehouse (1994) have articulated as the

paradoxical nature of qualitative research, “to be acutely tuned-in to the experiences and meaning systems of others—to indwell—and at the same time to be aware of how one’s own biases and preconceptions may be influencing what one is trying to understand” (p. 123).

Although it is a difficult goal, it was my goal in this paper to both acknowledge and speak from within and, at most, from the growing edge of my finite epistemological and ontological limits. To do this effectively, I engaged in two practices. First, I co-monitored my insider/outsider statuses, via a deliberative and scaffolded Vygotskian discourse guided by my dissertation advisor, that is, a more knowledgeable other, to help develop a “consciousness of difference” (Albert, 2005, p. 60). Second, I engaged in Tuck, Yang, and Gaztambide-Fernández’s (2015) citation practice challenge, which in building upon the work of Sara Ahmed (2013), argues that as citation practices are a reproductive technology that makes and re-makes fields of study, we must pay attention to and reflect upon whose work we do/should re-circulate, erase, and stop citing and the ways we approach the referencing of said works in our writing. Together, my goal was to not only produce knowledge useful for anti-colonial purposes, but also to do so through attentiveness towards anti-colonial praxis.

### **Definition of Terms**

In order to aid the readers of this study, two key terms are defined narratively, below: Indigenous and anti-colonial. These terms were selected because of their relative importance to this study and the problematic nature of their ambiguous usage. Indigenous will be discussed first given its centrality to defining the structure of settler colonialism, a key term itself, which is fully explicated within its eponymous section of the literature

review. Next, to avoid confusion with other related terms, anti-colonialism will be defined narratively in relation to anti-racism, decolonizing, and post-colonial. Finally, although criticalmathematics and anti-colonialism are often mentioned together in this study, criticalmathematics it is not discussed below as it is both treated extensively within the literature review and defined explicitly within the methods section.

First, this study works from Wildcat's (2009), an American Indian STEM educator's conceptualization of *Indigenous* and modifies it in relation to Grande's (2015) cautioning against both the *essentializing* and *post-modernizing* of Indigenous identity; processes linked to the dispossession of Indigenous peoples and the appropriation of their lands by the settler state. In line with Wildcat (2009), Indigenous as an adjective refers to ways of being (ontology); ways of knowing (epistemology); ways of conceptualizing human origins, spirit, and matter (cosmology); and fundamental assumptions about time, space, logic, order, nature of being (metaphysics) that stem from a people's reciprocal and mutual transformation of and by the particularities of a place within which they have had inter-generational relationships (Wildcat, 2009; Deloria & Wildcat, 2001).

Indigenous peoples as a noun, given the reality of our "everyday lives," which "are increasingly shaped by social forces such as corporations and marketers that attempt to transcend the unique features of the peoples and places of the planet" (Wildcat, 2009, p. 32), are not simply people who embody the philosophical precepts of the adjective Indigenous. Rather, Grande's (2015) call for "an Indigenous theory of subjectivity" that "addresses the political quest for sovereignty, the socioeconomic urgency to build transnational coalitions, and creates the intellectual space for social change," is affirmed in line with other calls to enhance Indigenous states' sovereign right to determine their

own membership (p. 163). Within this call is the understanding that the project of settler colonialism always necessitates the erasure of Indigenous peoples and nations for the purpose of land theft (Patel, 2014), which is often attempted by calls for the absorption of Indigenous peoples within peoples of color and by the metaphorical “border crossing” of non-Indigenous peoples, particularly White settlers, into a fluid conceptualization of Indigenous identity (Grande, 2015). As such, although anyone can attempt to live in a way that ruptures coloniality, attempts to claim an Indigenous subjectivity, within and beyond settler colonial states may act to undermine Indigenous peoples’ unique claims to land and thus advance Settler justification for further land theft.

As discussed further in the literature review, imperialism and colonialism and its particular manifestation within the United States, that is, settler colonialism rests upon a dichotomized Western logic that stratifies beingness on a continuum of fully human to non-living for the purposes of justifying and operationalizing dispossession for the purpose of material wealth accumulation (Wynter, 2003). The most effective system of oppression upon which this logic rests has been systemic racism, which is intertwined with systemic sexism, amongst other systems of stratification (Taylor, 2009). However, while anti-racism opposes systemic racism as a manifestation of the underlying logic of imperialism and colonialism that positions White Europeans as fully human and peoples of African descent and Indigenous peoples as closer to non-human beings, anti-racism does not inherently critique anthropocentrism or settler colonialism.

Yet, within the United States, the construction of race and anthropocentrism are genealogically linked (Grande, 2015). Anthropocentrism is a way of relating to and structuring reality whereby humans imagine their needs above, their agency

superordinate to, and themselves as separate from other beings and our shared habitat (Ani, 1994; Grande, 2015; Wynter, 2003). In viewing the world as de-agenized and de-spiritualized, the process of extracting wealth from our shared habitats, reconstituted as saleable and extractable land, was facilitated by the stolen labor or enslaved African and Indigenous peoples (Ani, 1994; Grande, 2015). However, as implied earlier, anti-racism is not always anti-anthropocentric. For example, an anti-racism framed in either capitalist or Marxist ideology, still presumes an anti-racist theory of change whereby a more just power, status, or wealth arrangement is affected via a more meritocratic or equitable distribution of *resources* derived, directly or indirectly from Indigenous lands (Grande, 2015). As discussed by Weheliye (2014) of course there are other theories of anti-racist change that are not anthropocentric, but the day-to-day burden of transitioning towards a non-anthropocentric, anti-racist way of being should be shouldered foremost by those who created these interlocking systems of dispossession: White folks.

Meanwhile, decolonization calls for the reciprocal re-matrimonization of land and beingness in such a way that removes the material, sociopolitical and economic structures (and logics) of imperialism and settler colonialism and allows for an Indigenous material, sociopolitical, and economic order (Tuck & Yang, 2012). Presumed within this is an anti-racist, that is, general anti-stratification ideology, but this is not necessarily the first work of decolonization. Rather, Indigenous sovereignty, de-Settling, and as implied by both, a new relationship with land and other beings is given primacy. Thus, anti-racism and decolonization may or may not be aligned, may or may not be concurrent, but either way - one is not a metonym for the other (Tuck & Yang, 2012).

Decolonization, as such, is not a light term, or a synonym for freeing one's mind of oppressive ideologies, even though such a process is nonetheless important and, even critical to such work (Tuck & Yang, 2012). A better term for the work encompassed herein and for much of the supposedly *decolonial* work in education is anti-colonial. For although teaching and learning within classrooms cannot unilaterally reshape our relationship to land and other beings this does not mean that educators and teacher educators should disallow themselves of the work of decolonization (Patel, 2014). Rather, as called by Patel (2014) we can collectively embrace an anti-colonial stance as it “still allows for locating the hydra-like shape-shifting yet implacable logics of settler colonialism, but does not include in its semantic shape the unmet promises of stripping away colonization, as the term *decolonization* gestures to do” (Patel, 2014, p. 360).

Finally, postcolonial is a term more useful to describing the study of and struggle against the ongoing power differentials between the nation states of the Global North and the Global South. In the spirit of postcolonial scholars such as Prashad (2012), the Global North represents the socio-economic and political alliance between imperial states, their allies, and settler colonial states, while the Global South represents the countries under imperial and/or (neo)(settler)colonial rule and their allies. Of course, these oppositional categories of Global North and Global South are a simplification of the relationships between places differentially identified with the legacy and ongoing project of imperialism via their degrees of responsibility for, participation in, subjugation by, and resistance to imperialism. However, it must be noted that as postcolonial studies and movements focus on balancing the power differentials between nation states, that “the actions of Indigenous [peoples have] faced as much resistance from the national

governments of the South as from the transnational firms that treated their land as *terra nullius*” (Prashad, 2012, p. 124).

Thus, although potentially placed into strategic and contingent alliances, postcolonial, anti-colonial, and decolonizing efforts are not inherently aligned. Yet, given the United States unique and dual position as the leader of the Global North and as a settler colony, anti-colonial thought within the context of the United States may necessitate considerations of both decolonizing and postcolonial thought, policy, and actions. Again, as strongly cautioned by Tuck and Yang (2012) these alliances may often be incommensurable and thus may be best approached strategically and contingently.



## **CHAPTER TWO: REVIEW OF THE LITERATURE**

This study aimed to build upon the work of anti-colonial scholars and criticalmathematics education scholars in order to develop and apply an analytical criticalmathematics framework from an anti-colonial perspective to evaluate a Common Core mathematics curriculum. Operating from an anti-colonial perspective, this literature review presents relevant theorizations of coloniality in the United States and the genealogical connections between coloniality, mathematics, and mathematics education within both the West and the United States. Working from within the criticalmathematics tradition, a review of critical, mathematics curriculum evaluations and criticalmathematics conceptualization of justice is presented and critiqued from an anti-colonial stance.

### **Settler Colonialism: The Structure of Coloniality in the United States**

The logics of colonialism, instantiated in the United States as settler colonialism, circumscribes every aspect of the historical, social, political, economic, and cultural dimensions of interpersonal, inter-species, and institutional life within the United States (Grande, 2015; Tuck & Yang, 2012). At its core, the logic of colonialism naturalizes systems of material dispossession and wealth accumulation via the projection of a biologically fallacious, hierarchical stratification of reality from fully human, to less than human, to non-living (Wynter, 2003). Between human beings this hierarchical logic, local to the West and globalized through systems of power (de Sousa Santos, 2008), defines wealthy-, able-bodied-, Western-, hetero-normative-, and cysgendered-males and their control-oriented, techno-material culture as superior (Ani, 1994; Wynter, 2003; Grande, 2015). Over the past 500 plus years, this hierarchy has justified the extraction of

excess labor and capital from other humans and their lands via the interlocking systems of racism, sexism, ableism, heterosexism, and classism. Concurrently, between human beings and other species this hierarchical logic has created an ecologically dangerous anthropocentrism that positions other species and our shared habitat as extractable resources to be managed, at best, technocratically, and in subordination to human needs (Grande, 2015).

Although the core logics of colonialism hold across contexts (Wynter, 2003; Grande, 2015), its instantiations are localized and adaptive to the particulars of place and peoples (Tuck & Yang, 2012). Broadly, in the US, colonialism instantiates itself as a form of settler colonialism, which given the US' global hegemony, takes on dimensions of both internal and external colonization (a.k.a., imperialism) (Tuck & Yang, 2012). Internally, settler colonialism is built upon the reconstitution of land as property (Grande, 2015; Seawright, 2014) and a triad of being, that is, enslaved, Indigenous, and settler, which is organized to facilitate the extraction of excess value from labor and land (Tuck & Yang, 2012). Historically and generally speaking, this triad of being assumes that Indigenous peoples and their land claims are constantly being erased, the labors of both enslaved Africans (and their descendants) and imperially-pushed migrants of Color are coerced for the purpose of reconstituting land as wealth. Accordingly, White settlers are differentially positioned to accumulate property (materially or psychological) as overseers of a process that benefits an extreme minority of elite Western capitalists (Tuck & Yang, 2012; Grande, 2015).

However, this is not to say that the structure of this triad is fixed. For, the core logic is not innately prescriptive nor a reflection of a deeper biological reality, but rather

organized to maximize wealth accumulation for the very few (Ani, 1994). As such, coloniality tends to have a highly flexible structure, which is able to combine and adapt to resist struggles for justice (Lowe, 2015). For example, as noted by critical race scholars, popular appeal for radical Civil Rights era calls for uprooting systemic racism have been incompletely, yet effectively co-opted by White settler institutions through the making of intermediary goals, such as resource re-distribution/reparations, which are only accessible through People of Color's competitive success and integration within perniciously racist, White, settler-colonial institutions (Bell, 1980; Delgado & Stefancic, 2012).

Thus, in this model Peoples of Color and Indigenous' peoples are asked to receive their reparations for violence via their competitive application, matriculation, and movement through the very same White settler institutions that were organized to maximize systemic violence for the perennial and problematic goal of anthropocentric, racially-stratified wealth accumulation. As such, justice as redistribution, given its effective co-option by White settler institutions, risks creating what Tuck and Yang (2012) have termed, a *merry-go-round* model of change/justice. In this *merry-go-round* of change/justice, the organizing logics of White settler colonial patriarchal institutions, which begets our intertwined social and ecological crises remains unchanged, even as the positions on the *merry-go-round* may superficially include a greater diversity of faces within it. Thus, there is no separation between past and ongoing systems of human and ecological injustices, just adaptations and combinations within the same perimeters of coloniality's logics (Lowe, 2015; Grande, 2015; Prashad, 2012).

Yet, with all due respect to Tuck and Yang's (2012) real and observed risk, as argued by Weheliye (2014), People of Color's aspirations for human freedom, even if

incommensurable with Indigenous peoples' desires, are not innately tied to the anthropocentric and stratifying logics of coloniality within the settler state. In particular, within Black and critical ethnic studies, there are a plethora of examples of anti-colonial thinking from non-anthropomorphic and non-stratifying stances (Weheliye, 2014). Nonetheless, given the often incommensurable aims of Indigenous peoples', Peoples of Color's, and White anti-colonial projects, solidarity within a settler state often means purposeful and tentative alliances, without the foreclosure of potential conflict and disunion (Tuck and Yang, 2012). However, as observed by Weheliye (2014), White people should bear the greatest responsibility and burden with respect to the material implications of solidarity in relation to projects of justice, including decolonization within the White settler state. On the other hand, if these often incommensurable justice projects aim towards (or at least contribute towards) inter-being, well-being, and life amplification (Wildcat, 2009; Cajete, 2000), then the short-term material implications of solidarity may plant seeds that may result in an increased bounty of wellness for all to harvest.

### **Curriculum and Coloniality**

Defining the term *curriculum* is not a philosophically, nor politically neutral act (Posner, 2004; Apple, 2008; Jackson, 1992). As such, there is no single or definitive conceptualization of curriculum. Rather than belabor and replicate a comprehensive list of how others have defined curriculum herein, in alignment with Jackson (1992), this study forwards Jackson's position that curriculum definitions, like all definitions, are parts of arguments embedded within rhetorical structures that aim to "persuade us of the value of looking at something in a particular way" (p. 12). Thus, given the objective of this study, that is, to understand the way coloniality manifests itself within mathematics

curriculum, the conceptualization of curriculum (and schooling) operationalized herein ideologically aligns most closely with critical sociocultural and economic reproduction theories of curriculum. Critical theorists, like Apple (2008) and Westbury (2008), who take on a critical sociocultural and economic position, focus on the ways curriculum privileges and advances particular forms of knowledge, ways of knowing, ways of being, and ways of understanding/interpreting social, political, and economic phenomenon.

Even in light of the political and philosophical implications of varying curricular definitions, Eisner's (2001) conceptualization of curriculum is intended to be broad enough to support sense making across a variety of ideological positions on the purposes and nature of curriculum. At its broadest level, Eisner (2001) defines curriculum as "a series of planned events that are intended to have educational consequences for one or more students" (p. 31). Eisner (2001) categorizes curriculum into the intended and operational curriculum, that is, the curriculum as described in formal documents, and the curriculum embodied in actual teaching practices and tests, respectively (Posner, 2004). Across these two manifestations of curriculum, Eisner (2001) further breaks down the curriculum into three concurrent curriculums: the explicit, the implicit, and the null (i.e., what is not included).

Although, the presence of sociocultural and economic reproduction is more widely associated with the *hidden curriculum*, for critical scholars, sociocultural and economic reproduction instantiates itself within both the intended and operational curriculum and across all three concurrent types of curriculum, that is, the explicit, the implicit, and the null (Apple, 2008). For example, in relation to the explicit intended curriculum, as noted by Kemmis and Stake (1988): "the content a curriculum includes,

the way the content is arranged, and the kind of pedagogy the curriculum enacts (the patterns it establishes for teaching and learning) reveal the values at work in schooling” (p. 46). For anti-colonial scholars theorizing within a settler state, this conceptualization of curriculum is particularly important, as settler states do not adhere to Indigenous ways of knowing and being, but rather transpose the dominant laws, epistemologies, and ontologies of the settlers’ home state(s) onto the lands they occupy (Tuck & Yang, 2012).

As such, the explicit curriculum is necessarily composed predominately of dominant settler ways of knowing and being, and the null curriculum is predominately composed of subjugated and inferiorly stratified ways of knowing and being. Of course, within the settler state, there are multiple ways of knowing and being, even within the Western tradition. However, as noted by Tuhiwai Smith (2012) there is incredible coherence across modernist Western ways of knowing and being in relation to metaphysical constructs, such as the individual and society, space, and time. As noted by many critical ecofeminist and/or critical Indigenous scholars, the core logics of modernist Western ways of knowing and being has facilitated and perpetuated the structures of coloniality that has affected our dual human and ecological crises (Wolfmeyer & Lupinacci, 2017; Tuhiwai Smith, 2012)

Although it is argued that the logics of coloniality are present within the explicit and null intended curriculums, it is also acknowledged that coloniality’s deep structures are largely transmitted to youth not by “explicit means, but rather by habituating them to specific forms of social organization and behavior patterns” that initiate them into the “formal and impersonal relations associated with market societies” (Grande, 2015, p. 100). Specifically, Grande (2015) forwards five habits of schooling [*italicized below*]

which promote a colonialist consciousness: 1) rewarding detached self-reliant *Independence* in spite of being in a wider social space; 2) upholding instrumentalist and consequentialist attitudes towards success via impersonal and abstract standards of *Achievement*; 3) the implicit rejection of spirituality and religion via the promotion of *Humanism*, that is, Western science and technology's inevitable triumph over all epistemological boundaries; 4) the idealization of one's *Detachment from Sources of Local and Personal Knowledge* in favor of *universalistic*, that is, modern and particularistic Western knowledge; and 5) schooling's separation from and fictitious (triumph over and) *Detachment from Nature* as progress and inevitable. Collectively, these habits of schooling aim to produce people who are "competitive, rational, materialistic, consumerist, and anthropocentric individuals," who act and think within the functional parameters of White settler colonial structures (Grande, 2015, p. 101).

Taken together, given the innate nature of the settler state as a hegemonic and transplanted cultural structure and Grande's (2015) synthesis of ecocritical and critical Indigenous observations of coloniality's deep structures, coloniality's concurrent presence within the explicit, null, and implicit curriculums is presumed within this study. Admittedly, this is a broad critique and is applicable to all subjects taught and ways of knowing and being promoted within the settler state. However, in the next section, a connection between curriculum, coloniality, mathematics, and mathematics education was established to evidence the need for the illumination of coloniality's logics within mathematics curriculum. This is uniquely worthwhile as, even more so than Western science, Western mathematics (outside of university-based mathematicians) is rarely recognized as being anything, but universal and thus in line with Platonic idealism.

## **The Development of Coloniality, Mathematics, and Mathematics Text(book)s from the Renaissance to the British/American settler colonies**

Herein, it is argued that Western mathematics has developed, and continues to develop, in direct relation to the demands of Imperial Western states and their, now independent, settler colonies. This claim is in line with a dynamic problem-driven view of mathematics (Thompson, 1992), as it assumes that mathematics has existed within all human cultures and societies and has developed to the specific needs and purposes of said cultures and/or societies (Bishop, 1990; D'Ambrosio, 2014). Specifically, it is argued in the following two sections that over the past 500 years, reciprocally, Western mathematics was advanced for the interlocking projects of hierarchical stratification for wealth accumulation, *which* were advanced by modern Western mathematics.

### **The Development of Mathematics for the Interlocking Projects of Hierarchical Stratification for Wealth Accumulation**

The development of Modern Western mathematics' and mathematics education occurred around 600 years ago and aligned directly with the rise of mercantile capitalism and, later, the rise of the settler colonies and/or Imperial nation states of Europe. In fact, modern mathematics education first gained traction in the merchant cities of Renaissance Italy during the 15<sup>th</sup> century, where it was sponsored by both "the rise of mercantile capitalism and the economic beginnings of industrialization" (Swetz, 1987, p. Xvii). These Italian cities' merchants and trade guilds heavy investment in the development of Reckoning schools, that is, schools of commercial arithmetic resulted in a mathematics education whose excellence was made evident by its attraction of the adolescent sons of merchants, civil servants, and the middle class from all over Europe (Swetz, 1987). In



these schools, rather than using abacuses and recording results with Roman numerals, as had been done since ancient Rome, students learned the highly efficient and symbolic Hindu-Arabic numeral system (used in the West today) and its corresponding computational schemes of *arithmetic*, developed by Muslim scholar (Abu Jafar Mhammed ibn Musa) al-Khwarizmi (Swetz, 1987, pp. 27-28).

Furthering the spread of al-Khwarizmi's eponymous *arithmetic*, and, eventually, the corresponding development of modern mathematical language within Europe, was the printing press. As exemplified by the widely circulated 1478 publication of Treviso Arithmetic, the first mathematics textbook (and one of the first printed books) known in the West, the importance of the printing press to the development of mathematics cannot be understated. For the printing press both facilitated the democratization of mathematical knowledge and, as the Hindu Arabic numerals were easier to print (and read) than the cluttered images of abacus calculations, distinctly shaped the development of standardized symbolic mathematics (Swetz, 1987; O'Halloran, 2005). In fact, Newton, amongst other mathematicians critical to Western mathematics development, was self-taught via mathematical text(book)s, which were made available through advances in the quality and affordability of printing (O'Halloran, 2005). As such, even though Venetians, amongst other European metropolises, created university chairs in mathematics dedicated to mathematics and mathematical sciences, in particular, navigation, most mathematical learning occurred via reckoning schools and/or mathematical texts (Swetz, 1987).

However, as important as the printing press was and mathematical texts, the elevation of mathematics as a discipline and the acceleration of its particular development in the West was a result of its profitability to the dual projects of expanded trade and

European colonization (O'Halloran, 2005). In this social, political, and economic environment, the demand for mathematical knowledge was so strong that by the end of the 15<sup>th</sup> century, most printed texts “were concerned with practical arithmetic and algebra” (O'Halloran, 2005, p. 33). In particular, during this time period, mathematics was driven by the need to refine navigational techniques and increase military strength in support of trade and early colonization (O'Halloran, 2005). Later, mathematics was called upon in colonies within the Americas and elsewhere to enhance the engineering, military, and mining capacities necessary to extract material wealth (D'Ambrosio, 2014).

Again, even with mathematics' increased prominence, most mathematical education was practical and taught in schools sponsored by mercantilists and trade guilds interested in increasing trade and colonial profits (O'Halloran, 2005; Holmes, 1997). For, unlike universities within Europe and the Americas today, mathematics role within universities from the 15<sup>th</sup> to the 18<sup>th</sup> centuries was minimal, as universities did not aim towards practical knowledge, but rather “scholastic speculation” (Swetz, 1987, p. 34; D'Ambrosio, 2014). Nonetheless, as noted explicitly by Holmes (1997) in relation to both mathematics and its mathematical sciences of astronomy and physics:

[T]hese studies had become matters of general, practical interest simultaneously with the 16th century exploration of the globe. The rewards of trade and conquest overseas made reliable navigation absolutely essential, and the necessity of crossing oceans made the rutters ...or landmark guidebooks of traditional European coastal navigation insufficient. The only reliable means of getting somewhere and back across seas devoid of landmarks and, more importantly, recording how one did so, was astronomical observation based upon a reliable

calendar. The key to geographical knowledge was thus astronomy, and the central link between astronomy and geography was provided by mathematics. Since reliable navigation was essential to successful foreign trade, the trading companies of London had a keen practical interest in these sciences. (p. 53-54)

Undoubtedly, the private sponsorship of mathematics and mathematics education within Europe and, of particular relevance to this study, in England, was motivated by its necessity for the realization of the dividends of colonialism and imperialism.

Within England, from whom the settler colony of the United States was begotten, mathematics had an especially prominent role in the development of Britain's strain of imperialism and settler colonialism, albeit via a circuitous path (Holmes, 1997). As meticulously argued by Holmes (1997), much of mathematics' prominence was connected to the efforts of John Dee. John Dee (1527-1608) was an advisor to royalty in the late 15<sup>th</sup> and early 16<sup>th</sup> centuries, whose writing primarily concerned the quadrivium of arithmetic, astronomy, geometry, and physics, but whose major contribution to British imperialism was the application of the Ramist method and the practical arts associated with mathematics to colonization schemes (Holmes, 1997).

Providing the mental architecture for a British colonial empire was both a) John Dee's *Synopsis* and *Perfect Arte of Navigation* and b) the Ramist method itself, which also structured the presentation of the former works (Holmes, 1997). To begin, the Ramist method utilized a "rigid system of dichotomies" in order to organize knowledge, decomposed into *tickets* (i.e., discrete pieces of information), from general statements into more specific components into a framework often visualized as a *branching tree* (Holmes, 1997, p. 41). Its adeptness at deconstructing, reorganizing, and unpacking

information in a systematic and digestible manner made it pervasive within the practical arts, all of which were essential to the “the spread of the British microcosmos,” that is, the replication of British society across the Atlantic Ocean (Holmes, 1997, p. 101).

Specifically, Dee’s two works, that is, the *Synopsis* and the *Perfect Arte of Navigation*, formed “the cradle of English colonization” as they articulate a vision and roadmap for a British sea-empire (Holmes, 1997, p. 115). Collectively, these works called for a British empire, bolstered by “naval and internal improvements” and linked to a “program of economic expansionism,” “methodical economic analysis,” and “development by corporate investors” (Holmes, 1997, p. 115). Such methodical approaches were necessary as the Spanish model of repaying investors relied upon the plunder of bullion-rich Native American empires, which was not replicable (Holmes, 1997, p. 22).

Rather, key to the English colonial model was the reconstitution of Indigenous land and fauna as a resource to be plundered through *development* (and, later enslavement) rather than seizure (Holmes, 1997; Grande, 2015; Tuck & Yang, 2012). In Dee’s works, the Ramist method explicitly aided in this process via the “objective analysis of land,” which involved the quantification and categorization of resources, strengths, and weaknesses of a prospective territory (Holmes, 1997, p. 108).

Paradoxically, this model gave the systems and structures of British settler colonialism logical consistency and coherence (Holmes, 1997), even as it allowed for an incredibly high degree of adaptability to the specifics of place and peoples (Tuck & Yang, 2012).

Further, Dee’s promotion of mathematics and the Ramist method were also central to the project of settler colonialism, given the former’s ability to enhance the

practical arts and the latter's ability to systematically break down, sequence, and later unpack all of the practical tasks necessary for extending the British microcosmos (Holmes, 1997). First, Dee saw mathematics as key to the methodical improvement and treatment of the practical arts, especially those related to "improving maps, navigation, gunnery, instruments, building and ship design," and a host of other practical arts necessary for colonization (Holmes, 1997, p. 68). Further, Dee's construction of a mathematical tree, under which all practical arts were subsumed, and his Ramist presentation of practical skills extended his vision of a mathematics, in service to the project of empire, into the public realm (Holmes, 1997, p. 69).

However, out of all of the practical arts, Dee prized architecture the most as he viewed it as the most mathematically exacting and practically central to the extension of the British Microcosmos (Holmes, 1997). First, the design and construction of a house, both of which relied upon architectural arts, was both necessary to day-to-day living and a legal condition for the possession of land, land being the basis of all wealth construction and extraction within the settler colony (Holmes, 1997, p. 130; Tuck & Yang, 2012). Further, through the mathematical exactness of architecture and the discipline of mathematics, which Dee forwarded as the logic governing a continuous intellectual universe, a coherent experiential and intellectual reality was reciprocally reinforced by the construction of the "house, village, city, colony" as extensions of the same inherent relationship between people, land, and other beings (Holmes, 1997, p. 130). This construction of perceptual reality, anthropocentrically, as wholly mappable, knowable, and thus controllable, was also enhanced by architecture's tangible ability to help the

English establish their “first outposts of empire” (Holmes, 1997, p. 127; Tuhiwai Smith, 2012).

Like other British settler colonies, the British settler colonies in the Americas that would become the original states of the United States, were largely colonized by individuals identifiable as Ramists (Holmes, 1997, p. 48). This was particularly true in New England, and especially in Massachusetts, where Ramist logic and Ramist texts on the practical arts greatly informed settlement (Holmes, 1997, p. 46). Even Harvard’s curriculum, though its original intent was religious, was decidedly Ramist (Holmes, 1997, p. 47) Non-coincidentally, given the Ramist devotion to the application of the mathematical practical arts for the projects of empire and settler colonialism, Massachusetts is both the location and model for the first public schools and state-funded Normal schools in the United States. However, in the earliest periods of settlement and until the 1800s in the United States, the formal study of mathematics in the university was not central, as it “mathematics long remained associated with the study of astronomy and geography in the universities, and with navigation, land surveying, business or building outside of them” (Holmes, 1997, p. 73).

### **The Development of Interlocking Projects of Hierarchical Stratification for Wealth Accumulation via the Semantic Resources of Western Mathematics**

As a consequence of the imperialistic investment by the Capital and the Crown in mathematics and mathematics education, Western mathematics and mathematics education for coloniality also developed. This, in turn, advanced Western colonialism and imperialism ideologically and materially. While Dee facilitated the engagement of, advancement of, and investment in the practical arts via mathematics for colonization,

Descartes', and later Newton's mathematical and philosophical works led to the development of mathematical semantic resources, that is, mathematical meaning making systems that would reshape "the face of the world and life on Earth" (O'Halloran, 2005, p. 58).

Descartes, in his distrust of sensory perception (e.g., *I think therefore I am*), developed the interconnected symbolic, visual, and written language of Western mathematics in support of his vision of mathematics as an infallible logic through which the natural world could be re-cast and fully understood (O'Halloran, 2005). The psychological dysfunction, particularly from the perspective of non-Westerners, in distrusting one's own sensory perception of reality has been commented on extensively by many for example, Wildcat (2001) and Ani (1994). Nonetheless, in tracing the history of mathematical representations within the West, O'Halloran (2005) notes the influence of Descartes' work in the growing absence of human actors and non-explicit purposes for solving mathematical problems (e.g., cannon trajectories). Specifically, Descartes promoted the "re-organization of perceptual reality" by reconstructing physical relationships through "the visual images of the curves, the symbolic description of those curves and the use of language....to create a new version of reality" (O'Halloran, 2005, p. 38).

Newton, building on Descartes' work, readmitted sense-perception, albeit through a filter that permitted only that which was physically observable and quantifiable, with enormous consequences for the British Empire (O'Halloran, 2005). First, the readmission of sensory perception within the exacting language of mathematical symbolism and visual curves facilitated the development of inductive, scientific reasoning. This led to

not only the *scientific revolution*, but also “a new way of conceptualizing the world using new forms of semiosis” (O’Halloran, 2005, p. 24). Second, with the reconceptualization of the physical world and recasting of the world in material, non-theological terms, the “means for industrialization, colonization and commerce rapidly increased” (O’Halloran, 2005, p. 58). In fact, mathematics’ high status within Western society is directly related to its ability to use its symbolic and visual meaning making systems, in conjunction with written language to actualize the aforementioned and interlocking projects of wealth accumulation (O’Halloran, 2005).

Ideologically, both mathematical language and its development of the practical arts and sciences enabled the material actualization of a scientific view of the world, which “underlines our day to day conceptions of reality” (O’Halloran, 2005, p. 94). The ability of mathematics to present itself as a discourse that “operates from an uncontested position of dominance” is rooted in its semantic choices that make it seem objective and factual based on a:

*combination of the restricted selections in the fields of experiential and interpersonal meaning in the mathematical symbolism (which is also reflected in linguistic parts of the text), the textual strategies of condensation through which meaning is officially encoded, and the emphasis directed towards logical meaning (pp. 113-114).*

This objective and factual ideological orientation of mathematical language, combined with the goals of Western mathematics “to order, to model situations, to present patterns, solve problems and to make predictions” make Western mathematics seem to represent



the “ultimate truth which is difficult to renegotiate, question or even interrupt” (O’Halloran, 2005, pp. 108, 116).

This linguistic orientation of mathematics adds to the more pernicious aspects of colonialism, that is ideological and psychological aspects, wherein mathematics education played a critical role in promoting Western culture as universal, value-free, law-like and superior to Indigenous forms of knowledge (Bishop, 1990; Bauchspies, Croissant, and Restivo, 2006). Moreover, in conjunction with its advancement of epistemological racism via the inferiorization of Indigenous ways of knowing and being, it also promoted a modernist way of relating to, perceiving, making sense of, and being within the world through its mechanistic, atomistic, and rationalistic portrayal of physical reality (Grande, 2015; Tuhiwai Smith, 2012). This advancement of modernism aided in the development of a colonialist consciousness, that is, the aforementioned rationalistic, materialistic, consumeristic, anthropocentric, and competitive orientation towards the Earth and other peoples (Grande, 2015). As such, postcolonial and anti-colonial scholars Semali and Kincheloe (1999) have claimed that mathematics, given its aforementioned cultural projection, is the most powerful cultural and hegemonic export of the Imperial West.

### **A Possible History of the Federal Influence on Mathematics Curriculum Reform in the United States from Founding to Present**

Even though mathematics has developed differently across societies, in relation to different social-economic, political, and cultural forces, there are several reasons why any individual within a society may desire or be encouraged to learn mathematics. For example, practically, mathematics has many useful applications in a wide-range of

human tasks and/or occupations; conceptually, mathematics can be quite engaging and enlivening; and, as argued by some Western humanists, can even help create the *proper discipline of the mind*. However, national mathematics curriculum reform is not about individual choices and desires, it is a project circumscribed by power. Curriculum projects of national import involve the coalescing of a variety of interests and groups around a particular set of choices, which privileges a particular selection, sequencing, contextualization, orientation, and delivery of content for specific purposes.

As argued herein, mathematics curriculum reform in the United States has always served the larger project of American wealth accumulation first, internally, via the ongoing and adaptive structure of the raced, gendered, and classed project of settler colonialism and later and then concurrently, externally via White/European supremacist imperialism. Given the historical power differentials between educationalists v. policy makers and their corporate interlopers it is not surprising that the purposes are driven by the latter with the former at times acting as “flexians,” that is, in this context, individuals who advance their educational priorities by framing them in the discourse of their powerful counterparts’ purposes (Wolfmeyer, 2014, p. 25). With this in mind, even though there are several worthwhile and comprehensive accounts of the curricular and pedagogical changes within mathematics education from the early 1800s to the *New-New Math* of the present (see Krulik & Weise, 1975; Grabiner, 1997; Schoenfeld, 2004; Jones & Coxford, 1970; Stanic & Kilpatrick, 2003), to date, there is no account of both a) mathematics education’s reform in relation to contemporaneous conceptualizations of race and b) mathematics education’s reform in relation to the America’s systems of wealth accumulation, that is, enslavement, settler colonialism, and imperialism.

The absence of race, settlement, enslavement, Indigenous dispossession, and imperialism in histories of mathematics curriculum reform is odd, as many authors have echoed Krulik and Weise's (1975) position that "mathematics education in the US has evolved intermeshed with the economic, sociological, and philosophical forces which have shaped the nation" (p. 59). Surely, all of these projects, however spun internally, are integral to the United States global hegemony, self-definitions, and relations between peoples and lands. As such, this absence is striking.

This absence is observed, even within the critical mathematics community. As self-consciously noted by Wolfmeyer (2014), Martin (2013; from Wolfmeyer, 2014) has rightfully critiqued critical mathematicians, like Wolfmeyer, for their lack of and/or theoretically weak analysis of mathematics education's development in relation to racism. Wolfmeyer (2014), to his credit, both masterfully synthesizes mathematics education's development from a neo-Marxist perspective and correctly observes that mathematics education's policy, historically, has rarely mentioned race explicitly. However, the same could be said of class, which is also infrequently cited explicitly in mathematics education policy, but nonetheless is rigorously analyzed by Wolfmeyer (2014) and others using conceptually-sound, neo-Marxist analytical frameworks. The irony of this, of course, is that within the United States, the imagery of *poverty* (low class) or of *impoverished* countries (3<sup>rd</sup> world, that is, the bottom global class) is not White, nor European.

Thus, the focus of this review of mathematics curriculum reform was on how race/racism, the dual projects of enslavement and settlement, and the concurrent project of imperialism advanced and/or was advanced by the development and expansion

mathematics education during specific intervals of time. Further, in what might be an oversimplifying stagnation of Tuck and Yang's (2012) construction of the settler-native-slave triad, the focus of this literature review was on tracking the mathematics education histories' of the original and raced positions within the triad, that is, White Americans, American Indians, and African Americans. A future interest would be a tracking of the educational histories of Hispanics/Latinx and Asian Americans in relation to both mathematics education and the desires of the White settler capitalist class, as expressed through policy.

Similar to Wolfmeyer's (2014) neo-Marxist critique, what is presented below is based off a historical interpolation of a) the critical, historical and sociological accounting of the construction of racism, settler colonialism, and imperialism and b) the historical accounts of federal involvement in mathematics education curriculum. Further, in the spirit of Prashad's (2012) *The Poorer Nations: A Possible History of the Global South*, the re-construction below is one interpretation and re-telling of the history of mathematics education. Further, like Prashad's use of the term "possible," this re-telling is plausible, as it builds from the work of other scholars while attempting to build a coherent narrative that aligns with what we know of the logic of Globalized White supremacy, that is, its quest for power and control for the purposes of material dispossession (Ani, 1994). Better researched, articulated, and theorized accounts are welcome. For now, this plausible interpolation focused on:

- 1820 to 1850: Federal investments in *mathematics* for the expansion of enslavement and the systematized theft of Indigenous lands

- 1850 to 1890: The North's federal exportation of *mathematics curriculum* for racial stratification, Indigenous erasure, and the seeding of American Imperialism
- 1890 to 1941: Standardization of *mathematics curriculum* for the development of the settler colony as an Imperial power
- 1941 to 1970: The *New Math* for the new Imperial powerhouse and the struggle with the Soviets over the direction of Imperialism
- 1970 to the Present: *Back to the Basics math and the New New Math* for White superiority, *for* yellow peril, and/or *for* all?

### **1820 To 1850: Federal Investments in Mathematics for the Expansion of Enslavement and the Systematized Theft of Indigenous Lands**

Before the United States could even begin to actualize a national mathematics curriculum, two pre-conditions needed to be met: 1) a collection of powerful interest groups would have to find a national curriculum desirable and 2) a group of educators capable of advancing such a curriculum would need to be cultivated. In relation to this, the 1820s to the 1850s saw an increased interest in the systematic mapping of “the new continent and the waters off its coasts” and a general advancement in scientific knowledge production driven by a “desire to explore, understand, and subdue the new land” (Grabiner, 1997, pp. 10, 12-13). Both interests necessitated increased mathematical knowledge and directly supported not only the powerful interests of Southern enslavers, eager to expand their already overwhelming wealth and political power within the new nation, but White settlement more generally, via the reconstitution of unseen Indigenous nation's lands as *mappable*, fungible, tradable, and marketable property (Baptist, 2016).

In response to this, the federal government enacted *affirmative action for Whites* by employing the first professional mathematicians in the construction of the Nautical Almanac and within the newly created US Coast Survey (Grabiner, 1997). Thus, tangibly, professional mathematicians, via their advancement of surveying and their facilitation of inventive financial instruments, made the prospects of and, later, the profiting from Black and Indigenous enslavement upon stolen Indigenous land possible for enslavers and/or settlers. Further, inventive financial instruments and the 1830 Indian Removal Act (and other thefts) also made it possible for any European national or Euro-American settler who was able and willing to buy a share of an enslaved person and/or a disarticulated piece of land to profit from the expansion of enslavement upon newly mapped and stolen Indigenous lands (Grande, 2015; Baptiste, 2015).

Nonetheless, during this time period, mathematics education played a very minor role in the general curriculums for White Settlers, free African Americans, and American Indians, who (coercively) attended the nation's first federally funded schools. For enslaved African Americans learning mathematics was prohibited, either de jure or de facto. For White settlers and immigrants, from the first settlements until the 1850s in the North, education was largely religious in nature, with mathematics having a limited role in the curriculum, even within college preparatory schools as neither Harvard, nor Yale, had many mathematics electives (D'Ambrosio, 2014; Grabiner, 1997). For Indigenous peoples during the 1820s to 1890s, the first peoples within the United States who (coercively) attended either federally funded religious mission schools (via the Civilization Fund, 1819-1873) and/or early vocational boarding schools, mathematics education was either nonexistent or marginally present within vocational training

programs for males only (Grande, 2015; Hagenbuch, 1998). These programs explicitly aimed to assimilate American Indians off their land and into industrial society for the facilitation of White Settlement and/or the expansion of enslavement (Grande, 2015). For African Americans, most of whom were enslaved, educational opportunities were both limited and, in most southern states were de jure, if not de facto forbidden. For example, in Virginia, it was a criminal offense to receive payment for teaching enslaved people or even assembling free Blacks for the purposes of learning (Julienne & Tarter, 2016).

### **1850 To 1890: The North's Federal Exportation of Mathematics Curriculum for Racial Stratification, Indigenous Erasure, and the Seeding of American Imperialism**

However, from the 1850s to the 1890s, the federal government's role in mathematics and mathematics education began to expand as Northern politicians and industrialists vied for political, social, and economic control over the shaping of the Settler States' project of wealth accumulation. Before the Civil War heavily industrialized Northern States, such as Massachusetts, increased their support for mathematics education in response to the demands of politically powerful industrialists (in particular those in railroad and textile) for a more consistently educated, technically-enabled, White-male workforce (Department of Education, Commonwealth of Massachusetts, 1930; Grabiner, 1997). This desire for a publicly funded expansion of the supply of uniformly educated White-male workers who could become technicians and/or technically trained managers (which, effectively brings down the cost of specialized labor for capitalists at the public's expense) also dovetailed with growing nativist interest in homogenizing the *eugenically*, that is pseudo-scientifically, less desirable White nationalities (Painter, 2010). Thus, moral reformers, industrialists, and local and state

governments began to fund public education alike. Together, this led to the construction of the first Normal Schools, that is, teacher colleges in Massachusetts, the expansion of State control and supervision in curriculum matters, and, given the success of these schools and the North's victory in the civil war, its expansion as the national model for teacher education (Hagenbuch, 1998; Department of Education, Commonwealth of Massachusetts, 1930). After the Civil War and as (the so called) *Indian Wars* ravaged on, the military success of the mathematical sciences applications in explosives, telegraph, medical statistics, and transportation infrastructure increased federal support for the mathematical sciences and mathematics education (Grabiner, 1997). This enthusiasm for mathematical science's usability for wealth creation within the settler state and beyond via imperialism, propagated into other areas as well, albeit indirectly, for example, federally-backed vocational education for both liberated African Americans and occupied American Indian nations (Grabiner, 1997).

For American Indians, this policy had two impetuses. First, by the 1870s, public backlash towards genocidal crimes committed during the *Indian Wars* increased federal interest in supporting more palatable genocidal policies aimed at "killing the Indian, but saving the man" (Hagenbuch, 1998). Second, the Freedman's Bureau's and Northern social reformers' racially paternalistic claims of success in "socializing and educating freed blacks," and in creating a class of Black educators who "have an opportunity of learning 'the three great lessons of life – how to live, how to labor, and how to teach others'" encouraged the federal government to expand a highly-gendered and racially-stratified, vocationally-oriented elementary and secondary public education (Hagenbuch, 1998, p. 55). Similar to other efforts to increase vocational education in the United States,



the prominence of mathematics education in this federally-backed curriculum meant increased federal investment in mathematics education reform.

To be clear, this vocational-oriented public education was not geared towards preparing African American males or American Indian males for jobs as technicians or technically trained managers, that is, White male jobs, but as jobs as self-sufficient farmers and compliant industrial workers. As such, the mathematics curriculum was more focused on the knowledge of arithmetic and its applications in farming, light industry, and household finances (Hagenbuch, 1998). Females, on the other hand, were prepared for domestic service or domestic life. For American Indians, unlike African Americans, the desire to instill an industrial or protestant work ethic was also linked to a desire to facilitate land theft through American Indian's indoctrination into capitalistic ontology either through the promotion of wage-based work in urban centers or individual farming plots (Grande, 2015).

Interestingly, although federally-backed curriculum for African Americans, via the Freedman's Bureau, was aimed at fitting them at the base of a racially stratified workforce, African American's yearning for and seemingly quenchless interest in literacy, mathematics, science, and their applications became a significant threat to White Supremacist structures and ideology. In light of the inaccessibility of quality education by the majority of Southern Whites, most of whom banked on the self-fashioned aristocratic race of Whiteness, Black educational excellence, in line with Coates' (2017) summarization of W.E.B. DuBois' analysis of White supremacy, triggered the greatest existential threat to White Supremacy, that is, Black (intellectual) superiority. Without such a threat, the Confederate South showed no indication of developing public education

for Southern Whites. Thus, to the presumed great discomfort of many Southern Whites, especially those who use *State's rights* as a racially-coded rallying cry for a glorified White supremacist police state, Southern public education and its increased interest in literacy and vocationally-oriented mathematics skills was Northern in design, federal in its exportation, and inspired by Blacks' superior educational outcomes. Interestingly, such a radical increase in the federal government's investment and intensity of efforts to improve public education was never replicated when the supposed *Achievement Gap* fallaciously evidenced Black inferiority.

However, the greatest impetus for federal mathematics curriculum reform was in higher education, which directly related to the further development of the Imperial Settler State's military and Industrial capacities, its maximization of profits from the settlement of occupied lands, and its economic system premised on racial stratification. Specifically, the simultaneous enactment of the Homestead Act of 1862 and the Morrill Land Grant Act of 1862, also known as the Land-Grant Agricultural and Mechanical College Act of 1862, was one of the country's greatest investments in mathematical sciences, its derivative fields, and mathematics education itself. As suggested in its descriptive title, the Land Grant Act of 1862 apportioned 30,000 acres of Indigenous land (then a *territory* of the US) per Senator and per Congressman to each State (including well-established states like Massachusetts; e.g., University of Massachusetts at Amherst) for the purpose of funding at least one University that actively supported education in military tactics, agricultural arts, and mechanical arts to advance the "practical education of the industrial classes in the several pursuits and professions in life (Morrill Act, 1862). This act also created a pipeline of future students for these new, Western land-grant universities by

earmarking every 1-square mile of each 6-square mile township in the West for the financial support of public education, a fact that “became a substantial factor in providing education to most American children who could never hope to attend private or charity-supported schools” (Morrill Act, 1862).

Although mathematics is not explicitly mentioned, military tactics, agricultural arts, and mechanical arts, and, generally, practical education writ large always required, to varying degrees, an expectation of mathematical fluency and/or literacy of its pupils beyond that required in typical liberal arts programs (Grabiner, 1997). As such, the federal government, through legislated policy, circumscribed the curricular conditions for a national system of State universities’, within which mathematics would serve a central role within its halls with the aim of “reshap[ing] the nation’s social and economic fabric” (Morrill Act, 1862). Therefore, our State University system represents the largest federal investment in mathematics education, constructed through an act of Congress and funded by the dispossession of and settlement upon Indigenous people’s lands.

### **1890 To 1941: Standardization of Mathematics Curriculum for the Development of the Settler Colony as an Imperial Power**

While the 1850s to 1890s were marked by the expansion of the federal government’s investment in and prescription of mathematics within public education curriculums, the 1890s to 1920s were distinguished by an emergence of federal interest and experimentation with the standardization of mathematics curriculums for White Americans and American Indians, in particular (Krulik & Weise, 1975). From the 1890s to the 1920s, the growth of the United States’ wealth relied upon the growth of its military and industrial strength. This in turn relied, internally, on the continued theft and

exploitation of Indigenous lands; the extraction of excess labor from a racially-stratified, homogenized, and specialized labor force; and, externally, upon greater access to labor and natural wealth beyond the US borders (i.e., Imperialism) for the extraction of oil, iron ore, rubber, and other raw materials and commodities necessary for *modern Industrialism*. All three of these projects depended on increased attention to and standardization of the quality of mathematics instruction within the United States.

For White Americans, the National Education Association of the United States Committee of Ten on Secondary School Studies (1894) was established over the federal government's and industry's concerns about the quality of secondary education for White pupils and, as such, was related to the desire for a more homogenized (read: whitened, *less ethnic*) and specialized White labor pool and military recruits. Although prepared by the National Educational Association, a non-governmental agency, it was a federally endorsed curriculum as "it was first published by the Bureau of Education, at Washington, and distributed at public expense" (NEA Committee of Ten, 1894, p. 12). Interestingly, as a federally backed curriculum, it explicitly rejected the pedagogical and curricular model of practical or vocational education, which at the time was being promoted by the federal government for African American and American Indian children. Specifically, this curriculum for White students advocated for a universal course of study, up to "the first year's work in algebra" (NEA Committee of 10, 1894, p. 107).

This concern over the development of the full mental potential of White students, who, according to the pseudo-scientific Eugenicist racial theories of the time, should be a state priority, seemed to predominate the energy of the discussion (Painter, 2010). For example, disproportionate space was allocated by the committee for the rebuffing of

commercial arithmetic, a more vocationally oriented mathematics program, aimed at preparing White pupils for “the demands of modern commercial and business life,” as it took up roughly 1/12<sup>th</sup> of committee’s entire report on the K-12 mathematics curriculum (NEA Committee of 10, 1894, p. 107). Specifically, the call for mathematics education for all White students included recommendations for increased inductive (i.e., scientific) reasoning, deeper conceptual understanding, inclusion of algebra in the middle school curriculum, a concurrent teaching of algebra and geometry, and a prioritization of complex integration over memorization and utilitarian applications (NEA Committee of 10, 1894; Krulik & Weise, 1975). In some ways, in the face of nativist concerns over the influx of less desirable White ethnic groups, this racially based logic was a radical rebuffing of classist and intra-racist notions of White hierarchy (Painter, 2010) and a reaffirmation of what Coates (2017) called the only true aristocracy of the United States, the race of White men.

Central to their sub-arguments was the claim “that such a discipline [that is, commercial arithmetic] is greatly inferior to that which may be gained by a different class of exercises,” which they warranted by the conjuring the racialized and speciesist warrant that “the movements of a race horse afford a better model of improving exercise than those of the ox in a tread-mill” (NEA Committee of 10, 1894, p. 108). For, like the race horse, White Americans were not to be conditioned to be the overworked Ox of industry, but rather the competitive, strong, intelligent, and freedom-loving being that would grow to outpace every other nation state’s, if you will, stable of horses. By comparison, African Americans and American Indians were, by analogy, expected to become the Oxen of industry and agriculture, stuck within a clearly defined treadmill.

Meanwhile, federal policies towards American Indian education had shifted from missionary towards vocational, assimilationist curricular schemes and by 1901, now received its first attempt at standardization via Superintendent of Indian Schools Estelle Reel's *Uniform Course of Study: Industrial and Literary (UCS)* (Lomawaima & Lomawaima, 1996). Unlike the Committee of 10's report, which afforded all White students, male and female alike, nearly equal educational access to an intellectually disciplining and homogenizing curriculum, the UCS was highly gendered and focused on "physical training as a spiritual leavener for a race she deemed 'too dull' to excel intellectually" (Lomawaima & Lomawaima, 1996, pp. 12-13). Although Reel was generally an advocate for practical education over liberal education for all races, her curriculum for American Indians was "intensely practical" and focused on education for "manual labor, agriculture, trades, and 'civilized,' but not too fancy, domestic life" (Lomawaima & Lomawaima, 1996, p. 12).

Reel's (1901) mathematics curriculum mirrored these objectives with six years of coursework in arithmetic (up through multiplication and division of fractions and whole numbers) and applied geometry, the latter being introduced only in relation to measurement scenarios (e.g., volume, area, distance in Imperial units) in gendered occupational roles such as carpentry or sewing (Reel, 1901). Further, this curriculum also mirrored the curriculum's assimilationist desires, for students by year six. In addition to being competent in the "multiplication and division of fractions" and "decimal fractions," students should be able to apply mathematics to manage "accounts and bills" and handle scenarios involving "interest" or "simple practical problems" of the White settler's *modernist* society (e.g., wall papering a room, "number of yards of wire required to fence

a field”) (Reel, 1901, pp. 50-51). In fact, “School and allotment [that is, the Dawes Act of 1887], which aimed at promoting capitalist logic via individual land ownership,” were perceived as equal educational institutions.” (Lomawaima & Lomawaima, 1996, p. 19). Noticeably absent is the Committee of Ten’s (1894) focus on conceptual understanding, the introduction of algebra in the middle grades, a premium on inductive reasoning, and a non-vocational, mental disciplinarian education.

Federally-endorsed vocational curriculums for African American’s in the South were the model of American Indian curriculum, which in turn were the models of curriculums sent by the United States to its newly occupied territories ceded after the Spanish-American War, that is, Puerto Rico and the Philippines. However, while American Indian educators like Reel (1901) exalted the work of early historically Black Normal schools such as Hampton and Tuskegee, and the historically Black agricultural and mechanical colleges created by the Morrill Land Act of 1890, American Indian children were recommended “more manual training programs rather than Normal schools” as Reel, representing the federal government’s broader position, viewed American Indians as “neither inventive nor creative, but merely, ‘wonderful imitators’” (Lomawaima & Lomawaima, 1996, p. 16). Given the United States historical imagining of Filipinos as both somewhere in between a) the ever shifting and geographically determinate bottom of the racial hierarchy, that is, between American Indians and African Americans, and b) *non-White Orientals* (Rodriguez, 2016) the federal distribution, but non-adoption of 6,000 copies of Reel’s (1901) *Uniform Course of Study* to the Philippines and Puerto Rico, is insightful to the US Imperial state’s desire (and later

enactment; see, Alidio, 2016) of education for hegemony and wealth accumulation as a project of empire (Lomawaima & Lomawaima, 1996).

As the United States grew as an imperial power (that is, its external modes of colonization) during the early 1900s up until the start of World War II, corporations backed by the federal government's military and diplomatic capacities began to take on the roles of managing the coercive resource and labor extraction that broadened the United States' wealth (Prashad, 2012; Galeano, 1997). The new demands and outlook that this shift in America's interlocking systems of racism, settler colonialism, and Imperialism also called upon a new outlook and demands for mathematics education. During this time, progressive era reforms dominated the federal government's shaping of White students mathematics education, which called for "the development of those attitudes, skills and knowledge needed by large corporations" via "changes to school instruction include[ing] the introduction of group work and problem solving, in the place of traditional drill and practice performed by individuals" (Wolfmeyer, 2014, p. 8).

In 1916, the federal government, in aiming for consistency of implementation and citing concern over the quality of teaching, encouraged the formation of "The National Committee on Mathematics Requirements ...under the Auspices of the Mathematical Association of America," which become the guide for both content selection and organization in the preparation of what currently is referred to as *traditional* American textbooks (Krulik & Weise, 1975, p. 64). Of note, is the committee's vision regarding the purpose of mathematics, which largely reflects a desire to develop a colonialist consciousness amongst White students via the mathematics curriculum:



*The primary purpose of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and space which are necessary to an insight into and control over our environment and to an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought and of action which will make these powers effective in the life of the individual (from report, but cited in Krulik & Weise, 1975, p. 65)*

Specifically, this report called for mathematics curriculum to focus on knowledge transfer, for functions to become the unifying concept in the mathematics curriculum, for a reduction in excessive drills in algebraic technique, for more practical and intuitive geometry, and for more opportunities for cross-curricular enrichment (Krulik & Weise, 1975). In addition, as was the trend, mathematics was recommended for all White students in every grade, although the elective system was encouraged for grades 10-12 with one set of options ostensibly for those in a vocational track (i.e., utilitarian ends and integrative – e.g., mathematics of investment, shop mathematics, surveying and navigation, and descriptive geometry) and those in a college preparatory track (i.e., focus on separate areas of math – e.g., plane demonstrative geometry, algebra, trigonometry, and elementary calculus) (Krulik & Weise, 1975). Such curricular divisions, of course, represented existing stratifications within White society based on intra-racial, linguistic, and genderized class distinctions in comparison to a White Anglo Saxon, Christian, and heteronormative ideal of White masculinity and, thus, collegiate and leadership capacity (Painter, 2010).

During this time period, both American Indians and African Americans in the South were being exposed to greater State and local control, as opposed to federal

influence over curriculum. After reconstruction, African Americans in the South attended segregated and deeply underfunded schools, which according to Miller (1919), were funded five to six times less per capita than schools for White children in the South. In the North, before the great migration of African Americans to Northern cities from 1915 to 1970, African Americans attended schools alongside White students and were not segregated by race (Du Bois, 1899; Smith, Osgood, & Young, 1912). Although the official government position advanced a practical, vocational education for African Americans in the South, W.E.B. DuBois and Booker T. Washington classically represented a similar division within the African American educational tradition as did White Americans; for example, Dubois and Washington focused on an intellectually ambitious (especially for a talented tenth) versus a preeminently practical or vocational educational philosophies. The latter of these positions, in line with the federal position and as seen elsewhere, demanded a solid mathematical foundation for the purported advancement of Black peoples. Of course, the radical difference in educational purposes between Black educators and that of the federal government was a desire to overcome and/or transcend White supremacy, rather than neutral complicity or active advancement of White supremacist ideology.

For American Indians, assimilation via integration into White public schools became the official policy from 1906 until the Indian Self-Determination and Education Act of 1975 (Grande, 2015). Although boarding schools continued to exist until 1933, when the Commissioner of Indian Affairs John Collier defunded them, by 1912, approximating half of American Indian children attended public schools. Bolstering this policy was the concurrent shift in policy for White American school children aimed at

addressing the “change in school population” (Krulik & Weise, 1975, p. 64). From 1880 to 1910 there was an increase in the immigration of less-desirable *ethnic* White immigrants who grew from 6.7 million to 13.5 million by 1910 through a homogenizing, Whitening curriculum aimed at preparing the *great-unwashed masses* “for a useful and productive life in society” (Krulik & Weise, 1975, p. 64). Therefore, one plausible explanation in the shift from a mathematics for all to an elective, tracked, secondary mathematics curriculum were racist and eugenicist policies, related to the integrationist Whitening of two groups whom the government considered inferior: the intra-racially-inferior, White immigrants and the racially-inferior American Indian students.

#### **1941 To 1970: The *New Math* for the New Imperial Powerhouse and the Struggle with the Soviets Over the Direction of Imperialism**

However, by 1941, Admiral Nimitz, chief of the bureau of navigation and later the Commander in Chief of the Pacific Fleet, sounded the alarm on the inadequate quality of mathematics education in the United States after 62% of the “4,200 entering freshman [sic] at 27 of the leading universities and college” failed an officer examination in mathematics covering arithmetical reasoning, combinations, vocabulary, and spatial relations (Nimitz, 1942, p. 213). Ostensibly, as this letter was written in 1941, this was a call to improve education for college-bound White male students, as the first female Naval officer was commissioned in 1942 via Public Law 689 and the first African American naval officers were commissioned in 1944, a.k.a., the Golden 13 (Comerford, 2012; Naval History and Heritage Command, 2018). Although evidently, a non-educator, given the reciprocal fact that “mathematics has been seen as a foundation for the nation’s military and economic preeminence,” Nimitz’s status as an Admiral gave him near

preeminent status amongst the Mathematical Association of America to evaluate the quality of mathematics education (Schoenfeld, 2004, p. 256).

Well before the American public was shocked by the sight of the Soviet's launch of Sputnik in 1957, Admiral Nimitz's letter, published shortly after the United States entered World War II, became a rallying cry for reform in the mathematics and mathematics education community (Krulik & Weise, 1975). In response to this, the National Council of Teachers of Mathematics published a three-part report titled *The Report of Commission on Post-War Plans*, but, "truth be told...there was not a huge amount of change in the actual curriculum, before or after these complaints" (Schoenfeld, 2004, p. 257). Without federal support from the National Science Foundation, funded in 1950 by an act of Congress and motivated by the *Cold War*, little curricular change took place (Schoenfeld, 2004; Krulik & Weise, 1975).

The *Cold War* itself and the *New Math* that emerged from it was largely a struggle for Imperial hegemony between the United States and its allies in the Global North versus Russia and its communist allies (Prashad, 2012). In many ways, the state's interest in bolstering mathematical sciences aimed at accelerating control-oriented scientific and technological developments, and as such signified (at least internally) both the cultural superiority of capitalism and the Western European tradition while maintaining the military and industrial capacity to maintain Imperial relationships globally (Prashad, 2012). With the support of the Carnegie Foundation and, shortly thereafter, from the newly formed National Science Foundation, the *University of Illinois Committee on School Mathematics* began constructing "the first large-scale [*New Math*] project designed to prepare materials for secondary school mathematics" (Krulik & Weise, 1975,

p. 78). The curricular materials and goals of this project served as an early exemplar of the principles of *New Math*, that is, a consistent presentation of mathematical content, an emphasis on precision and clarity of mathematical language, pedagogy aimed at intellectual engagement, the engagement of manipulatives for introductory topics, the internalization of mathematical rules and skills via discovery, and the prioritization of students' conceptual understanding (Krulik & Weise, 1975). These efforts at curricular change were accelerated by the National Science Foundation's support of the School Mathematics Study Group in 1958, which was founded by mathematicians, created sample *New Math* textbooks that in turn "provided a model for commercial texts" (Krulik & Weise, 1975, p. 80).

As noted by Martin (2013), the National Science Foundation's funding of *New Mathematics* was always focused on educating the *best and brightest*, which had a similar demographic target to the Committee of 10's report, which assumed them to be White men. In fact, like most other *New Math* curriculum projects, the *University of Illinois Committee on School Mathematics* curriculum was initially developed for "college bound students," and was later adapted for use with "other groups" of students (Krulik & Weise, 1975, p. 79). American Indians and African Americans were not the imagined targets of these programs. Rather, during this period, although there was an assimilationist tradition within the United States of accepting a select cohort of American Indians into US institutions (including educational institutions and the military), the federal government aggressively stepped up its assimilationist and vocational education policy via the Indian Relocation Act of 1956, which funded the relocation of American Indians for vocational education in urban cities (Grande, 2015). As a model policy during the *termination*

*period*, the federal government's goal, once again, was the integration of Indigenous lands into White holdings and the government's abrogation of its treaty responsibilities to Indigenous nations (Grande, 2015).

Further, this curricular shift was not intended for African American children either. It was not until the *Brown v. Board of Education* Supreme Court decision in 1954 and the Civil Rights Act of 1964 that segregation in public K-12 schools and historically White universities, respectively, became illegal. However, both actions were educationally significant and marked a major federal action, albeit only after mounting pressure from decades of Civil Rights activism, with the majority of activists being African American. Granted, due to the legacy and entrenchment of residential segregation after World War II, although segregated schools were *de jure* illegal, to date, schools remain *de facto* segregated. This is largely constructed by a) the concurrent and parallel practices of red lining and racialized land covenants that prevented *de jure* equal access to housing for People of Color until the Fair Housing Act of 1968 and b) ready access to an unprecedented supply of affordable homes in the suburbs, fueled by the federal construction of highways and easily attainable federally subsidized loans for White World War II veterans. On top of this, historically and into the present, the majority of school funding comes from local (44%) and state taxes (43%), and since local taxes are largely funded through property taxes, White families are at an inherent advantage given that White men's access to *property* is facilitated in the *affirmative* by government *action* (United States Government Accountability Office, 2014, p. 12).

## **1970 to the Present: *Back to the Basics Math* and the *New New Math* for White Superiority, *for Yellow Peril*, and/or *for All*?**

Nonetheless, by the 1970s, some People of Color were finally accessing rights that were originally enjoyed by White citizens since the 1798 Naturalization Act. The Act guaranteed all White people who immigrate access to the full benefits and protections of citizenship through naturalization. Interestingly, by the 1970s, there was also public backlash to the *New Math* from both parents and teachers who were calling for a shift *Back to the Basics*, a shift *back* towards a traditional mathematics curriculum. Curiously, many university-based mathematicians, also disagreed with the *New Math*, even though *New Math* itself was developed by mathematicians and mathematics educators (Wolfmeyer, 2014; Schoenfeld, 2004). Although Schoenfeld (2004) states that the public backlash, albeit ill-informed, stems from parents' inability to help their children with homework and teachers' discomfort with an unfamiliar implementing a curriculum, there is another explanation hidden within Schoenfeld's *Math Wars*.

Instead, is it possible that *popular* backlash to *New Math* curriculums, within a White majority populace, could be explained as White resistance to Affirmative Action policies? After all, the New Math was ostensibly a countermovement to the “the traditional curriculum, with its filtering mechanisms and high drop-out and failure rates (especially for certain minority groups)” (Schoenfeld, 2004, p. 281). Resembling the discourse of social meliorism, albeit for the purpose of maintaining global economic hegemony, *New Math* sounded like a rebuffing of the highly gendered and racialized social efficiency philosophies at the heart of the traditional curriculum, which was highly

effective at “putting and keeping certain groups ‘in their place,’” (Schoenfeld, 2004, p. 281).

Further, given the history of mathematics education in relation to race, which adults were intended for the traditional curriculum developed prior to and implemented from the 1920s-1940s by the National Committee on Mathematics Requirements? The answer, of course, is White adults, many of whom are now the parents of the 1960s and 1970s, and, in particular, White men, who also constitute the majority of the professorial ranks of mathematicians during the same period. Thus, perhaps, *Back to the Basics* represent the resolution of cognitive dissonance. For example, how does a White adult make sense of their difficulty with or solving a mathematics problem developed for children, especially when it is part of a new curriculum that People of Color and women are publicly benefiting from? For many White adults, this may have meant making the decision between: a) acknowledging some temporary inadequacies/inferiority in relation to Students of Color and/or women, which would run counter to their own racialized (and gendered) experiences of internalizing superiority within a White supremacist culture, or b) simply demarking the new curriculum as being inadequate/inferior (Helms, 1995). Of course, there are the very reasonable cognitive alternatives, which would sidestep the issue entirely. For instance, one could determine that *New Math* is an equally valid way of doing mathematics, which they have not *yet* had the opportunity to understand, but may also benefit from (and dare one say, enjoy) coming to understand. Interestingly, this latter consideration did not seem to win the day, but seems curiously present within the logic of the *Growth Mindset* movement within mathematics education in the 2010s.



Concurrently, during the 1960s and 1970s, American Indians had successfully fought for greater recognition of their treaty rights, as sovereign states who require a government-to-government relationship, which in the field of education, culminated in the Indian Self-Determination and Education Act of 1975 (Grande, 2015). This act provided American Indians increased authority over their children's education via greater control over school funding, "parent involvement in program planning," "the establishment of community-run schools," and the creation of "culturally relevant and bilingual curriculum materials" (Grande, 2015, p. 20). It is important to note that unlike the highly visible integrationist Civil Rights project of the 1960s, advanced largely by a sub-set of African American activists, American Indian's efforts centered on increasing sovereignty and rejecting integrationist plans for assimilation. Although both movements are laudable, as advanced by Tuck and Yang (2012), these two projects are often incommensurable.

Yet, by 1980, based on results from comparative international tests, the failure of the *Back to the Basics* movement was well evidenced empirically, leading to the National Council of Teachers of Mathematics publication of an *Agenda for Action*, which largely called for a shift towards promoting problem solving in mathematics classrooms (Schoenfeld, 2004). At the same time, the national economy slowed, while "Japanese and other Asian economies" rose and, along with it, re-articulations of *yellow peril* (Schoenfeld, 2004, p. 259; Wolfmeyer, 2014). *Yellow peril* is a term popularized by novelist Jack London within Hearst newspapers that builds from the social Darwinist belief that "human life was governed by evolutionary competition for resources between opposing races," within which Asians are "innately hostile to people of European

descent” (Robinson, 2001, p. 16). Specifically, the discourse of *yellow peril* hypocritically fears mongers a reversal of imperialism, wherein Asia, “weary of white domination” would “rise up, with Japan at their head, and challenge the Anglo-Saxon race for world domination” (Robinson, 2001, p. 31; Wu, 2002). Such sentiments were not without import or impact, as they had directly justified Japanese internment during World War II and sustained an austere restriction of immigration from Asia from the 1924 Immigration Act until the passage of the 1965 Immigration Law (Robinson, 2001; Wu, 2002; Takaki, 1998; Tamura, 2001).

In this context of yellow peril, U.S. Secretary of Education Bell appointed the National Commission on Excellence in Education in 1981 to produce the *Nation at Risk* (1983). This report both lamented losses in mathematics performance since the shelving of the 1950s and 1960s *New Math* curriculums during the 1970s, and claimed that our preeminence in commerce and science were at risk due to our “unthinking, unilateral educational disarmament,” which needed to be reversed via “genuinely high standards” with the aim of creating a “learning society” (National Commission on Excellence in Education, 1983). In general, it reaffirmed economic prosperity, military superiority, and the fostering of a common culture as the central purposes of mathematics education while, at the same time, asserting the belief that such purposes can be achieved while creating a curriculum focused on both providing equity, without mediocrity and high-quality, without elitism. Interestingly, parallel to the ethos that ushered in the democratic extension of public schooling to Southern Whites after the Civil War, that is, fear of Black intellectual superiority, the ethos that ushered in a democratic discourse on high quality mathematics education for all races was the fear of Asian economic superiority.

This discourse was furthered by McKnight (1987) with the publication of the *Underachieving Curriculum*, which condemned, described, and explicated American mathematics curriculum's supposed inadequacies from the perspective of Japan's and Hong Kong's superior mathematical performance on standardized international tests. Contrary to Schoenfeld's (2004) surprise, within this discursive environment of *yellow peril*, it is predictable that the National Council of Teachers of Mathematics and the National Research Council coordinated the 1989 releases of the *Curriculum and Evaluation Standards for School Mathematics* (a.k.a., *Standards*) and *Everybody Counts*, respectively, which was well received and widely circulated. Both documents signaled its connection to the perceived social-cultural-political-economic threats of Japan and Hong Kong, namely, *yellow peril*, by reifying mathematics education's role as central to the United States' economic, political, and cultural future (Diaz, 2016).

Meanwhile, educationally, these documents were well conceived. Using findings from the *Underachieving Curriculum* (1987) that U.S. students were "well below the international average" in problem solving, these documents, backed their claims from research by cognitive scientists and studies on how professional mathematicians construct innovative knowledge (Schoenfeld, 2004). Most significantly, they called for increased opportunities for students to engage in mathematical thinking and problem solving (Schoenfeld, 2004). Dubbed the *New-New Math* by its opponents, it resembled *New Math* in its shift away from procedural arithmetic and didactic teaching methods towards a non-prescriptive vision of K-12 mathematics centered on increased group work, problem solving, conceptual understanding, metacognition, and mathematical thinking (Schoenfeld, 2004). In addition, similar to *New Math*, it not only offered a mathematics

curriculum, whose ways of teaching and learning served women and People of Color better, but also, as indicated in its title, *Everybody Counts*, centered equality in relation to race, gender, and class as explicit curricular goals. Again, could it be true that resistance to this program was related to anxiety around retaining one's ability, as a White person, to internalize notions of superiority in relation to race? For if one embraces the integrationist and, as such, the Affirmative Action discourse of *Everybody Counts*, does one worry about the risk of possibly seeing the tangible evidence of one's fictitious superiority in which equal educational achievement and thus superior achievement by Whites disappear? After all, what are anti-Affirmative Action claims, such as, "They took our seats!," all about?

Yet, for all of its discussions of equality and its slogan of *Mathematics for All*, these documents, similar to their progeny, perniciously frame Western mathematical thinking and approaches to problem solving as non-culturally specific. Per se, they inevitably set up a dichotomized, racialized, and oppositional set of student identities, that is, Students of Color who are impediments to national progress and White (and Asian) students who are stalwarts of national progress (Diaz, 2016). For if barriers to rigorous mathematics teaching and learning are removed, if all students have the capacity to learn mathematics, and if critical versions of history and sociology are ignored, as they were in these documents, then who is responsible for student failure? In line with this, Asian Americans, although not positioned as stalwarts of national progress (given raced notions of their unassimilability) they are nonetheless opportunistically positioned as the *model minority* and thus as evidence of non-structural forces preventing gains for other Students of Color (Wu, 2002).

The documents discussed here are absent of any concurrent calls for structural relief, which Ladson-Billings (2006) aptly characterized as an *education debt* to People of Color. Furthermore, these documents present an ahistorical, anti-empirical, and definitively meritocratic discourse that improperly puts the life outcomes of children of Color squarely in their own hands. As expected, the oppositional identities foreshadowed in these policy documents found a rhetorical match in the achievement gap discourse was constructed in the 1960s and remerged in the 1980s as a research agenda and hit its stride in the 1990s and 2000s (Ladson-Billings, 2006). In constructing an achievement gap, attention was directed towards People of Color's performance, rather than towards an ongoing system of racism. For example, the systematic structures of racially disparate school funding schemes, nor the unilateral construction of tests based on the Anglo-American intellectual tradition was considered.

As such, this discourse also has the potential of maintaining, what Du Bois (2014) termed the *physiological wages of Whiteness*, while attending to threats to U.S. imperial hegemony. Specifically, even with the risk of Asian economic superiority, one could say, "at least in the United States, which colloquially is often dubbed a *United Nations onto itself*, White Americans, according to the achievement gap, have historically and into the present performed superiorly," This is, of course, not true as Asian Americans on average and as a collective, perform better than White students on standardized tests. However, as noted by Wu (2002) when Asian Americans perform superiorly to White Americans on standardized tests and when the Japanese outperform Americans in mathematical problem solving tasks, White Americans disregard such achievements by casting people

of Asian descent, specifically Asian men, as robotic, non-creative, and procedural, compared to the supposed dynamism of White masculinity.

In this tradition, based on the 1989 Standards and funded by the National Science Foundation, curriculum based on the *Standards* emerged as early as 1993, and by the year 2000, produced results “unambiguously in favor of reform” (Schoenfeld, 2004, p. 270). With this evidence, combined with increased calls for educational institutions to both prepare the youth against U.S. economic threats (presumably from Asian nations, that is, yellow peril) and the closing of the (White-superiority-affirming) achievement gap, the National Council Teachers of Mathematics published the *Principles and Standards for School Mathematics* in the year 2000. Part of its successful reception, despite the ongoing *Math Wars*, was the process that included many rounds of public drafts, public feedback, and thorough review and oversight and support from the National Research Council (Schoenfeld, 2004).

Shortly thereafter in 2001, while using the same racial rhetoric of international competitiveness and the achievement gap, the *No Child Left Behind Act* with its accountability discourse and requirements for state testing, was enacted, which ushered in a federally initiated age of racialized, neoliberal mathematics education policy. Combined with the *Race to the Top* funds in December of 2009 that required economically-depressed states to quickly adopt college and career ready standards (facilitated by the near concurrent publication of the college and career ready Common Core State Standards in early 2010), for the first time, the potential for neoliberal, market-like comparisons of schools was possible under the banner of justice (Patel, 2014; Apple, 2008). Further, perceived by many as an affront to Indigenous sovereignty, the *No Child*

*Left Behind Act*, with its stipulations around Title I funds and annual yearly progress reports, serve as a incidentally re-opened federal incursions into American Indian curriculums as, unlike public schools, they are both entirely funded by federal agencies and rely partially, albeit significantly, on Title I funds (U.S. Government Accountability Office, 2014).

As noted by Apple (2008), there is an “established tradition of the conservative production of discourse that incorporates progressive language while simultaneously advancing key elements of the neoliberal and neoconservative agendas” (p. 29). For example, the leading organization for mathematics educators in the United States, that is, the National Council of Teachers of Mathematics (2015), claims that the achievement of equity will be assessed by “student outcomes—including achievement on a range of mathematics assessments, disposition toward mathematics, and persistence in the mathematics pipeline” (n.p). Thus, both neoliberal-backed, high-stakes testing and capital’s labor demands are prioritized and validated under the banner of equity and justice.

Disturbingly, given the ongoing reality of systemic racism, NCTM’s calls for increased participation of Students of Color, “not in the service of their families or communities, but for the overall economic health of the nation,” which as commonly measured by stock market gains, evidently “privileges those already in positions of economic well-being” is detestable (Berry, Ellis, & Hughes, 2014, p. 547). Further, in alignment with Wolfmeyer (2014), calls for college and career readiness are largely in the interest of increasing human capital of all workers, thus increasing the supply of skilled workers and, consequently, lowering the wages such workers can demand. This, of

course, serves the interests of “corporate profit rather than individual economic success,” while doing nothing to disrupt the racially stratified and patriarchal global projects of wealth accumulation (Wolfmeyer, 2014, p. 72).

Together, this creates a sketch of a mathematics curriculum project that is hardly for all, but rather for the interests of an elite global minority. At its head is, ostensibly, a corporate and political elite (Wolfmeyer, 2014) who are wielding White superiority via the achievement gap, yellow peril via international testing and comparisons, and integrationist notions of justice via mathematics for all to cajole a racially stratified populace into its aims. All the while, such aims, by design, lead to the majority of US citizens to forgo their own wellbeing at the bequest of the settler, Imperial state and at the expense of Indigenous sovereignty, the citizens of Global South nations, and other beings and our shared habitats.

### **Empirical Review of Critical, Qualitative Curriculum Evaluations from 1980 to Present**

The purpose of this qualitative curriculum evaluation was to construct a critical mathematics analytical framework from an anti-colonial perspective and engage it iteratively to evaluate a Common Core-aligned middle school mathematics curriculum. The underlying goal was to use the understandings generated from this evaluation to advance both human and ecological justice. In order to understand both the significance of this study specifically and the field of critical curriculum inquiry within mathematics education more broadly, a systematic search for peer-reviewed, empirical evaluations of mathematics education curricula since 1980 was undertaken. To date, based on a systematic review of Education Source, Education Reference Complete, and ProQuest



Dissertations, evidence was not found of a study that analyzed a mathematics curriculum for the purposes of illuminating the presence of colonial logics in mathematics education texts. However, as discussed below, there are seven kindred studies that try to illuminate the presence of constructs of sociopolitical import, e.g., values or gender stereotyping, in the mathematics curriculum.

Taken as a whole, the systematic search for empirical inquiries into a mathematics curriculum yielded three broad approaches to curriculum evaluation: comparative analysis (32 studies), case study (8 studies), and content analysis (33 studies) (Confrey, 2008). Of these studies, only eight studies were critical in nature, that is, they attended to issues of power, justice, and/or, oppression in some form, and all of these studies approached curriculum evaluation using some variety of content analysis. In addition, similar to the study undertaken herein, six of these seven studies analyze a mathematics textbook. However, given the dearth of critical evaluation studies in mathematics education and its relevance to the current study, Diaz's (2016) analysis of national mathematics policy documents was included despite this discrepancy. Collectively, these critical studies use content analysis to critically engage mathematics curriculum for the purposes of inquiring into the relationships between mathematics textbooks and gender (Bailey, 1988; Nibbelink, Stockdale, & Mangru, 1986), mathematics textbooks and the intersectionality of gender and race (Peterson Fischer, 2004), mathematics textbooks and Western ways of knowing and being (Dede, 2006a; Dede, 2006b), the transformation of Indigenous ethnomathematical ideas in Western mathematics textbooks (Dickenson-Jones, 2008), and discourses of stratification, broadly construed (Diaz, 2016; Dowling, 1996).

Nibbelink, Stockdale, and Mangru (1986) and Bailey (1988) similarly inquire into the construction of gender within mathematics textbooks by analyzing the relative frequency of gendered representations in relation to “sex-role assignments”/“sex stereotyping”, respectively, within elementary mathematics textbooks. As indicated by the use of the term “sex,” both studies operationalize a problematically binary notion of gender, which is fallacious from the perspectives of both a theorization of gender as a social construct and the empirically lived experiences of the diversity of ways peoples are gendered otherwise across a variety of places/spaces. Yet, both studies do offer insight into mathematics education’s hidden curriculum in relation to gender.

Nibbelink, Stockdale, and Mangru (1986), in particular, inquire into the relationship between the feminist movement and the proportion of gender to gendered-occupation assignments within mathematics textbooks. Specifically, they categorized the mathematics problems of the three most used textbooks in Iowa for the mid 1930s, mid 1950s, mid 1960s, early 1970s, late 1970s, early 1980s, and late 1980s in terms of the proportion of problems that featured males/females in neutral roles, males/females in male roles, and males/females in female roles. The results indicate that the feminist movement did have an impact on the relative frequencies of gender to gendered-occupations from the late 1970s onward for both sexes because there was a movement towards fewer stories about people, which falsely sidesteps the issue of gender, and shifts towards the assignment of more gender-neutral professions for both males and females.

Nonetheless, as rightly pointed out by the authors, since math problems are fictitious, if the socio-political and economic forces were aligned, it should be easy to create a textbook that is nonsexist, which, as operationalized by the authors, would be a

textbook that has completely gender-balanced occupation role assignments. Thus, antisexist mathematics curriculums are entirely possible. Oddly though, the implications indicate that for changes to happen in mathematics curriculum's problematically gendered hidden curriculum, the very "consumers" who are exposed to this hidden curriculum as children, but not its adult authors or producers who profit from it, are expected to grow up to demand a differently gendered mathematics curriculum. Given the author's concern about the potential influence of the hidden curriculum in mathematics' hegemonic construction of gender on students' consciousness, this theory of change seems to lack solvency.

Bailey (1988), in framing anti-sexism in mathematics in terms of equal participation and performance by sex posits that sex-stereotyping in primary school mathematics curriculum may be, partially responsible for the disparate participation and outcomes by sex that favor males in upper level mathematics classes within Britain. As such, the author examines three widely used mathematics curricular programs' infant, second year junior, and fourth year junior workbooks, textbooks, and work-cards using Kepner and Koehn's (1977) criteria for evaluating sexism in elementary mathematics textbooks. In particular, this analytical framework was operationalized to identify and characterize the percent and gendered nature of problems and illustrations with male/female figures and their occupations and/or activities therein.

In doing so, Bailey (1988) found that males tended to not only have greater representation in illustrations and problems, especially in the upper elementary grade-levels, but that they have a greater variety of professional roles (almost ten to one across all curriculums) and generally engage in more serious and strenuous activities. Females,

on the other hand, were represented less, engaged in more passive activities, and were typically limited to highly gendered professional roles, such as an elementary teacher, housewife, or cleaner. Although no implications were offered, the author left a clear impression that the elementary mathematics curriculum in Britain clearly gendered mathematics as an activity that men significantly engage in throughout their lives to pursue sociologically valued occupations. This clearly presents mathematics' hidden curriculum with respect to gender as responsible, to a highly culpable degree, for women's' limited participation and/or limited assignment to upper level mathematics and success therein.

Peterson Fisher (2004) conducted a comprehensive comparative content analysis investigation of Saxon Math, a traditional mathematics curriculum, and Investigations, a National Science Foundation and reform-based curriculum. The analysis focused primarily on fourth-grade material and resources for the two curriculums, which targeted content presentation, construction of teaching/learning contexts, content and lesson organization, assessment orientation, and orientation towards the intersectionality of gender and racial equity. Of most relevance to this study is Peterson Fisher's theorization of the intersectionality of gender and racial equity and the operationalization of this theorization within a content analysis framework was used to evaluate the aforementioned curriculums. For Peterson Fisher (2004), gender equity means presenting female students with opportunities to engage in non-routine problems via female ways of knowing and being, (e.g., relational learning with peers and connected and intuitive thinking), while developing self-efficacy and confidence, especially in ways of knowing

and being that are traditionally associated with males, such as spatial reasoning and technology.

Racial equity is presented additively, that is, parallel to gender equity, as opposed to as an assemblage of interacting, integrative, and mutually constituting constructions. Specifically, racial equity is advanced in terms of cultural relevant teaching, which is conceptualized as a way of teaching that illuminates issues of power while validating the ways of knowing and being of African Americans, creating greater cultural congruity between home and school, and aiming to transcend the harmful effects of the “dominant culture,” that is, White American culture (Peterson Fisher, 2004, p. 381). Thus, although attentive to the relationship between race and power, this definition of racial equity does nothing to disentangle the presumed fixed-trait relationship between race and culture, which has been aptly criticized by the likes of Gutiérrez and Rogoff (2003) and others for re-biologizing race, as opposed to confronting it as a social construct that is levied to stratify peoples for the purposes of dispossession.

Methodologically, these conceptualizations of gender and racial equity were engaged by both a quantitative, manifest content analysis and a more qualitative, latent content analysis. The quantitative analysis of manifest mathematics content through counts of names and images to categorize as African American or White and female or male. In terms of qualitative latent content analysis, the presence of contexts and thoughts of females and/or African Americans were analyzed and presented descriptively.

Although both texts were wanting, in relation to their ability, in the systematic promotion of gender and/or racial equity, the Investigations curriculum scored significantly higher than Saxon mathematics. First, Investigation presented both a higher

proportion of African American names, that is, 2% of names v. over 15% of names, and female names and images, that is, greater than 50% v. less than 45%, but also involved word problems and content introductions that aspired towards cultural relevance via the inclusion of students' material culture, albeit not deeper aspects of students' community of cultural practices. Additionally, in relation to female and African American ways of knowing and being, Investigations rated higher largely due to reform mathematics orientation towards communication of mathematical ideas, explanation over recitation, meaningful contextualization of mathematics, and collaborative problem solving. Emerging from this analysis, explicit and extensive recommendations highlighted the importance of including more culturally relevant content per content domain and adjustments to mathematical pedagogy for greater inclusion, i.e., thematic units and cooperative groups.

Similar to Peterson Fisher (2004), Dickenson-Jones (2008) is concerned with the ways Western mathematics relates to other ways of knowing and being. Specifically, Dickenson-Jones investigates the ways in which Indigenous ways of knowing and being transform when they are included in Western mathematics curriculum. Motivating this study is a similar assumption that culturally relevant material, in this case, ethnomathematical material, will affirm students' ways of knowing and being, thus reducing racial/cultural inequity, and persuade students to see mathematics as more relevant to their lives and themselves, as mathematical persons. Further, and beyond Peterson Fisher's (2004) presentation of culturally relevant material, Dickenson-Jones (2008) explicitly positions Indigenous peoples' mathematics and Western mathematics as concurrent, equally valid ways of knowing.

In order to determine how Indigenous ways of knowing and being were transformed in Western mathematics curriculum, the author descriptively and comparatively analyzed seven different mathematics curriculums used with and/or by Indigenous nations within the borders of New Zealand, Papua New Guinea, and Australia. As part of the selection criteria that supported the comparative analysis, all of the mathematics texts selected had to reference/engage cultural practices that could be compared to the English language, anthropological literature on the cultural practice. Of course, this is problematic, given the legacy of racist transformations of Indigenous ways of knowing and being by non-Indigenous anthropologists into academic English, that is, an English language variety ill-equipped for presenting non-hegemonic and non-Western ways of knowing and being (Tuhiwai Smith, 2012). As such, the ability of the author to fully understand the degree of transformation from Indigenous practices in Western mathematical texts is severely limited in this study.

Nonetheless, the author presents their findings in a concentric, non-hierarchical model that characterizes the degree of a curriculum's engagement with cultural practice. The model is presented using an outside-to-inside circle described below: disjunction - cultural material is an engaging stepping-stone to learning Western mathematics; translation - students engage in some aspect of a cultural practice by utilizing Western mathematics to complete the task; integration - students theoretically compare Indigenous and Western ways of knowing mathematics, but students are only tasked with Western mathematics; correlation - students are tasked with concretely comparing Indigenous and Western ways of knowing mathematics; and union - students engage in a cultural practice for its intended purposes and the Western mathematical task is approached from this

perspective. Examples of each type were found across the texts, with multiple types found in most texts, with the exception of texts that approached transformation as disjunction. In all, the findings suggest that this model could be used by curriculum planners and teachers to develop curriculum, to help teachers understand how ethno-mathematical ideas may be presented, and to evaluate the suitability of a curriculum given the intended student goals.

Rather than focusing on the ways in which Western mathematics relates with other ways of knowing and being, Dede (2006a; 2006b) aims to make explicit the ways in which Western values themselves are present within Turkish middle school and high school mathematics textbooks. Although Dede (2006a, 2006b) acknowledges the inherent difficulty of measuring the affective dimensions of learning mathematics, Dede rightfully argues that the values taught by the explicit, hidden, and null curriculums of mathematics must be better understood and controlled, for the wrong values could be propagated for life. In both studies, Dede (2006a, 2006b) uses Bishop's et al. (1999) framework for the values taught in mathematics lessons to engage in a semantic content analysis of eight randomly selected 6<sup>th</sup> and 7<sup>th</sup> grade mathematics texts (4 per grade) and 9 randomly selected grades 9-11 mathematics texts (3 per grade), which were approved by Turkey's National Educational Ministry's Instruction Council.

Bishop's et al. (1999) framework was used as the study's coding schemata and for the organization of the findings, forwards three kinds of values present in Western mathematical lessons, that is, general educational values, mathematical values, and mathematics educational values. Of particular importance to this study are mathematical and educational values. Western mathematical values are presented in complementary



value pairs, that is: rationalism-objectivism - using deductive logic with symbols, which were converted from objects to symbols, control-progress - correct answers in math can be used to control nature and social phenomenon for the purpose of progress, and openness-mystery - discussing and analyzing symbolic math opens up mystery's about nature. Western mathematics education values are also presented in complementary pairs, that is: formalistic view-activist view – using logic and intuitive discovery to understand math, instrumental understanding/learning-relational understanding/learning – procedural and conceptual rigor, relevance-theoretical knowledge - teaching mathematics relevance to daily problem solving and teaching its logic, accessibility-special – math for all or math for the elite, and evaluating-reasoning – procedural v. application rigor.

In using this framework, Dede (2006a, 2006b) found that mathematical textbooks in Turkey aired towards the mathematical values of rationalism, control, and openness and an orientation of mathematics education that favored accessibility, a formalistic view learning, and a preference for theoretical knowledge, instrumental understanding, and evaluation. As such, Dede concluded that mathematics textbooks would benefit greatly from offering students more opportunities to discover the mathematical rules (i.e., activist view) and making mathematics more relevance-oriented (over theoretical) through a greater focus on conceptual understanding (i.e., relational over instrumental) and opportunities for application (i.e., reasoning over evaluating). Interestingly, although Dede sets out to illuminate the Western values present in a mathematics curriculum in light of the importance of values on one's being, Dede does not explicitly present their value preference or the relative implications of the particular manifestations of the complementary pairs. Further, it should be noted that the complementary value pairs,

although presented as potentially mutually constitutive and complementary, seemed to operate more as dichotomies in Dede's presentation of the findings.

Dowling (1996) and Diaz (2016), although similarly concerned with the values propagated through mathematics texts, unlike Dede (2006a, 2006b), does not link the values to Western cultural values, but rather a more ambiguous sociological construct related to a non-descriptive oppressive/stratifying force. Thus, unlike other studies, such as Bailey (1988) or Nibbelink, Stockdale, and Mangru (1986), which was explicitly concerned with sexism or Peterson Fisher (2004), who was concerned with the intersectionality of race and gender, both Dowling (1996) and Diaz (2016) do not explicitly name the system(s) of oppression that they are illuminating.

Dowling (1996) engages in an inductive interaction between Bernstein's sociological theory on language and subject positions/practices within curriculum and empirical examples from both higher level (Series Y) and a lower level (Series G) pre-algebra textbook popular in England and Wales circa 1996. Analyzing such features of the textbooks such as the textbooks' cover, the textbooks chapter introductions and example problem's orientation towards the reader, and the word problem's relative contextualization of mathematics in the "real world" Dowling (1996) found that the text projected two kinds of readers, that is, the intellectually-oriented and the manually-oriented reader. Whereas the Y-series texts focused on abstract, relatively context-independent, esoteric, and universal and timeless nature of mathematics, the G-series text focused on presenting mathematics in a highly contextualized, concrete, and everyday manner. Further, although both create mythical planes of existence for their examples and practice problems, only the Y-series treats students as apprentices into the esoteric

discipline of mathematics. Ironically, Dowling observes that the G-series, although presenting more “realistic” problems by posing examples that assume the reader is already an expert shopper in a mathematically-deductive-logical way, both alienates the reader who is both not an expert shopper in this sense, nor a mathematician’s apprentice, but rather a consumer with everyday skills.

As such, Dowling (1996) forwards that the higher level and lower level texts reproduce the hierarchical opposition of the intellectual-manual. Specifically, the intellectual is associated with the superordinate, generalizing, abstract, context-independence, whereas the manual is associated with the subaltern, localizing, concrete, and context-dependent. Interestingly, this hierarchical labor-oriented opposition and their related connotations/manifestations are never connected by Dowling to its most obvious manifestation, that is, classism. Further, such distinctions between the abstract/universal (i.e., context-independent, generalizing) and the concrete/subjective (i.e., context-dependent, localizing) is a hierarchical and oppositional distinction levied between Western science and other cultures’ ways of producing knowledge about the physical and/or social world.

Diaz (2016), in examining U.S. national, mathematics education policy documents, aimed to illuminate how problematic notions of difference are created in the mathematics curriculum via these policy documents’ projection of a certain kind of mathematical person. Specifically, Diaz (2016) looked at the way the National Council of Teachers of Mathematics’ (1989) *Curriculum and Evaluation Standards for School Mathematics* and the National Research Council’s (1989) *Everybody Counts: a Report to the nation on the future of mathematics education* positioned the intersection of US

children and mathematics education in relation to the US' economic, political, and cultural future. Ironically, Diaz (2016) found that it is the very framing of the equality of all children that is at the heart of producing said difference.

In claiming that all students, as humans, have an innate mathematical logical capacity analogous to children's innate linguistic capacity, Diaz (2016) illuminates how these documents create a structure for oppositionally categorizing children as either mathematically literate or illiterate, a problematic difference that supposedly threatens the future of the US. This structure is premised on the false universalization of a particular (and, as argued in this study, culturally-specific and Modernist Western) way of approaching problem solving within the *real world* that is characterized by the use of symbolic mathematics and its logical-deductive structure. Because not all students share this way of perceiving and/or making sense of reality, either their personal or cultural ways of knowing, which may or may not follow a linearized and deductive logic, produce students and/or cultural groups (a.k.a., a euphemism for non-White racial and/or non-European ethnic groups) who, as argued by Diaz (2016), are positioned as impediments to national progress.

Further, Diaz (2016) claims that this (culturally-specific) orientation towards problem solving, although seemingly laudable from the perspective of privileging the processes of learning rather than the products of learning, promotes affective outcomes of learning that are deeply problematic. First, in focusing on the "right way to think about problems," aforementioned policies act to reorganize a child's value system by forwarding a specific view of the "real world," what constitutes problems within it, and the correct way to think through the resolution of these problems. Second, the framing of

universal and existentially important ways of thinking that are the US' and its citizens' future, students are led to believe that they have the power, as problem solvers, to determine their own (and their nation's) success and failure. Such meritocratic discourses perniciously superposition individuals over the social-political-economic structures, which circumscribe their life's options and chances.

Similar to Dowling (1996), Diaz (2016) fails to connect the construction of dichotomized and oppositional identities within a larger framework of oppression for the purposes of dispossession. This disconnect is hard to justify. As evidenced by the extensive use of parenthetical modifiers in relation to the summarization of Diaz's (2016) article, it is difficult to present the study's observations without alluding to the policy documents' projection of Western modernist, that is, logical-mathematical, ways of knowing and being as natural and superior. However, in fairness to Diaz (2016), given the purported apolitical and universal nature of mathematics, very few members of the educational community in the United States would endorse the claim that mathematics education could advance notions at the core of ideological racism (a.k.a., White supremacy) and ideological imperialism.

Thus, similar to the arguments made by Diaz (2016) herein, the purported universality of mathematics, similar to the purported universality of logical-mathematical problem solving, does bolster the supposed objectivity of measuring the advancement of a society in relation to its degree of engagement with Western mathematical-scientific-techno culture and artifacts. This of course, in turn, bolsters the position that Western societies are the most advanced. A conclusion almost inevitable when Western society

gets to measure all other societies in relation to artifacts produced via and in support of the West's advancement of its own ways of knowing and being.

### **Teaching Mathematics for Justice in the United States, Coloniality, and Curriculum Studies**

To date, mainstream conceptualizations of teaching mathematics for justice in the United States make no reference to the aforementioned linkages between the concurrent development of and/or relationship between Western mathematics education and Western systems of imperialism and colonialism. In curriculum studies, absences are noteworthy, since curriculums are inherently composed of both explicit and implicit presences and absences (Eisner, 2001). Thus, curricular decisions to de-historicize and de-contextualize the teaching of mathematics for justice outside of the presence of coloniality, whether explicit or implicit, are not made apolitically, but rather emerge from a “complex and dialectical relationship among curriculum, differential power, and the larger society” (Apple, 2008, p. 25). This struggle is larger than individual educators and serves the needs of the powerful considering that the “curriculum has played, and continues to play, a major role in forming the citizens as it institutionalizes the narratives that constitute the collective memory and shape individual's relationships with their natural and social environments” (Westbury, 2008, p. 59).

The most prominent of mainstream social justice positions is that of the National Council of Teacher of Mathematics (NCTM), an organization that has been at the center of mathematics curriculum reform in the United States since its 1989 publication of *Principles and Standards for School Mathematics*. Specifically, NCTM claims that the achievement of equity will be assessed by “student outcomes—including achievement on

a range of mathematics assessments, disposition toward mathematics, and persistence in the mathematics pipeline” (National Council of Teachers of Mathematics, 2018, n.p). Furthermore, NCTM (2018) claims that achieving this will require all students to have access to high quality teaching, data-driven interventions and accommodations, and opportunities for remediation and enrichment. In addition to implicitly and problematically positioning teachers as central to this theory of change, this conceptualization of achieving justice lacks any historicization of the intentional structuring of *achievement gaps* in schooling, aptly named the achievement debt by Ladson-Billings (2006), and ignores systemic issues such as the pernicious relationship between race, real estate, and differential school funding by student-body racial composition. In addition, NCTM paradoxically operationalizes all students’ *persistence in the mathematics pipeline* as necessary for both equity and US global economic competitiveness, thus positioning the need for equity itself in the service of a market economy, which domestically created the inequality it purports to resolve (Gutstein, 2006, p. 8), and, internationally, has maintained hegemonic and imperialistic relationships.

Of the mainstream justice discourses, the justice discourse that most robustly aligned with this study is that of criticalmathematics. Admittedly, there is no single definition of criticalmathematics education. However, within the United States the works of Marilyn Frankenstein, Eric Gutstein, and Arthur Powell are widely recognized as being representative of the theoretical development of criticalmathematics (Wager & Stintson, 2012). Although differences exist between their articulations, collectively, they present criticalmathematics as mathematics education that aims to a) engage students in

rigorous mathematics in order to eliminate mathematics as a systemic gatekeeper to educational and occupational institutions, b) promote students critical mathematical analysis of unjust systems of oppression, and c) challenge epistemological racism both internally in terms of who can do mathematics, and ideologically through ethnomathematics, in terms of who has historically done mathematics and which people's mathematics counts as valid mathematical knowledge (Powell, 2012; Frankenstein, 2012; Gutstein, 2006).

Pedagogically, with these goals in mind, criticalmathematics educators' approach to teaching mathematics for justice is characterized by reform-based approaches to teaching mathematics and sociocultural orientations towards student learning. Reform-based, in contrast with traditionalist approaches to teaching mathematics, focus relatively less attention on algorithmic procedures and procedural fluency and significantly more on "real-world application," problem solving, and conceptual understanding (Schoenfeld, 2004). In the context of critical mathematics, the analyses of unjust systems of oppression provide limitless "real-world" applications of mathematics, problem solving practice, and contextualized opportunities to understand mathematical concepts. In combination with a more conceptually- and application- oriented presentation of content, criticalmathematics educators take a sociocultural orientation to teaching and learning. Like most sociocultural orientations to learning, less focus is placed on transforming the individual student, while concerted attention is given to analyzing and transforming the ways classrooms as a sociocultural context, (under/over) privilege certain ways of being and knowing in relation to others (Gutiérrez, 2013, p. 38). For criticalmathematics educators, this orientation goes beyond a respect for student and community knowledge and ways of



being to include ethnomathematics, that is, other cultural constructions of mathematics, and the inversion of pedagogical structures, that is, the flattening and, at times, reversal of teacher-student relations.

That having been said, although there are defining characteristics of a criticalmathematics curriculum, there are several departing points within the community. Specifically, these differences tend to manifest in relation to one's positioning with respect to: ethnomathematics, Freirean pedagogy, ecological justice, sociopolitical action, theories of change, and high-stakes evaluation frameworks. The study proposed herein joins with more recent works that have distinguished themselves by their emphasis on the interconnectedness of ecological and social justice.

Therefore, they are limited but growing examples of conceptual and empirical work within criticalmathematics education that gives attention to issues of coloniality and its relationship to both out ecological and anthropocentric crises. For instance, in the December issue of the *Journal of Urban Mathematics Education* (Stinson, 2017), increased attention is given to mathematics education's relationship to and role in the deconstruction of settler colonialism and White supremacy in the United States (Gutiérrez, 2017b; Stinson, 2017). Yet, to date, there is scant evidence of a systematic anti-colonial curricular analysis of a mainstream mathematics textbook in the United States. However, what is worth paying attention to is the scholarship of Bishop (1990) who was one of the first mathematics education scholars to articulate instantiations of coloniality in the mathematics education's past and present.

Nevertheless, several prominent criticalmathematics scholars, such as Gutstein (2006, 2016), and emerging ones, such as Bratlinger (2013, 2014), have analyzed their

own critical mathematics pedagogy and curriculum as a basis for conceptual and theoretical articulations of what critical mathematics, as a field, can do, how it should grow, and focus more/less on. All the same, their works, like most critical mathematics scholars, neither focus on the larger meta-structures of globalized White supremacy, nor US settler colonialism, but rather focus on justice as the redistribution of resources, power, and/or status via the reform of settler institutions. Others, from adjacent sub fields of mathematics education for justice have focused their empirically-based theorization on ecological justice, and to varying degrees, settler colonialism. For instance, both place-based, eco-conscious (Nicol, 2018) and eco-cultural approaches (Owens, 2014) to mathematics education for justice, which build from a blend of ethnomathematics, place-based education, and, to a lesser degree, critical mathematics, differentially stress issues related to settler colonialism, Indigenous ways of knowing and being, and the environment.

Although all of these empirically based theorizations offer much insight into the field, it is only recently that conceptualizations of how White supremacy, settler colonialism, and anthropomorphism manifest within mathematics education itself. In particular, the special issue in the *Philosophy of Mathematics Education Journal* (Coles & Boylan, 2017), particularly through the works of Gutiérrez (2017) and Wolfmeyer and Lupinacci (2017), positioned the genealogy of these three related ideologies as related. As mentioned herein under the significance of the study, although these theoretical papers do not base their anti-colonial stances in critical Indigenous scholars' or critical scholars of Color's conceptualizations of colonality and, as such, do not robustly theorize settler colonialism in relation to Western constructions of self, others, and the

environment, they do offer a starting point for how mathematics education in the US may move towards greater justice.

### **Summary**

The projects and structures of Western mathematics, Western mathematics education, and Western imperialism, specifically, British/American settler colonialism, reciprocally developed and advanced each other over the past 600 years. Central to these projects was the printing press' democratization and standardization of a highly symbolic mathematical system based on the Hindu-Arabic numeration system, the reconceptualization and remapping of material (and Western metaphysical) reality via mathematics' symbolic and visual semiotic systems, and, later, Dee's centering of mathematics within his ideological and practical blueprints for a British sea empire and settler colonies. The United States, emerging out of the genealogy of Dee's conceptualization of settler colonialism as the reconstruction of the British micro-cosmos, cultivated, advanced, differentiated by race, standardized, and then continually reshaped mathematics education for the purposes of maximizing material wealth production within the settler colony.

This presentation of an intertwined project of Western imperialism, settler colonialism, Western mathematics, and Western mathematics education herein begs the question: "how, precisely, does Western mathematics education advance settler colonialism and/or imperialism in the present?". Further, given the historical centrality of mathematical texts to, first, mathematics democratization and standardization, then its linguistic and ideological development, and shortly thereafter to Dee's advancement of the mathematics for British Imperial wealth accumulation: "how does mathematics

textbooks, in the present, advance settler colonialism and/or imperialism?”. Underscoring the significance of such questions raised herein is the very absence of such historical interpolations between the concurrent development of Western mathematics, Western mathematics education, and Western imperialism/colonialism in mathematics for justice frameworks. Adding to its significance is the lack of curricular evaluation frameworks that have advanced or engaged in understanding how this manifest within curricular documents in the present. Deploying such a framework will better understand who is implied within, and for what do we advance *mathematics for all*?

### **CHAPTER THREE: METHODOLOGY**

The purpose of this study was to add to the scholarly research in criticalmathematics and anti-colonial education, both empirically and theoretically in order to better understand the problems and possibilities related to improving practice and policy towards greater human and ecological justice, from an anti-colonial stance via mathematics education. To accomplish this task, this study specified and particularized Grande's (2015) colonialist consciousness framework for evaluating mathematics education curriculum in the West. With this framework, aimed at illuminating colonialist consciousness in mathematics curriculum, a Common Core-aligned middle school mathematics curriculum was analyzed for the purpose of both illuminating the particularities of colonial logics manifestations within Western mathematics curriculum and, reciprocally, improving said framework. Finally, the results of this analysis were compared to the results of evaluating the curriculum from the standpoint of criticalmathematics in order to see the inverse, direct, and/or tentative relationships between criticalmathematics and colonialist consciousness

The method of this study applied Kemmis and Stake's (1988) qualitative absolute criterial curriculum evaluation approach. In this evaluation design, the author created criteria with explicit definitions, which were utilized to evaluate a curriculum. However, as one of the goals of this study was to utilize an anti-colonial perspective, the critical evaluation framework was based on Grande's (2015) conceptualization of colonialist consciousness, an anti-colonial perspective that illuminates instantiations of colonial onto-epistemologies in relation to schooling and the curriculum.

Grande's (2015) framework is comprised of five pillars of colonialist consciousness. Specifically, the five aspects are *Independence*, *Achievement*, *Humanism*, *Detachment from Sources of Local and Personal Knowledge* (DLP), and *Detachment from Nature* (DFN). While the framework itself provides a thorough definition and understanding of these concepts, these are not specifically written for a curriculum evaluation. As such, I interpreted each of these pillars with reference to the three main aspects of curriculum—the goals and objectives, pedagogy, and assessments. These ultimately formed criteria that were utilized to evaluate a prolific Common Core-aligned mathematics curriculum.

While the criteria can be measured as the mere presence or absence of the construct, or in this case, the presence or absence of each of Grande's (2015) five pillars, within a lesson's goals/objectives, pedagogy, and assessments, theories of curriculum also state that the manifestations of these concepts can be explicit or implicit (Eisner, 2001). As such, there were four categories in which these concepts were evaluated: Explicit, Implicit (teaching), Implicit (learning), and Null. The *Explicit category* indicates the written presence of the construct in the lesson. *Implicit (teaching)* is when the construct is presented implicitly, in the way that the curriculum provides instructions to the teacher. *Implicit (learning)* is when the construct is manifested implicitly, in the way that students are expected to learn. Finally, *The Null category* is when the construct is neither explicitly nor implicitly manifested in the curriculum.

In performing this study, it was assumed that the CCSS-M curriculum will contain instantiations of the five constructs within Grande's (2015) framework, and that the author will be able to specify in which parts of the curriculum these constructs are

present. It was also assumed that in illuminating these instantiations, this study will be able to better understand how coloniality instantiates itself in mainstream mathematics curriculum and, thus suggest how these understandings may be used to re-conceptualize criticalmathematics’ ideological foundations from an anti-colonial stance to better serve the dual purposes of human and ecological justice. Presented in Table 3.1 is the alignment of the research questions to the methods, analysis and results of the study.

Table 3.1

*Alignment of Research Questions to Methods, Analysis, and Results*

| <u>Research Question</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <u>Method</u>                                                                                                                                                                                              | <u>Analysis</u>                                                       |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------|
| How can both the results of a prior mathematics curriculum evaluation based on Grande’s (2015) conceptualization of colonialist consciousness and a literature review of the genealogy of Western imperialism, settler colonialism, and Western mathematics be used to specify Grande’s conceptualization of colonialist consciousness to create an anti-colonial mathematics evaluation framework?                                                                                                                    | Code literature review and author’s prior study for instantiations of Grande’s (2015) colonialist consciousness to develop anti-colonial mathematics curriculum evaluation framework (see <i>Table 5</i> ) | Pilot - Unit from Eureka Math, Grade 6, Equations and Expression Unit |
| <p>To what extent can a Common Core mathematics curriculum be evaluated by an anti-colonial mathematics evaluation framework?</p> <ul style="list-style-type: none"> <li>• In what ways does the qualitative evaluation identify instantiations of coloniality within a 6-8 Common Core aligned mathematics curriculum unit (i.e., Eureka Math, grade 7, Module 3 – Expressions and Equations)?</li> <li>• How does an anti-colonial mathematics evaluation framework highlight salient curricular elements</li> </ul> | <p>Criteria curriculum evaluation using piloted and revised anti-colonial mathematics curriculum evaluation framework</p>                                                                                  | <p>Results organized by Checkbox Data Table</p>                       |

| <u>Research Question</u>                                                                                                                                                                                                       | <u>Method</u>                                                                                        | <u>Analysis</u>                                                                                                                   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| that contribute to human and ecological (in)justices within a 6-8 Common Core aligned mathematics curriculum?                                                                                                                  |                                                                                                      |                                                                                                                                   |
| How does the curriculum evaluation help re-conceptualize critical mathematics' ideological foundation from an anti-colonial stance to better serve the dual purposes of human and ecological justice in mathematics education? | Analyze curriculum using <i>Critical mathematics Curriculum Evaluation Framework (See Table 3.4)</i> | Compare and contrast results from critical mathematics analysis with results from anti-colonial mathematics curriculum evaluation |

### Study Design

This study employed a qualitative absolute criterial curriculum evaluation approach. Absolute criterial evaluation is defined as an evaluation where curriculum quality is determined and defended in relation to the curriculum's adherence to or (a set of) theoretical constructs and/or values (Kemmis & Stake, 1988). Compared to other evaluation frameworks, Fournier (1995) writes that criterial evaluation tends to be more quantitatively oriented and consists of four idealized steps:

- 1) Establishing criteria of merit,
- 2) Constructing standards,
- 3) Measuring performance and comparing it to standards,
- 4) Synthesizing and integrating data into judgments of merit (p.16)

In establishing a criterion of merit, the author indicates and defines what is of value (House & Howe, 1999; Fournier, 1995). For this study, these values were supported by an extensive literature review as well as Grande's (2015) conceptualization



of colonialist consciousness. These, along with the positionality statement, provided a rationale for why these values need to be considered when evaluating the curriculum. The second step of criterial evaluation is constructing standards. Following the creation of the criteria, standards, which measure how much the curriculum adheres to the concepts, were created. Eisner (2001) defines the curriculum in three general categories—explicit, or the written curriculum, the implicit, or the “hidden” curriculum, and the “null”, or the curriculum that is not present. In measuring how much the curriculum adheres to the concepts qualitatively, it is important to illuminate whether or not the curriculum is explicit or implicit in manifesting Grande’s (2015) conceptualization of colonialist consciousness because this study’s goal was understanding how coloniality instantiates itself within the curriculum. Furthermore, because pedagogy, an aspect of curriculum, involves both teacher and student actions/experiences, it was important to illuminate whether or not the curriculum was demonstrating colonialist consciousness based on the recommended teacher’s pedagogy. This aspect includes lesson plans or the assumptions about students’ learning, as reflected in the student workbook, which indicates the way students are expected to learn the material. As a result, there were four main standards in measuring how much the curriculum reflects Grande’s (2015) conception of colonialist consciousness and critical mathematics:

- Explicit - Manifestations of the criteria were explicitly stated (written) in the curriculum.
- Implicit (teaching) - Manifestations of the criteria were expected in implementing the recommended pedagogy.

- Implicit (learning) - Manifestations of the criteria were illuminated in the way students are expected to learn and or perform the task or activity.
- Null - The criteria was not manifested.

The third step, or “measuring performance and relating them to standards” was the implementation of the absolute criterial curriculum evaluation (Kemmis & Stake, 1988, pp. 60). Finally, in the last step, “synthesizing and integrating data into judgments of merit”, the researcher reflected upon patterns that may be exhibited based on the evaluation (Kemmis & Stake, 1988, pp. 60).

However, despite the possibility of finding patterns, Kemmis & Stake (1988) note that a criterial evaluation needs not to be a “recourse to quantification of any kind” (1988, p. 60). Rather, when qualitative, theoretically or value-defined criteria are employed, it is expected that judgments will be defended in relation “to their definitions...as well as evidence from the settings being evaluated” (Kemmis & Stake, 1988, p. 61). As such, a memo was written for each evaluated lesson to ensure that the readers of the study could understand the perspective and reasoning behind the judgments made. The results from the evaluation and the memos, were utilized to further discuss problems and possibilities in the improvement of the mathematics curriculum development in support of human and ecological justice.

### **Data Sources**

Criterial curriculum evaluations necessitate an analytical framework in which to create rubrics as well as a curriculum to apply the rubric to. The analytical frameworks, that is, an anti-colonial mathematics curriculum evaluation framework founded on Grande’s (2015) conceptions of critical consciousness and a critical mathematics

curriculum evaluation framework is discussed in detail in the following section.

However, the following section discusses the two main data sources that address the research questions. The first section offers relevant information about *Eureka Math*, the curriculum that is utilized for the evaluation, and the second section describes the role of memoing as a data source.

### **Eureka Math**

The curriculum that was utilized for the criterial curriculum evaluation was *Eureka Math*, which is also more commonly known as *EngageNY*. The primary reason for choosing *Eureka Math* was because of its scale, distribution, and influence. The scale of *Eureka Math*, a.k.a., *EngageNY*, is immense. This curriculum is aligned with the Common Core Learning Standards for all grade levels. As such, the curriculum can be employed in every grade level for the entire year, and it is further differentiated for teachers and students. In addition to scale, *Eureka Math* is very popular because of its distribution and accessibility. Their website is open-access—in other words, anyone who has access to the internet can register and then download the *Eureka Math* curriculum free of charge. This convenient distribution system, along with the vast materials provided, propelled *Eureka Math/EngageNY* into being one of the most influential curricula in the United States (Opfer, Kaufman, and Thompson, 2016). National survey results from the RAND corporation indicate that about 57% of elementary teachers and 47% of secondary teachers use some version of this curriculum in their classroom, making it the most widely used (albeit, to varying degrees) mathematics curriculum in the United States (Opfer, Kaufman, and Thompson, 2016).

The *EngageNY* curriculum was developed for the State of New York by *Great Minds*, a curriculum-development non-profit organization to (1) support the implementation of the Common Core English Language Arts (ELA) and Mathematics Standards and Assessments, (2) integrate standards, lessons, assessment, and professional development through a holistic, state-wide curriculum model, and (3) increase student achievement (New York State, 2010). Initially emerging from New York State's Race to the Top funds, it has now been widely applied and accessed nationally both from the *EngageNY* website and from their enhanced, national *Eureka Math* website, as a tool for improving teaching and student learning.

This open-access K-12 curriculum is available throughout all of their websites, [www.engage.org](http://www.engage.org) and [www.greatminds.org/math](http://www.greatminds.org/math). On the homepages, there are links for English language arts and mathematics curriculum for every grade level ranging from prekindergarten through high school. On the *EngageNY* website, the original resources are directly downloadable without a login, whereas on the *Eureka Math* website, the enhanced national curriculum is downloadable after one creates a free account.

For this curriculum analysis, *Eureka Math* Basic Curriculum Files for Grade 7 were downloaded as they embody the newest iteration of the *EngageNY/Eureka Math* curriculum (2015). From the Eureka Math website ([greatminds.org/math](http://greatminds.org/math)), the Grade 7 expressions and equations of the student files (A and B) and teacher edition modules were downloaded as PDFs, with a set of teacher guides in PDF format, including a CCSS checklist, a curriculum map, a pacing and preparation guide, and a curriculum overview. In addition, the Grade 7 manipulative and supply lists were downloaded as PDFs.

To begin, the curriculum map, CCSS checklist document, manipulative list, supply list, and pacing and preparation guide are not unique to the expressions and equations module. The curriculum map provides an overview of the topics covered in Grades 6 to 8, including titles of each module, arranged sequentially, prescribed to instructional quarters and allocated instructional-days. The CCSS checklist then takes each module, by grade level, and aligns it with a Common Core State Mathematics Content Standard (CCSS-M). Meanwhile, the manipulative and supply lists describe the concrete materials intended by the authors to engage students with the content conceptually and/or via a mathematical application. The pacing and preparation guide provide guidance on how to use the materials, which include information about instructional preparation regarding how to teach a module or a lesson and append suggestions for consolidation or omission.

Specific to each module are two student files, A and B, as well as a teacher edition of the texts. The teacher edition is a PDF document containing an overview, an in-depth description of the appropriate CCSS, definitions of mathematics vocabulary (e.g. one-to-one correspondence), suggested tools, such as software suggestions and websites, pedagogical advice, and assessments. These modules are then further subdivided into lessons. Lessons comprise of student outcomes or objectives, lesson notes (a very short overview), and *classwork*, which provide step-by-step content and pedagogical advice, including examples and time allotment for each part of the lesson. At the end of each lesson, there are representative assessment tasks with examples of correct responses and multiple ways of correcting student misconceptions.

The second sets of documents are the student files A and B. The Student Edition A similarly breaks down the module in different lessons, key mathematics vocabulary, and worksheets that correspond with the teacher edition. As a result, teachers do not need to create worksheets for students that mirror the questions, examples, and assessments in their document. The Student Edition B contains fluency drills, exit tickets, and Mid- and End-of-Module assessments. While *Eureka Math* does not explicitly state that teachers and students must utilize these documents together, it can be assumed that they were designed to work together.

While *Eureka Math* and *EngageNY* covers grades K-12, the scope of this study was limited to one unit within one grade level. Specifically, as mentioned, the criterial curriculum evaluation targeted the seventh grade curriculum module on *Expressions and Equations*. The rationale for this is two-fold. First, seventh grade was selected, as opposed to sixth and eighth grade, because sixth grade curriculum is loosely tied to the elementary (K-5) curriculum and similarly, the eighth grade curriculum is tied to secondary (9-12) curriculum. As such, the seventh grade curriculum embodies the closest approximation to a middle school curriculum. Second, the unit on *Expressions and Equations* was selected because the standards within this CCSS domain are all considered a part of the major work of Grade 7, considering that the expressions and equations domain embodies students' first experiences with mathematics, modernist semiotic symbolic system, as described by O'Halloran (2005) and problematized herein.

In summary the following documents under the unit on *Expressions and Equations* were analyzed: (1) *Eureka Math*, Grade 7, Module 3, Teacher Edition; (2) *Eureka Math*, Grade 7, Module 3, Student File A and B; and (3) supporting documents.

For this evaluation, the supporting documents included the grade 7 manipulative and material lists. Together, these were evaluated using the anti-colonial mathematics curriculum evaluation framework and the critical mathematics curriculum evaluation framework, which was discussed below (See *Tables 3.4 and 3.5*).

## **Memos**

In addition to the *Eureka Math* curriculum as a data source, analytic memos were also utilized. An analytic memo is “a brief or extended narrative that documents the researcher’s reflections and thinking processes about the data” (Miles, Huberman, & Saldaña, 2014, p. 95). Charmaz (2014) argues that once a memo is written, it becomes data, which then can be used as part of the data analysis process. Thus, I utilized analytical memos in order to be reflexive and transparent about my analyses with respect to *Eureka Math* and the evaluation framework. Table 3.2 describes how I recorded my thoughts and observations. As recommended by Miles, Huberman, and Saldaña (2014), I kept memos easily identifiable and sortable.

The memo example in Table 3.2 includes a memo number in order to easily identify the memo, as well as creating a space for the date and time for which the memo was written and recorded. In order for memos to be sortable in multiple ways, I included a column for the “curriculum component.” In this column, I identified which curriculum component I am analyzing or thinking about (e.g., Student File A – Classwork – Working Exercise). The second column titled “Grande’s Framework” allowed me to record my reflections and perceptions about the curriculum component specifically, with respect to Grande’s critical consciousness framework. Similarly, the third column allowed me to record my thoughts and reflections of the curriculum component in relation to

criticalmathematics. In the fourth column, I recorded my thoughts and reflections that emerge that are necessarily relate to Grande’s (2015) framework or criticalmathematics. Finally, in the last column, I labeled the curriculum component with a particular code and or category, as they emerge.

Table 3.2

*Analytical Memo Table*

| Memo # __            |                    | Date & Time:         |                 |                 |
|----------------------|--------------------|----------------------|-----------------|-----------------|
| Curriculum Component | Grande’s Framework | Critical mathematics | Other Thoughts: | Codes/Cate gory |
|                      |                    |                      |                 |                 |
|                      |                    |                      |                 |                 |
|                      |                    |                      |                 |                 |

These analytical memos enabled me to systematically build on my conceptual reasoning for evaluating the *Eureka Math*, Grade 7 unit on *Expressions and Equations* based on the evaluation framework.

### **Anti-Colonial Mathematics Curriculum Evaluation Framework**

The work of creating this curriculum evaluation framework began with a prior study (PS), which was a curricular evaluation of a syllabus, course handouts, and assessments from a statistics and probability course taught by the author at an elite universities’ summer transition program for exceptional and accepted students from exceptions circumstances. This course was taught from the stance of criticalmathematics and was evaluated using Grande’s (2015) conceptualization of colonialist consciousness. Thus, unlike the literature review, which added theoretical insights and potential examples for the useful specification of Grande’s (2015) framework for an anti-colonial mathematics evaluation framework, the prior study added empirically-derived



generalizations that this author would have found inaccessible by reading the literature alone.

What follows is Table 3.3, which presents Grande's (2015) conceptualization of colonialist consciousness via her definition of its 5 main categories: *Independence, Achievement, Humanism, Detachment from Local and Personal Sources of Knowledge, and Detachment from Nature.*

Table 3.3

*Grande's (2015) Conceptualization of Colonialist Consciousness*

| <b>Category</b>                                         | <b>Definition</b>                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Independence                                            | Children are expected to be self-reliant, to complete school tasks on their own, and accept personal responsibility for their own behavior. (Grande, 2015, pp. 100-101)                                                                                                                                                           |
| Achievement                                             | Success and individual worth are measured by abstract and impersonal standards of excellence whereby students are aware of being in direct competition with others. Students are encouraged to make an impact on their environment. Process is merely a means to an end; instrumentalist consequentialism (Grande, 2015, p. 101). |
| Humanism                                                | Students are 'encouraged to believe that they are the masters of their own destinies, and that through technology and scientific inquiry, nature's unknowns can become knowable. Rejection of religion and spirituality as distortions in way of objective view of world (Grande, 2015, p. 101)                                   |
| Detachment from Local and Personal Sources of Knowledge | Children and reservoirs of local knowledge with which they come to school are not perceived as sufficient or valid foundations of real or universal knowledge. Students are cajoled to accept modern worldview in place of their local knowledge/worldviews. (Grande, 2015, p. 101)                                               |
| Detachment from Nature                                  | The world is studied at a distance; contact with the earth, animals, and plants are severely limited. Students discover through interference that real learning occurs indoors and is composed of knowledge bases separate from life and the natural world (Grande, 2015, p. 101).                                                |

While these categories sufficiently provide insight on colonial consciousness, the framework needed to be adapted in order to be more appropriately aligned with Kemmis

and Stake's (1988) curriculum evaluation guidelines. As such, Grande's (2015) categories were further divided into Goals/Objectives, Pedagogy, and Assessment to utilize the framework from a curriculum evaluation standpoint. Criteria (descriptors) in each of these subcategories were populated by first coding the literature review and a prior study using Grande's (2015) five aspects of colonialist consciousness.

Codes are "labels that assign symbolic meaning to the descriptive or inferential information compiled during a study" (Miles, Huberman, & Saldaña, 2014, p. 71). For the purposes of creating codes for the creation of a criteria, provisional coding, or coding "for the purpose of exploring information about a potential topic or determined topic" was employed (Onwuegbuzie, 2016, p. 138). Then, thematic coding, or "grouping summaries into a smaller number of categories, themes, or constructs" (Miles, Huberman, & Saldaña, 2014, p. 86) was administered. The resulting themes are then listed under each category and subcategory, as illustrated in Table 3.4.

Table 3.4

*An Anti-colonial Mathematics Curriculum Evaluation Framework based on Grande's (2015) Conceptualization of Colonialist Consciousness*

**Independence:** Children are expected to be self-reliant, to complete school tasks on their own, and accept personal responsibility for their own behavior. (Grande, 2015, pp. 100-101). [The corollary to this notion is the idea that people who do not learn "independently" or even whole societies that learn more cooperatively or interdependently are less advanced in their development, a sentiment that has justified democracy for some, and tyranny for others for the past 300 years (Lowe, 2015).]

| <u>Goals/Objectives</u>                                                                                                                                                        | <u>Pedagogy</u>                                                                                                                                                                                         | <u>Assessment</u>                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• The goals and objectives state individual work. [Grande]</li> <li>• The goals and objectives state personal responsibility</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Self-reliance</b> - Students are expected to "first attempt the problem yourself and use your textbook for assistance when needed" [Grande/ LR].</li> </ul> | <ul style="list-style-type: none"> <li>• Students are formatively assessed on their own. [Grande/LR]</li> <li>• Students are</li> </ul> |

| <u>Goals/Objectives</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | <u>Pedagogy</u>                                                                                                                                                                                                                                                                                      | <u>Assessment</u>                                                                                                                                                                        |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>for learning. [Grande]</p> <ul style="list-style-type: none"> <li>• Language of collectivity may be in objectives but shifts towards “singular pronouns, which facilitate[s] the specious shift in responsibility for success from collective to individual regardless of the inherently transactional nature of teaching and learning” [PS]</li> <li>• Goals and objectives assume individuals will achieve goals at the same pace, but separately, rather than collectively or collaboratively [LR]</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Alone in a group/crowd</b> - Problem sets and/or activities do not assume meaningful group work [Grande]</li> <li>• <b>Personal responsibility</b> - Students do not need to speak to each other to access or improve meaning making [Grande]</li> </ul> | <p>summatively assessed on their own. [Grande/LR]</p> <ul style="list-style-type: none"> <li>• Even in group work, individual worksheets and performance is required [Grande]</li> </ul> |

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*Note:* LR = Literature Review, PS = Prior Study

**Achievement:** Success and individual worth are measured by abstract and impersonal standards of excellence whereby students are aware of being in direct competition with others. Students are encouraged to make an impact on their environment. Process is merely a means to an end; instrumentalist consequentialism (Grande, 2015).

| Goals/Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Pedagogy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Assessment                                                                                                                                                                                                                                                                                                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• The goals and objectives focus on achievement and/or making an impact on their environment (engage/develop personal power) [Grande/LR]</li> <li>• Achievement is defined by impersonal standards such as test scores. For example, classroom expectations, homework policy, and grading policy where all developed <i>a priori</i>, “success and individual worth” were, necessarily, “measured by abstract and impersonal standards of excellence” (Grande, 2015, p. 101). [PS]</li> <li>• Achievement focuses on goals/objectives, not process or purposes of learning [Grande]</li> <li>• Goals/objectives aspire towards consistent and individual achievement of impersonal student outcomes over meaningful individuation of and/or communal goals [LR]</li> <li>• Alignment of goals/objectives to world class standards aimed at preparing students for global economic competitiveness [LR]</li> </ul> | <ul style="list-style-type: none"> <li>• The activities or word problems promote competition between students and/or make explicit/implicit comparison between performance of characters in problem, that is, vicarious competition [PS]</li> <li>• Different problem sets for different “levels” of students; right degree of mental discipline for the right pupil [LR]</li> <li>• Students are asked to compare situations, modeled as functions and make judgments of preference based on impersonal, utilitarian outcomes [LR]</li> <li>• Group work and problem solving for the purpose of developing the “attitudes, skills and knowledge needed by large corporations” (Wolfmeyer, 2014, p. 8).</li> <li>• Engaging students in “future-oriented problems” – engaging future-oriented, college-, and career-driven problems [PS]</li> </ul> | <ul style="list-style-type: none"> <li>• Students are assessed not by personal metrics but rather external, teacher/standard defined metrics.</li> <li>• Final assessments rank students based on test scores.</li> <li>• Assessment focuses on outcomes, not processes; instrumentalist [Grande]</li> </ul> |

Note: LR = Literature Review, PS = Prior Study

**Humanism:** Students are encouraged to believe that they are the masters of their own destinies, and that through technology and scientific inquiry, nature's unknowns can become knowable. Rejection of religion and spirituality as distortions in way of objective view of world (Grande, 2015). This implicitly both promotes the supremacy of Western science over other worldviews and place White male settlers, as their embodiment, at the top of the human hierarchy.

| Goals/Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Pedagogy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Assessment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• The goals emphasize the importance of learning this content/standard for the advancement of scientific inquiry; the math learned can help us understand and/or control nature's unknowns [Grande]</li> <li>• Ramist organization of content as employed by Dee, that is, mathematics organized via a "rigid system of dichotomies" that decomposes knowledge into <i>tickets</i> (i.e., discrete pieces of information), from general statements into more specific components into a framework often visualized as a <i>branching tree</i> (Holmes, 1997, p. 41)." [LR]</li> <li>• Goals/objectives present math abstractly even as they aim to enable students to engage in longstanding use of math within the British empire and its settler colonies, that is, to develop a "program of economic</li> </ul> | <ul style="list-style-type: none"> <li>• <b>Immutable truth, not subjective</b> - The imperial/colonial/ unjust genealogy, purposes, consequences of a mathematical concepts' development is not revealed, Rather, math in problems are first developed abstractly, then applied OR, instead, a suitable introductory example is presented so that readers can appreciate math's usefulness and immutable truth [PS/LR; (O'Halloran, 2005, p. 36)</li> <li>• <b>Immutable truth, non-subjective</b> – Objective and factual ideological orientation of mathematical language - combination of the restricted selections in the fields of experiential and interpersonal meaning in the mathematical symbolism ... the textual strategies of condensation through which meaning is officially encoded, and the emphasis directed towards logical meaning's (O'Halloran, 2005, pp. 113-114; 116). [LR]</li> <li>• <b>Immutable truth, not subjective</b> - Problems/activities promote the belief that mathematical problems lack cultural specificity [PS]</li> <li>• <b>Boundless truth</b> - Presentation of mathematics without epistemological boundaries/limits/ domain/range of relative efficacy/accuracy; lack of acknowledgment that most physical systems are only linear and/or curvilinear up to a certain point (O'Halloran, 2005, p. 58) [LR]</li> <li>• <b>Boundless truth</b> - Fields of human endeavor are mathematized, often in pseudo-scientific form, promoting a scientific view of the world while casual,</li> </ul> | <ul style="list-style-type: none"> <li>• Formative and/or summative assessments promote one answer as the immutable truth [LR]</li> <li>• Formative and/or summative assessments promote idea that math can be used to map, control, predict, explain social and physical reality without limits. [LR]</li> <li>• Assessments only admit sense to the degree they engage with mathematical visuals and symbolism. [LR]</li> <li>• Assessments assume that students can be tracked and ranked in relation to</li> </ul> |

| Goals/Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Pedagogy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Assessment                                                                                                |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|
| <p>expansionism,”<br/> “methodical economic<br/> analysis,” and<br/> “development by<br/> corporate investors”<br/> (Holmes, 1997, p.<br/> 115).[LR]</p> <ul style="list-style-type: none"> <li>• <i>Goals/objectives</i><br/> <i>promote</i> “rationalism-<br/> objectivism - using<br/> deductive logic with<br/> symbols, which were<br/> converted from objects<br/> to symbols, control-<br/> progress - correct<br/> answers in math can be<br/> used to control nature<br/> and social phenomenon<br/> for the purpose of<br/> progress, and openness-<br/> mystery - discussing<br/> and analyzing symbolic<br/> math opens up<br/> mystery’s about<br/> nature.” (Dede, 2006).</li> </ul> | <p>social-political theories underlying the<br/> selection of and relationship between<br/> variables remains implicit (O’Halloran,<br/> 2005, p. 94) [LR/ PS]</p> <ul style="list-style-type: none"> <li>• <b>Expansionistic truth</b> - Exactness of<br/> architecture and the discipline of<br/> mathematics promotes a continuous<br/> intellectual universe with the construction<br/> of the “house, village, city, colony” as<br/> extensions of the same inherent<br/> relationship between people, land, and<br/> other beings (Holmes, 1997, p. 130). [LR]</li> <li>• <b>Erasure of subjectivity</b> - Problems use<br/> implicitly generalized, aggregate<br/> relationships between variables with no<br/> attention to how the particularities within<br/> and across social-political context shape<br/> relationships; data that relationships are<br/> based upon assume that variables can be<br/> known, accurately and consistently<br/> recorded across time, aggregated across<br/> contexts, and used predictively. [PS]</li> <li>• <b>Erasure of subjectivity</b> - Absence of<br/> human actors in problems with physical<br/> reality reconstructed through “the visual<br/> images of the curves, the symbolic<br/> description of those curves and the use of<br/> language....to create a new version of<br/> reality” (O’Halloran, 2005, p. 38).</li> <li>• <b>Dematerialization of reality</b> - Sense-<br/> perceptions are re-admitted through the<br/> filter of that which was physically<br/> observable and quantifiable; led to “a new<br/> way of conceptualizing the world” and<br/> scientific revolution via inductive,<br/> scientific reasoning; recasting of the world<br/> in material, non-theological terms<br/> (O’Halloran, 2005) [LR]</li> </ul> | <p>universal<br/> pathways<br/> and/or<br/> standards of<br/> mathematical<br/> achievement<br/> [LR]</p> |

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*Note:* LR = Literature Review, PS = Prior Study

**Detachment from Local and Personal Sources of Knowledge:** Children and reservoirs of local knowledge with which they come to school are not perceived as sufficient or valid foundations of real or universal knowledge. Students are cajoled to accept modern worldview in place of their local knowledge/worldviews. (Grande, 2015). Peoples' ways of knowing and being that deviate from or are not associated with a modernist, Western worldview are stratified as inferior.

| <u>Goals/Objectives</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <u>Pedagogy</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <u>Assessment</u>                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Goals/objectives aim towards <i>world-class standards</i>, universalistic mathematical standards as the pathway up the personal attainment of a uni-linear mathematical knowledge as personal capital [Grande]</li> <li>• <i>Goals/objectives “develop an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought” (from report, but cited in Krulik &amp; Weise, 1975, p. 65) [LR]</i></li> <li>• Goals/objectives do not assume the engagement of students local knowledge to realize learning</li> <li>• Course schedule is organized and sequenced in relation to mathematical content and the “logical” sequence of said content, as opposed to topics that require or expect the incorporation of students personal or</li> </ul> | <ul style="list-style-type: none"> <li>• Mathematical examples do not focus on problems as described by students or community members. Instead, data and applications presented reflect hegemonic, universalistic Western humanist interpretations of a materially stratified reality [PS, LR]</li> <li>• Use of “real-world” problems and/or data aim to evidence the notion that mathematics is omnipresent and has superior explanatory power over intuition; counter-intuitive solutions [PS]</li> <li>• Solutions to “Real world” problems, devoid of computational error, are presented as deductively true and superior to “other” problem solving strategies; promotes the “right way to think about problems,” aforementioned policies act to reorganize a child’s value system by forwarding a specific view of the “real world,” what constitutes problems within it, and the correct way to think through the resolution of these problems. (Diaz, 2016) [PS, LR]</li> <li>• Some characters within word problems engage in passive v. active roles and in low/high status roles [LR]</li> <li>• Inclusion of non-White and non-male names into Western construction of problems while not including non-Western ways of knowing and/or being [PS]</li> <li>• Examples aim to superficially represent cultural practices through a Western lens, while assuming a</li> </ul> | <ul style="list-style-type: none"> <li>• Assessment does not include content related to personal and/or local sources of knowledge</li> <li>• Assessment does not utilize students’ local and/or personal ways of knowing and/or being to assess learning.</li> <li>• Assessment superficially engages modernist, White, and/or Western interpretation of non-White ways of knowing and being within problems to engage students</li> </ul> |

| <u>Goals/Objectives</u>                                                                                                                                                                                                                                                                                                                                                            | <u>Pedagogy</u>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <u>Assessment</u> |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| <p>local sources of knowledge [PS]</p> <ul style="list-style-type: none"> <li>• Objectives/Goals make mathematical “habits of thought and of action which will make these powers [<i>of understanding and of analyzing relations of quantity and space</i>] effective in the life of the individual” (<i>from report, but cited in Krulik &amp; Weise, 1975, p. 65</i>)</li> </ul> | <p>problematic trait approach to culture/race [LR]</p> <ul style="list-style-type: none"> <li>• Teachers do not ask and utilize students’ local knowledge during discussion or activities [Grande]</li> <li>• Pedagogical strategies do not engage or reflect multiple ways of knowing or being [Grande]</li> <li>• Opportunities where pedagogical structures could be inverted to allow for learners and, the teacher-learner, to learn from each other’s and their communities’ knowledges and experiences are missed [PS]</li> <li>• Presentation of math’s development as uni-linear and Western; does not acknowledge either assimilation of other cultures mathematics or the existence of parallel mathematics from other cultures, peoples, and/or places for other purposes [LR]</li> </ul> |                   |

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*Note:* LR = Literature Review, PS = Prior Study



**Detachment from Nature:** The world is studied at a distance; contact with the earth, animals, and plants are severely limited. Students discover through interference that real learning occurs indoors and is composed of knowledge bases separate from life and the natural world (Grande, 2015).

| Goals/Objectives                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Pedagogy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Assessment                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• The goals and objectives in the lesson require indoor work [Grande/PS]</li> <li>• <i>Learning objective and goals related to the development of “those powers of understanding and of analyzing relations of quantity and space which are necessary to an insight into and control over our environment” (from report, but cited in Krulik &amp; Weise, 1975, p. 65) [LR]</i></li> <li>• Objectives assist in the “objective analysis of land,” which involved the quantification and categorization of resources, strengths, and weaknesses of a prospective territory (Holmes, 1997, p. 108). [LR]</li> <li>• Goals related to learning aspects of vocations to re-orient people towards land and/or other beings [LR]</li> </ul> | <ul style="list-style-type: none"> <li>• Pedagogical materials for the lesson are inorganic, but presented as a natural object. e.g., Base Ten Blocks, fraction towers, algebra tiles, rulers.</li> <li>• All learning and problem solving happens indoors, even if the problem engages in the “real world”; implicitly, the real-world of valued human activity happens indoors; people who work closer to nature, e.g., blue colored, are stratified lower[PS/LR]</li> <li>• Word problems including nature focus on extracting wealth, controlling, manipulating, and/or mapping/measuring nature. Little to no consideration of mathematical actions/relationships on other beings or our shared environment. Promotion of material consumerism [PS]</li> <li>• [PS/LR]</li> <li>• World presented as mechanistic, atomistic, and rational physical reality (Grande, 2015; Tuhiwai Smith, 2012). [LR]</li> <li>• Nature conceptualized as resource or capital. Examples are Anthropocentric, that is, they assume “nature” as lacking agency while centering human needs without consideration of the needs of other beings or our shared habitat (Wildcat, 2009). [PS]</li> <li>• Land is presented as unoccupied, empty, and/or untouched (a.k.a., terra nullius) until approached by mathematical actor(s). Problems involving the construction of a house and the architectural arts, as it is “a legal condition for the possession of land, land being the basis of all wealth construction and extraction within the settler colony (Holmes, 1997, p. 130; Tuck &amp; Yang, 2012). [PS, LR]</li> </ul> | <ul style="list-style-type: none"> <li>• “Real world” problems on assessments, assume indoor problem solving [LR]</li> <li>• Assessment problems focus on controlling, manipulating, mapping, or exploiting nature for material wealth [LR]</li> <li>• Assessment requires student to see the world as mechanistic, atomistic, and rational (Grande, 2015) [LR]</li> </ul> |

Note: LR = Literature Review, PS = Prior Study

For the critical mathematics evaluation framework the field's founders' works were consulted (Powell, 2012; Gutstein, 2006; Frankenstein, 2012), in conjunction with the author's own experiences with teaching mathematics from a critical stance. In reviewing these works, three main sub-constructs defined their approach to teaching mathematics. Specifically, these sub-constructs are (1) Reform Based Mathematics, (2) Sociocultural Approach to Learning, and (3) Critical Consciousness Raising. Under the sub-construct of Reform Based Mathematics, the categories are (1a) Teaching for Understanding and (1b) "Real-World" Application. Under the sub-construct of Sociocultural Approach to Learning, the categories are (2a) Respect for student and community knowledge, (2b) Ethnomathematics, and (2c) Inverting pedagogical structures. Under the sub-construct of Critical Consciousness Raising, the categories are (3a) Critical reflection, (3b) Political efficacy, and (3c) Critical action. Table 3.5 summarizes how these sub-constructs' categories are defined.

Table 3.5

*A Critical mathematics Curriculum Evaluation Framework*

| Sub-construct                  | Category                         | Definition                                                                                                                                                                                                                                                                                         |
|--------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Reform Based Mathematics (RBM) | Teaching for Understanding (TFU) | Teaching with a focus on conceptual understanding and meaningful application, rather than algorithmic and rote procedural fluency. Focus on building from students prior knowledge and experiences. Allowing students opportunities to construct their own understanding of mathematical content.  |
|                                | "Real-World" Application         | A focus on teaching, motivating, and engaging mathematical concepts through real-world applications. In the context of critical mathematics, the analyses of unjust systems of oppression provide limitless "real-world" applications of mathematics, problem solving practice, and contextualized |

|                                                                               |                                                               |                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------------|---------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                                               |                                                               | opportunities to understand mathematical concepts.                                                                                                                                                                                                                                                                                                                                                  |
| Sociocultural Approach to Learning (SC)                                       | Respect for student and community knowledge and ways of being | Less focus is placed on transforming the individual student, while concerted attention is given to analyzing and transforming the ways classrooms as a sociocultural context, (under/over) privilege certain ways of being and knowing in relation to others (Gutiérrez, 2013, p. 38). Students ways of knowing and being are meaningfully engaged to advance student understanding of the content. |
|                                                                               | Ethnomathematics                                              | Exposing and/or teaching students: a) other, non-Western cultural constructions of mathematics and/or b) the contributions of non-Western peoples to Western constructions of mathematics in an effort to rebuff the myth that only Westerners have historically done <i>real</i> mathematics.                                                                                                      |
|                                                                               | Inverting pedagogical structures                              | Student-centered teaching with a primacy of Freirean approaches to engaging students through their context.                                                                                                                                                                                                                                                                                         |
| Critical Consciousness Raising (CCR)<br><br>(Watts, Diemer, and Voight (2011) | Critical Reflection                                           | Using mathematics to illuminate unjust systems of oppression                                                                                                                                                                                                                                                                                                                                        |
|                                                                               | Political efficacy                                            | Using mathematics to learn how to advocate for socio-political change                                                                                                                                                                                                                                                                                                                               |
|                                                                               | Critical action                                               | Using mathematics in a process aimed at transforming socio-political injustices                                                                                                                                                                                                                                                                                                                     |

In testing these evaluation frameworks, I conducted a pilot study on the Grade 6 *Expressions and Equations* module. This pilot study's results would later become the basis of the stage two, anti-colonial mathematics curriculum evaluation frameworks.

### Curriculum Evaluation

Because this study aimed to determine how *Eureka Math* reflects instantiations of coloniality, two levels of evaluation were administered. The first round of evaluations utilized the evaluation framework based on Grande's (2015) work, while the second round utilized the framework based on criticalmathematics. Furthermore, because this is

a qualitative absolute criterial evaluation (Kemmis & Stake, 1988), the evaluation aimed to illuminate how *Eureka Math* does or does not exhibit aspects of Grande's critical consciousness and how *Eureka Math* reflect categories of criticalmathematics.

To accomplish this task, Tables 3.6 and 3.7 were developed—one based on Grande's conceptualization of critical consciousness, and the other based on criticalmathematics. While each table differs depending on the categories and subcategories within, the evaluation process itself was similar. In the evaluation, each curriculum component was evaluated using the following rating scale:

- Explicit - Manifestations of the criteria were explicitly stated (written) in the curriculum.
- Implicit (teaching) - Manifestations of the criteria were expected in implementing the recommended pedagogy.
- Implicit (learning) - Manifestations of the criteria were illuminated in the way students are expected to learn and or perform the task/activity.
- Null - The criteria did not manifest.

In using these rating scales in stage-two of the first evaluation round, the author was able to answer the study's second question regarding the instantiations of coloniality within mathematics curriculum. Then, by completing the second round of evaluation and thus administering both frameworks separately, a comparison of the results of the two evaluations' helped illuminate the (in)commensurabilities, similarities, and differences between the aims and purposes of criticalmathematics and anti-colonial scholarship.

Table 3.6

*Evaluation Table – Grande's (2015) Framework*

| Curriculum Component | Goals |   |   |     |     | Pedagogy |   |   |     |     | Assessment |   |   |     |     | Total |
|----------------------|-------|---|---|-----|-----|----------|---|---|-----|-----|------------|---|---|-----|-----|-------|
|                      | I     | A | H | DLP | DFN | I        | A | H | DLP | DFN | I          | A | H | DLP | DFN |       |
|                      |       |   |   |     |     |          |   |   |     |     |            |   |   |     |     |       |
|                      |       |   |   |     |     |          |   |   |     |     |            |   |   |     |     |       |
|                      |       |   |   |     |     |          |   |   |     |     |            |   |   |     |     |       |
|                      |       |   |   |     |     |          |   |   |     |     |            |   |   |     |     |       |
|                      |       |   |   |     |     |          |   |   |     |     |            |   |   |     |     |       |

Table 3.7

*Evaluation Table – Criticalmathematics*

| Curriculum Component | Goals |   |    |    |    |    |     |    |    | Pedagogy |    |   |    |   |    |     |    |   | Assessment |   |    |    |    |   |     |  |  | Total |
|----------------------|-------|---|----|----|----|----|-----|----|----|----------|----|---|----|---|----|-----|----|---|------------|---|----|----|----|---|-----|--|--|-------|
|                      | RBM   |   |    | SC |    |    | CCR |    |    | RBM      |    |   | SC |   |    | CCR |    |   | RBM        |   |    | SC |    |   | CCR |  |  |       |
|                      | TF    | R | RS | E  | IP | CR | PE  | CA | TF | R        | RS | E | IP | C | PE | C   | TF | R | R          | E | IP | C  | PE | C |     |  |  |       |
|                      | U     | W | C  |    | S  |    |     |    | U  | W        | C  |   | S  | R |    | A   | U  | W | S          |   | S  | R  |    | A |     |  |  |       |
|                      |       | A |    |    |    |    |     |    |    | A        |    |   |    |   |    |     |    | A | C          |   |    |    |    |   |     |  |  |       |
|                      |       |   |    |    |    |    |     |    |    |          |    |   |    |   |    |     |    |   |            |   |    |    |    |   |     |  |  |       |
|                      |       |   |    |    |    |    |     |    |    |          |    |   |    |   |    |     |    |   |            |   |    |    |    |   |     |  |  |       |
|                      |       |   |    |    |    |    |     |    |    |          |    |   |    |   |    |     |    |   |            |   |    |    |    |   |     |  |  |       |

## CHAPTER FOUR: THE ANTI-COLONIAL MATHEMATICS EVALUATION FRAMEWORK

*Every Saturday morning, a fellow critical math educator and I traverse the same rugged trail of the Massachusetts nation's eponymous Blue Hills. The glares of other hikers as we park reminds us that this space is racialized as a White settler space and that I am welcome, but my friend is suspect. From Saturday to Saturdays, we cross the trail's head and marvel at the forest's non-linear, punctuated, and complex weekly transformations. The non-linear character of these ecological shifts reminds us of the linearized mythology of Western mathematics, exposes the hidden curriculum of our schooling, and amplifies our critical conversations about ways of knowing, ways of being, axiology, and metaphysics.*

*However, one Saturday morning, we realized that the life forms surrounding our path were strangers to us. We laughed as we ludicrously called each tree, "pine tree" or "not pine tree" and each non-tree plant, "plant" or "moss." We bemoaned the fact that we had the equivalent understanding of this forest as a preschool-age child. Together, we committed to an inquiry we refer to as 20 Seasons. As we learned more, the familiar became unfamiliar and we found ourselves meandering off our usual route. We were nearly lost at times. Yet, for the first time, we started to see this space more intimately; we were really learning.*

This chapter aimed to address the question, *in what ways does the qualitative evaluation identify instantiations of coloniality within a 6-8 Common Core aligned mathematics curriculum unit (i.e., Eureka Math, grade 7, Module 3 – Expressions and Equations).* In answering this question, this chapter aimed to specify and create an

empirically-based, theoretically-informed, anti-colonial mathematics evaluation framework that is capable of illuminating colonialist logics within mathematical texts for the purpose of promoting the well-being of human beings, other beings, and our shared habitats. To develop the evaluation framework presented in this chapter, two stages of specification were carried out. First, as presented in the methods chapter, the results of a prior mathematics curriculum evaluation, based on Grande's (2015) conceptualization of colonialist consciousness and a literature review of the genealogy of Western imperialism, settler colonialism, and Western mathematics, were used to particularize Grande's (2015) conceptualization of colonialist consciousness for mathematics education texts.

Second, the anti-colonial mathematics evaluation framework produced from the first stage was engaged as a provisional coding schema (Onwuegbuzie, 2016) to analyze *Eureka Math's* sixth grade Equations and Expressions Unit. The coding data emerging from the provisional coding was then organized in a table, first by sub-construct and curricular component (e.g., *Humanism* - pedagogy), and then clustered into meaningful groupings, for which descriptions, framed as manifestations of colonialist consciousness, were eventually created as a list. Concurrently, in conjunction with the coding data, analytical memos were reviewed to create a construct visualization of colonialist consciousness' manifestations within mathematical texts.

Thereafter, for each sub-construct, additional thematic coding was employed to the manifestation descriptions to create descriptive sub-categories within each sub-construct. Iteratively, the construct visualization and the list of descriptive sub-categories within each sub-construct informed each other. Finally, after the sub-categories within

each sub-construct stabilized, the thematically coded manifestations of colonialist consciousness within each sub-construct were checked against the stage one framework, in an effort to assure construct representativeness and theoretical robustness. Results from the second stage are presented herein.

### **Instantiations of Colonialist Consciousness**

In total, 371 instantiations of colonialist consciousness (and 9 counter examples) were coded using the evaluation framework produced in stage one. Given the goal implied in question one of assuring construct validity, with respect to the conceptualization and specification of colonialist consciousness in relation to English-language mathematical texts in the United States, the systematic collection of all unique instantiations was paramount. Of the 45 curricular components (e.g., lesson plans, assessments, and unit and/or section overviews), 25 of those were coded without concern for redundancy, while the other 20 were coded in a search for novel sub-construct manifestations. As the more focused analysis of the 25 curricular components resulted in only 11 additional, novel instantiations (out of the 371 in total), construct saturation was sufficiently evidenced.

Presented in Tables 4.1 and 4.2 are the frequency and relative frequency tables, representing 360 out of the 371 instantiations of colonialist consciousness coded using the evaluation framework from stage one. The 11 instantiations from the focused review were not included, as they are necessarily non-proportional in relation to construct manifestation. The 11 instantiations not included in the tables below were from curricular components that were deemed redundant due to similarities in their presentation of content, pedagogical approach, goals, and/or assessment types.



Table 4.1

*Frequency Table of Instantiations of Colonialist Consciousness*

| Sub-construct | Goals/Objectives | Pedagogy | Assessment | Total |
|---------------|------------------|----------|------------|-------|
| Humanism      | 35               | 40       | 50         | 125   |
| DLP           | 20               | 17       | 12         | 49    |
| DFN           | 16               | 22       | 10         | 48    |
| Independence  | 1                | 24       | 75         | 100   |
| Achievement   | 12               | 14       | 12         | 38    |
| Total         | 84               | 117      | 159        | 360   |

*Note.* DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature

Table 4.2

*Relative Frequency of Instantiations of Colonialist Consciousness*

| Sub-construct | Goals/Objectives | Pedagogy | Assessment | Total  |
|---------------|------------------|----------|------------|--------|
| Humanism      | 9.7%             | 11.1%    | 13.9%      | 34.7%  |
| DLP           | 5.6%             | 4.7%     | 3.3%       | 13.6%  |
| DFN           | 4.4%             | 6.1%     | 2.8%       | 13.3%  |
| Independence  | 0.3%             | 6.7%     | 20.8%      | 27.8%  |
| Achievement   | 3.3%             | 3.9%     | 3.3%       | 10.6%  |
| Total         | 23.3%            | 32.5%    | 44.2%      | 100.0% |

*Note.* DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature

Although the Tables 4.1 and 4.2 provide a sense of numerical proportionality, they are not necessarily representative of the magnitude, that is, the significance or

weighting one may accord to each sub-construct's impact on the shaping of colonialist consciousness. For example, although *detachment from local and personal sources of knowledge* (DLP) and *Detachment from Nature* (DFN) have lower counts than *Independence*, the former two instantiate themselves in more substantive and varied ways than *Independence*. This is evident, as *Independence* has 14 unique data entries, *DLP* has 44 unique data entries and *DFN* has 19 unique data entries. Further, upon closer inspection, *Independence-Assessment*, which makes up 20.8% of all instantiations of colonialist consciousness, logged the greatest amount of redundant construct manifestations. Specifically, 36 out of 75 instantiations were related to assessing students independently, while another 36 out of 75 instantiations were related to the use of impersonal command verbs in directions. Thus, although they are significant manifestations, the repetition and consistency of these two manifestations of *Independence* seems to be related to *Independence's* connections to ontology—that is ways of being—it is not proof of its paramount importance, but rather its specific role (i.e., ontology) in shaping colonialist consciousness.

Building from Tables 4.1 and 4.2, the analytical memos, and thematic coding from stage two both: a) a construct visualization, that is, Figure 4.1 and b) an empirically-specified evaluation framework for colonialist consciousness in mathematics, that is, Tables 4.3 through 4.7, were created. First, the construct *visualization* is presented and discussed. Second, the updated evaluation framework is presented and discussed, sub-construct by sub-construct.

## Visualization of Colonialist Consciousness

Emerging from the analytical memoing, the *visualization of colonialist consciousness* (See Figure 4.1.), as a construct, is framed as a coherent philosophical system. Although colloquially, consciousness is framed as a way of thinking and/or being, based on this study's analysis and in the spirit of Grande's (2015) scholarship, it can be more accurately conceptualized as *a way of life*. As such, colonialist consciousness, as a way of life, inclusively structures our fundamental assumptions about reality (metaphysics); the positioning of humans, both materially and spirituality, within the cosmos/nature (cosmology); our ways of knowing (epistemology); our ways of being (ontology); and our ways of creating, replicating, and discerning value(s) (axiology).

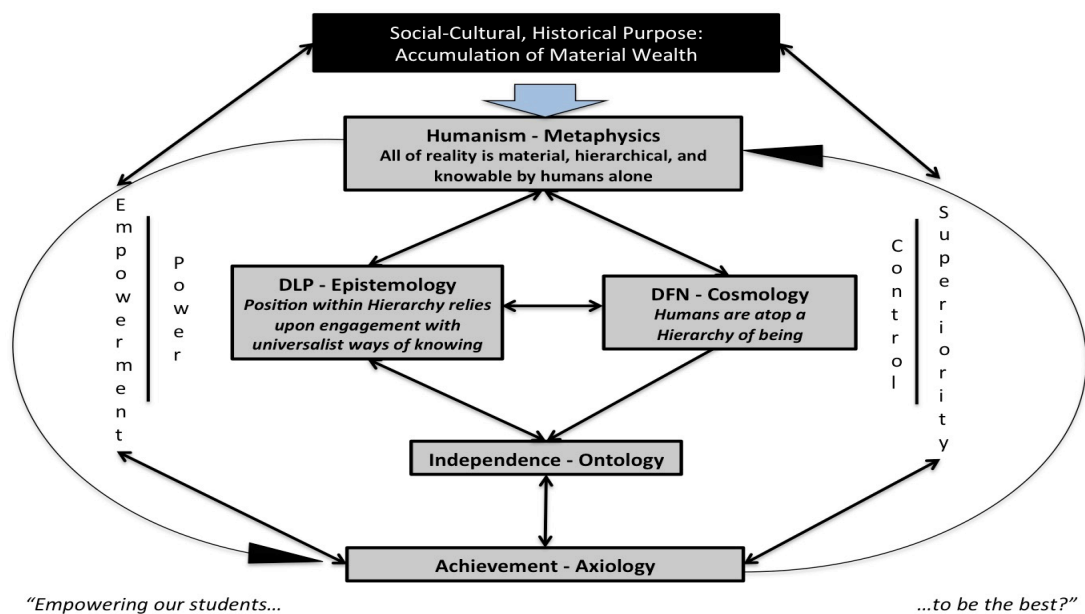


Figure 4.1. Construct visualization of colonialist consciousness as a way of life and philosophical system. DLP = Detachment from Local and Personal Sources of Knowledge. DFN = Detachment from Nature.

Within the construct visualization, and emerging from the analytical memos, Grande's (2015) five sub-constructs for colonialist consciousness are positioned as an aspect of the philosophical system that sustains colonialist consciousness as a way of life.

In general, the construct visualization of Colonialist Consciousness (Grande, 2015) reads from top to bottom, with both ends (i.e., purpose and values) pointing back, bi-directionally, to what Ani (1994) calls the organizing and energizing principles of Western cultural thought and behavior, that is, power and control. Although this visualization gives the impression that the components of all philosophical systems are hierarchical, this is not necessarily the case. Rather, the hierarchical nature of this system is a particular feature of modernist, hegemonic European philosophy. For example, other philosophical systems may place ontology (way of being) and cosmology (way of relating to the cosmos) via rituals as a cyclical precursor to an epistemological development (way of knowing) that non-anthropocentrically helps humans understand the metaphysical nature of reality and the values necessary to live harmoniously within this reality (axiology). However, despite Colonialist Consciousness' hierarchical orientation, *Figure 4.1* includes bi-directional arrows to recognize that Colonialist Consciousness' components operate in mutually reinforcing, overlapping, and at times, non-linear ways to achieve its purpose of material wealth accumulation.

At the top of the diagram, given the anti-empirical and particularistic nature of modern Western metaphysics (Deloria, 2012), is the larger socio-cultural and historical purpose of *Humanism*'s ideological development: the facilitation of expansionistic, material wealth accumulation as an expression of power and control (Ani, 1994). Thus, unlike other people's metaphysical assumptions, *Humanism* is a non-empirical,

ideologically-driven construct and is neither informed by our ways of being (ontology), nor our ways of relating to and/or positioning ourselves within the cosmos and/or nature (cosmology). Further, modern Western thought's consumptive ideological development and its brazen re-shaping of material reality within anthropocentric time scales underscore the anti-empirical nature of *Humanism*, and in general, the Western scientific project. To be clear, *Humanism's* development within an anthropocentric time scale stands in radical contradistinction to other people's metaphysical systems, which were wisely and empirically constructed within ecological time scales and in relation to specific places and the beings therein (i.e., millenniums versus decades or centuries) (Deloria, 2012; Wildcat, 2009). Ironically, given Western science's exclusive claim to understanding empirical reality, there is now overwhelming empirical evidence of the failure of *Humanism's* metaphysics given its ideological support for our ontological and existential crises, as exemplified by and exacerbated by climate change (Wildcat, 2009).

Deeply informed by *Humanism's* non-empirical and improvable metaphysical assumptions (i.e., that reality is hierarchical, material, and knowable by humans alone) is an orientation towards the cosmos (i.e., cosmology) that positions human beings as superior to and separate from all other beings (*DFN*). This positioning of human beings at the top (with rocks and minerals as the reconstituted, non-living bottom of beingness) of a despiritualized, materialistic hierarchy of being allowed for the ideological development of systems of human stratification, in particular race, for the purposes of material wealth accumulation (Wynter, 2009). White, European people who purportedly belong at the top of this specious hierarchy of being has been evidenced both through *DFN's* eco-/biologically-based and *DLP's* equally-problematic, culturally-based racism that stratifies

peoples by their purported ability to produce universal (i.e., non-local), and objective (i.e., non-personal, subjectless) knowledge via humanistic inquiries (*DLP*) (See *Figure 4.1*). Together, the illusion, often implicit, of the biological superiority of (White) human beings (*DFN*) offers a justification for Westerners pursuit of hegemonic *control*, while the illusion of cultural and intellectual superiority (*DLP*) offers a justification for Westerners to exert material *power* over nature, other beings, and non-Western human beings. The brilliance of this interconnected, overlapping, and bi-directional triad of *Humanism*, *DLP*, and *DFN* is that it materially facilitates, ideologically reconstitutes, and morally justifies a reality where Westerners can circularly exert a materialistic, anthropocentric, and despiritualized form of *power* and *control* for the purposes of obtaining signifiers of said power and control in the form of material wealth.

As this way of knowing and orienting oneself towards non-humans asks one to prove their personal worthiness within a stratified hierarchy of being by separating oneself from both local community knowledge (*DLP*) and their local community's ecology (*DFN*), an ontology, of *Independence* is rewarded and policed. In practicing this ontology, one is cajoled to embrace this way of life via the axiology of *Achievement*, which through its material manifestations and signifiers, reinforces both one's sense of superiority and empowerment, as well as the larger validity of *Humanism*'s metaphysical assumptions. Like the other sub-constructs the bi-directional, overlapping, and often non-linear nature of their interactions are reflected in *Figure 4.1*.

Theoretically, *Achievement*'s relationship to both *Humanism* and the organizing and energizing principles of Western cultural thought and behavior, that is, power and control is of particularly important. First, *Achievement* not only completes the circuit

through which colonialist consciousness fully manifests itself, but acts as the conduit for a cyclical, positive feedback loop that replicates and propagates colonialist consciousness. Circularly, in orienting people's values towards the quantifiable and material signifiers of *Achievement*, colonialist consciousness fulfills its purpose, that is, the accumulation of material wealth, which in driving its metaphysics validates *Humanism's* metaphysical assumptions. Thus, ironically, a purportedly empirical metaphysics is justified pseudo-empirically in relation to the quantifiable nature of its material culture, which is masterfully disarticulated from the empirically observable ecological and social harm that is inseparable from its construction. Second, the ecological and social harm caused is euphorically invisible ("ignorance is bliss") as *Achievement* offers the material signifiers that fulfill, temporarily, the Western desire to connect with its energizing and organizing cultural principles: power and control (See Figure 4.1). As such, given *DLP's* and *DFN's* relationship to *power* and *control*, respectively, *Achievement* via its bi-directional connection to power and control, also indirectly reinforces *DLP* and *DFN*.

Collectively, colonialist consciousness is a way of life that promotes the development of an *empowered* (via a European, maleness) being that is justified, in their *superiority*, to exercise their power and control, respectively upon other beings, their habitat, and even other human beings. In a seemingly innocuous manner, teachers within this way of life are encouraged to "*empower* students to be their best," that is, *powerful* and *superior* (See Figure 4.1). Of course, many reasonable critics may rightly claim that empowerment is described differently by a variety of justice-oriented scholars, and even social justice activists. However, given the orientation of empowerment, as a theory of

change, towards power as the natural organizing principle of human reality, rather than, for example, harmony and balance, caution should be taken with educational programs embracing this theory of change as it may also, inadvertently, promote aspects of colonialist consciousness.

### **Stage-Two, Anti-colonial Mathematics Evaluation Framework**

In this section, the stage-two anti-colonial evaluation framework is presented in tabular form by sub-construct. Each sub-construct's table has sub-category headings that describe a cluster of manifestations. These sub-category headings take up the language and philosophical orientations embedded within the empirically-informed visualization of colonialist consciousness. Within each sub-category, each row of the table represents a manifestation within that thematic sub-category. Further, for each manifestation, the location(s) within the curriculum (i.e., goals/objectives, pedagogy, and assessment) where the manifestation is present – “Y”, where it was not present – “N”, and where it was not empirically found, but theoretically assumed to exist elsewhere –“(Y)” is noted.

Overall, between the pilot of the stage-one anti-colonial mathematics evaluation framework and the development of the stage-two evaluation framework, only two manifestations were removed and two manifestations were moved to a different sub-construct. Two manifestations were removed because of the ways in which the manifestations of colonialist logic have recast themselves over time, thus making these two manifestations relatively antiquated instantiations of coloniality. As noted by Patel (2014), the hydra-like shape shifting of colonial logics aims to perpetuate material wealth accumulation in the face of resistance, refusal, and re-imaginings of the current reality.



Specifically, the two manifestations that were removed were from *DLP* and *Achievement* relate to the explicit stratification of people by a) race and gender and b) perceived intelligence (implicitly, mathematical), respectively. Although racist and sexist narratives may continue to manifest within many curriculums, (i.e., in word problems and pictures), this is not the primary way coloniality should be expected to manifest moving forward in Common Core mathematics curriculum. Rather, further analysis in Chapter 5 illustrated that this curricular text includes ostensibly female and non-White names within word problems, albeit insufficiently, who are doing a greater diversity of high and medium status activities. In reference to this study's literature review, this trend is most likely a re-enactment of the global elite's desire to make as many potential workers as profitably, mathematically proficient as possible, both as an intertwined wage reduction mechanism and a resolution of a supply-side, labor issue (Wolfmeyer, 2014).

In addition, the two manifestations that were moved to *Humanism* were originally in *DFN*. As seen in the construct visualization *DFN*, *DLP*, and *Humanism* are closely linked, which at times makes distinctions between them difficult to discern. Related to this, the two manifestations that were moved both concerned the nature of physical reality, which, given modern Western metaphysics, makes the assumption that all nature is de-spiritualized and agentless, a belief that certainly facilitates humans' Detachment from Nature. Specifically, the two manifestations moved from *DFN* to *Humanism* were: *DFN*-Pedagogy to *Humanism*-Pedagogy – “World presented as mechanistic, atomistic, and rational physical reality (Grande, 2015; Tuhiwai Smith, 2012). [LR]” and *DFN*-Assessment to *Humanism*-Assessment – “Assessment requires students to see the world as mechanistic, atomistic, and rational (Grande, 2015) [LR].”

Of course, even with minimal removals and movement with respect to the manifestations of colonialist consciousness, the thematic coding of the provisional coded data produced groups that were further thematically clustered into theoretically robust sub-categories. Thus, many substantive re-clustering of manifestations occurred, which although different from the stage-one evaluation framework, as aforementioned, was crosschecked to ensure construct validity in terms of theoretical representativeness. In addition, unlike the stage-one evaluation framework, in stage-two the impact of the manifestations on different aspects of the curriculum was more accurately identified and evidenced via the empirical process of coding. Collectively, the stage-one and stage-two evaluation frameworks may share the same spirit, but stage-two reflects a more defined enfleshing of that spirit, which is shared hereafter in tabular format.

### **Humanism as a Non-empirical and Material, Wealth-driven Metaphysics**

Based on the relative frequency of *Humanism* (34.7%), its four sub-categories and nine manifestations, and the driving role of *Humanism* in the construct visualization of colonialist consciousness, it is argued herein that mathematics' contribution to colonialist consciousness is largely metaphysical. Presented almost uniformly throughout the curricular components, that is, 9.7% - goals/objectives, 11.1% - pedagogy, and 13.9% assessment, *Humanism* consistently sets and polices the assumptions necessary for both the *Detachment from Sources of Local and Personal Knowledge* (DLP) and the *Detachment from Nature* (DFN).

As shown in Table 4.3, there are four main sub-categories through which *Humanism* manifests itself metaphysically within mathematical texts. These sub-categories, labeled a, b, c, and d in Table 4.3 are:

- a) Reality is governed by mathematical principles
- b) Like mathematics, reality is singular and objective
- c) All of reality is material and knowable via mathematics, and
- d) Understanding and engagement with reality is limited by mathematics, not mathematics by reality

Noticeably, *Humanisms*' sub-categories overlap with what are seemingly epistemological concerns. This overlap is intentional within Western thought. In fact, this overlap has resulted in Western epistemology's overtaking of metaphysics. For, as Western metaphysics has been reduced to questions about the nature of an atomistic physical reality and its causality, scientific processes, via mathematics' semiotic systems, has seemingly erased the need for metaphysics entirely (Carroll & Markosian, 2010). As such, metaphysics is largely considered moribund within Western philosophical circles (Deloria, 2012).

The purpose for this philosophical overlap and the seeming erasure of metaphysics is twofold. First, this overlap erases the need, desire, and even the discursive permission to ask questions about the fundamental nature of reality, which if answered differently may undermine the entire project of material wealth accumulation. Second, this overlap makes other people's metaphysical claims seem anti-scientific, that is, mythical and untrue, which also positions these people as inferior and thus unworthy of full humanity within a stratified hierarchy of (well) being. Of course, this is ironic, as the anti-scientific label is applied to knowledge and ways of being transmitted between other beings and/or human beings over geological (rather than human) timescales and that have empirically, ensured human and habitat well-being (Deloria, 2012; Wildcat, 2009).

### **Reality is governed by mathematical principles.**

One of the sub-categories inferred from secondary thematic coding was that “all of reality is governed by mathematical principles, which can be discovered via the symbols, syntax, and logic of algebra, which themselves are discovered detached from any social or historical purposes”. This sub-category is the heading for two manifestations (*ai* and *aii*), which assume that both: 1) symbolic logic and logical processes can create immutable and universal truths about reality (*ai*) and 2) mathematical symbols and logic are not socio-cultural products, but rather objects to be discovered (*aii*). Again, although these manifestations are seemingly epistemological claims, if accepted, they do not tell us anything about the nature of knowledge production, but more significantly about the fundamental nature of reality. They tell students that other beings and our habitat lack agency and that the universe, in general, is impersonal and spiritless, as they operate on largely mathematical principles. Feeding into *DLP* and *DFN*, the only agentic beings are humans who can understand and position themselves intentionally, using mathematical symbolic reasoning, within this hierarchical and mathematized space. Like mathematics, reality is singular and objective.

At the heart of sub-category “b” is the metaphysical belief that there is a singular objective reality. This improvable metaphysical claim that reality is both singular and objective is often used to hegemonically position Western mathematized knowledge, whose underlying sociopolitical theories remain hidden (Zuberi & Bonilla-Silva, 2008) above local, empirical, but non-quantitative knowledge construction (*DLP*). Hiding the subjective nature of mathematics, a discipline that maps the nature of a singular reality is of paramount importance to those who wish to advance this sub-category of *Humanism*.

Table 4.3

*Manifestations of the Sub-construct of Humanism*

Humanism (Metaphysics): Students are encouraged to believe that they are the masters of their own destinies, and that through technology and scientific inquiry, nature's unknowns can become knowable. Rejection of religion and spirituality as distortions in way of objective view of world (Grande, 2015). This implicitly both promotes the supremacy of Western science over other worldviews and place White male settlers, as their embodiment, at the top of the human hierarchy.

| Description of Manifestation                                                                                                                                                                                                                                                                                                                                                                                                                       | O/G | Ped | A   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
| a) All of reality is governed by mathematical principles, which can be discovered via the symbols, syntax, and logic of algebra, which themselves are discovered detached from any social or historical purposes.                                                                                                                                                                                                                                  |     |     |     |
| ai) If the symbolic logic and logical processes of mathematics is correct then it is the best and most trustworthy representation of reality – immutable and universal, truth                                                                                                                                                                                                                                                                      | Y   | Y   | Y   |
| aii) Mathematical symbolism involved in symbolic logic is portrayed as logical truths to be discovered, even though they are social and cultural products.                                                                                                                                                                                                                                                                                         | Y   | Y   | N   |
| b) Like mathematics, reality is singular and objective - Human subjectivity and larger socioeconomic, political, or cultural purposes do not effect the nature of mathematical knowledge, which in being the nature of a singular reality, is universal and immutable.                                                                                                                                                                             |     |     |     |
| bi) Mathematics is presented as universal, immutable, and detached from human and social purposes, interests, applications and power – as such it is the “purest” discipline, even though it has a genealogy tied to power and socioeconomic purposes. Rather, a suitable introductory example is presented so that readers can appreciate math’s usefulness and immutable truth, without revealing its particularistic and problematic genealogy. | Y   | Y   | (Y) |
| bii) Human subjectivity is erased even when human actors could/should be assumed within word problems                                                                                                                                                                                                                                                                                                                                              | N   | (Y) | Y   |
| c) All of reality is material and knowable via mathematics and/or mathematized disciplines and thus, can be made predictable, mappable, controllable, and/or manipulatable via mathematics                                                                                                                                                                                                                                                         |     |     |     |
| ci) All of reality can be made predictable, controlled, and/or manipulated via mathematics and/or mathematized disciplines (universalizing the particular), even though casual, social-political theories underlie the selection of and relationship between variables                                                                                                                                                                             | Y   | Y   | Y   |
| cii) Physical reality can be reconstituted through mathematics multisemiotic nature and/or remapped as rectangular, even though most physical systems are only linear and/or curvilinear up to a certain point                                                                                                                                                                                                                                     | (Y) | Y   | Y   |

| Description of Manifestation                                                                                                                                                                                                                                              | O/G | Ped | A |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|---|
| d) Understanding of and engagement with reality is limited by mathematics, not mathematics by reality                                                                                                                                                                     |     |     |   |
| di) Infinite solutions to algebraic problems are presented with no regard for issues with measurement, realistic physical constraints, and/or social contexts of use                                                                                                      | Y   | Y   | Y |
| dii) Universality and immutability of algebraized mathematics is justified by arithmetic and geometric examples, even though they are innately particular (arithmetic) and local (Euclidean)                                                                              | Y   | Y   | Y |
| diii) The essential characteristics necessary for understanding and interacting with social and physical reality is readably quantifiable via sense perceptions with precision, reliably, and aggregated across time and contexts, despite empirical experience otherwise | Y   | Y   | Y |

*Note.* O/G = Objectives and/or goals; Ped = Pedagogy; A = Assessment; Y = Yes, manifestation is empirically backed in Eureka Math, Grade 6 Equations and Expressions Module; (Y) Yes, but manifestation is only evidenced in the literature review and/or the prior study.

Given this, the presentation of Western mathematics as a pure discipline, separate from its imperial genealogy (*bi*) and presenting mathematics as a subjectless discipline (*bii*), is important to solidifying its objectivity and, thus, the objective nature of reality, which it purportedly describes. Again, although these could be labeled epistemological manifestations, their impact is metaphysical, reinforcing humanistic, Western thinking as the only way to conceive reality.

**All of reality is material and knowable via mathematics.**

By stating that all of reality is material and knowable via Western mathematics and/or its mathematized disciplines, it is assumed that some humans are separate and superior as exclusive knowers of this reality. Consequently, it is projected that full ethical treatment does not extend beyond those deemed equally human. Thus, mathematically uninitiated human beings in social (and physical) reality should be made manipulatable and controllable through mathematics (*ci*). Meanwhile, physical reality, that is, other beings and, in particular, our shared habitats, can be modeled, reconstituted, and/or remapped as linear (or curvilinear) models or as rectangular (*cii*). Together, problems that demonstrate mathematics predictive ability, apart from its underlying social-political theories (*ci*), or pretend that physical systems can be mapped limitlessly using rectangular, linear, or even curvilinear models (*cii*), promote a fictitiously materialistic reality.

This materialism, beyond projecting the improvable metaphysical assumption that all of reality is knowable, exists for the purpose of extracting material wealth from the mathematically uninitiated (*ci*) and/or agentless nature (*cii*). Essentially, the purpose of reality is material, the objective of being is material, and the ethics that may prevent such

human and ecological suffering does not extend to those who have not risen above the material. In fact, the material only has value to an individual when they are able to control, own, or manipulate it.

**Understanding and engagement with reality is limited by mathematics, not mathematics by reality.**

In K-12 mathematics, infinite solutions (*di*), arithmetic and geometric proofs (*dii*), and a highly quantifiable reality (*diii*) are presented as if the nature of reality is bound by the rules of mathematics and not vice versa. First, infinite solutions to problems (*di*) are presented as if humans' sense perceptions, their physical and social limitations, and/or the social contexts of a problem do not constrain or have bearing on the domain (*x* values) and the range (*y* values) that are acceptably true within a person's sociopolitical and cultural reality. Although often presented, infinite solutions are often not possible, nor meaningful, but they do project a limitless idea about mathematics' *objective* capacity that matches the expansiveness of the universe.

Second, the truth value of mathematics' universal expansion is often fictitiously validated using arithmetic, which is innately particularistic given its meaninglessness apart from contexts, and/or Euclidean geometry, which is definitively useful in local spatial contexts, but could not get a satellite into space (*dii*). In ignoring these caveats, the idea that mathematics and reality are one is advanced. This further reifies the notion that our understanding and engagement with reality is limited by our knowledge of mathematics, and not vice versa. Third, this mathematical understanding of reality is positioned as limitless, as all of reality is readably quantifiable with precision and reliably



measurable across time and contexts despite the aforementioned empirical experiences urging us otherwise.

Together, this presents the metaphysical claim that accessing reality is limited by a being's mathematical capacity, which although demonstrably culturally specific, is imagined to be universal. As such, once again, those whose cultures do not match this way of thinking and being are positioned as inferior within the metaphysically assumed hierarchal reality (*DLP*), while nature is further materialized as discrete commodities that can either be rectangularized or quantified for consumptive purposes (*DFN*).

### **Detachment from Sources of Local and Personal Knowledge as Epistemology**

Mathematical texts recruit students away from their local and personal sources of knowledge and towards a colonialist consciousness in three key ways, labeled sub-categories a, b, and c in Table 4.3:

- a) by forwarding Western mathematics as the valid foundation for all knowledge,
- b) by positioning mathematized knowledge as more appropriate than the personal or tacit knowledge found in communities and,
- c) in line with the mathematics for all movement, purporting that mathematics' power is can be availed by anyone who engages in its authoritative discursive patterns.

Driven by *Humanism*'s positioning of reality as singular, objective, and knowable, students are urged to believe not only that there are universal and immutable truths, but also that those truths emerge from mathematized disciplines and mathematics alone. As such, if students are to be intelligent, they are to accept Western mathematics as the valid foundation for knowledge (sub-category *a*), engage in a materialistic and reductionistic

mathematics to frame and solve everyday problems (sub-category *b*), and take up an authoritative and mathematized, logical way of speaking (sub-category *c*). If students do not exhibit these habits of thinking and being, then they risk evidencing their lack of worthiness within a stratified hierarchy of being. This has real material risks, as it may inadvertently create an apparent justification for their own domination by others who can and will empower themselves via Western mathematics.

**Western mathematics is the valid foundation for all knowledge.**

The textual positioning of Western mathematics as the proper starting point and valid foundation for knowledge construction and decision making, both in relation to physical and social reality, may be an essential step in transforming the way students interpret reality. First, both the frontloading of standardized mathematical content (manifestation *ai*) and its prioritization in the sequencing of content (*aii*) as preconditions to learning real-world applications of mathematical concepts positions universalistic, symbolic mathematical knowledge as superior to local and personal knowledge.

Although it may seem logical to first sequence abstracted mathematical content, this is generally done to privilege conceptual and procedural understandings related to specific symbolic progressions. Further, the privileging of these symbolic progressions, in a decontextualized and universalistic way, largely ignores the very particularistic and genealogical purposes of these symbolic progressions. In fact, many of these progressions have had very negative impacts on many places and peoples, for example, through mining, conquest, or extractive cost-benefit analyses, such as, with the Flint water crises. Second, not only are local and community knowledges minimized in the present, but also cultural mathematical knowledge central to or parallel to Western mathematics

development is ignored or hidden (*aiii*). For example, the Middle Eastern, and definitively Arabic and Muslim origins of algebra are ignored. Thus, especially for students of color, their communities' present and historical knowledges are positioned as inferior, either innately or in relation to its assumed non-existence. Instead, there is an imagining that all worthwhile and valid knowledge has been and continues to be the property of the West and its progeny.

**Mathematized knowledge is superior to personal or tacit knowledge found in communities.**

In the actual application of mathematical knowledge, once again, Western mathematics through its multisemiotic meaning-making-systems, that is, symbols, visuals (e.g., tables and graphs), and written language are privileged in the resolution of real-world problems. Even in situations where the application of Western mathematics' multisemiotic meaning making systems contradicts personal knowledge (*bi*) and or tacit knowledge (e.g., gardening) (*bii*), the reconstitution and solution of said problems remain unchallenged and/or unqualified. As such, the knowledge developed and made meaningful in communities, such as, tacit knowledge related to building homes or gardens and/or personal knowledge related to everyday purchases are minimized as inferior. Adding to this inferiorization of personal and tacit knowledge is the trivialization of mathematical examples from other cultures, which are either validated through their inclusion into or explanation via Western mathematics knowledge base (*biii*). Often, with respect to the latter, it is assumed that any universalistic truth claims emerging from any non-Western mathematical example was only tacitly understood by the non-Western culture and only fully understood more recently by Western mathematicians, using

Table 4.4

*Manifestations of the Sub-construct of Detachment from Local and Personal Sources of Knowledge*

DLP (Epistemology): Children and reservoirs of local knowledge with which they come to school are not perceived as sufficient or valid foundations of real or universal knowledge. Students are cajoled to accept modern worldview in place of their local knowledge/worldviews. (Grande, 2015). Peoples' ways of knowing and being that deviate from or are not associated with a modernist, Western worldview are stratified as inferior.

| Description of Manifestation                                                                                                                                                                                                                                                                                               | O/G | Ped | A   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
| a) Standardized Western <i>mathematized</i> knowledge is the valid foundation and proper starting point for knowledge construction and decision making; knowledge of community and local knowledge, experiences, preferences, or relationships unnecessary for application in real world                                   |     |     |     |
| ai) Standardized mathematical knowledge, which also encapsulates standardized habits of thought and action, is all students need to know to solve quantitatively-oriented, real-world problems.                                                                                                                            | Y   | Y   | N   |
| aii) The logic and supremacy of mathematics dictates the sequence of knowledge to be taught (teacher-centered), prioritizing mathematical knowledge and its sequential symbolic, algebraic development.                                                                                                                    | (Y) | Y   | N   |
| aiii) Real math understanding can only come from formal use of Western mathematics logical, symbolic structure. No acknowledgement of the assimilation of other cultures mathematics within Western mathematics, nor the existence of parallel mathematics from other cultures, peoples, and/or places for other purposes. | Y   | (Y) | N   |
| b) Mathematics is everywhere, universal, and superior to personal, tacit, and other, explicitly cultural ways of knowing, which are often found in communities. These other knowledge bases are minimized and replaced by mathematical ways of knowing as progress                                                         |     |     |     |
| bi) Personal knowledge, experiences, ways of being minimized in preference for using the multisemiotic nature of math (graphs, tables, algebra, language) to re-constitute the "real world," what counts as a problem within the real world, and reasonable solutions to said problems.                                    | Y   | Y   | Y   |
| bii) Tacit knowledge, often found in communities, speciously minimized/ignored in favor of engaging with reality, unrealistically (and often incompetently) via mathematics as personal capital.                                                                                                                           | N   | Y   | Y   |
| biii) Non-Western mathematical examples are presented superficially, using a problematic trait approach to race/culture, only to made valid via Western mathematics.                                                                                                                                                       | N   | (Y) | (Y) |
| c) This way of knowing is deceptively positioned as available to anyone and everyone who engages in its authoritative, decontextualized, and seemingly objective discursive patterns                                                                                                                                       |     |     |     |

| <b>Description of Manifestation</b>                                                                                                                                                                    | <b>O/G</b> | <b>Ped</b> | <b>A</b> |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------------|----------|
| ci) Privileging authoritative, decontextualized, and seemingly objective speech acts and policing context-dependent, contingent, and relational discourse associated with colloquial ways of speaking. | Y          | Y          | Y        |
| cii) Superficial inclusion of non-Western names and peoples in mathematized problems and problem solving.                                                                                              | N          | Y          | Y        |

*Note.* O/G = Objectives and/or goals; Ped = Pedagogy; A = Assessment; Y=Yes, manifestation is empirically backed in Eureka Math, Grade 6 Equations and Expressions Module; (Y) Yes, but manifestation is only evidenced in the literature review and/or the prior study

universalistic mathematical symbols and logic. Collectively, this encouraged students to not identify with their personal or local communities knowledge bases, but rather universalistic, mathematized knowledges.

**Mathematical power for all via its authoritative, universalistic discourse.**

Beyond disabusing students, particularly students of color, from their sources of local and personal knowledges, mathematical texts offer students inclusion into this modern Western way of knowing and being by explicitly teaching and policing how they engage in its authoritative, decontextualized, and seemingly objective discursive patterns (*ci*). This discourse is positioned as available to all, via the superficial inclusion of non-Western names and peoples into mathematized problems and problem solving (*cii*). Together, these manifestations cajole students to leave their local and personal sources of knowledge and, instead, invite them to participate in a theory of justice based on justice as full inclusion into White supremacist, settler structures and access to its material and social capital.

**Detachment from Nature as Cosmology**

In conjunction with *DLP*, which offers to *empower* students through mathematics authoritative semiotic systems, *Detachment from Nature* reciprocally teaches students that they are superior to (sub-category *a*), separate from (*b*), and in *control* within an oppositional, hierarchical, and materialistic nature (*c*). Together, *DLP* and *DFN* produce the orientation towards power and control that Western culture desires (Ani, 1994) and that a colonized consciousness needs to become fully actualized within an axiology of *Achievement*. Of course, a corollary to this is that humans who do not fully actualize their

ability to exert power and control (over supposedly lesser humans, other beings, and our shared habitat) may succumb to domination and inferiorization themselves.

**Human beings and human needs are superior to other beings and their needs.**

Students are often encouraged to treat other beings, plants, and their local ecology consumptively either as an agentless commodity or as an experience to be consumed (manifestation *ai*). This habit of being reinforces the notion that human needs, recreational or otherwise, supersede the needs or desires of other beings. More importantly, the needs of other beings are myopically treated as separate from our own, as if we live in different and unconnected habitats. Ironically, this adversely effects the long-term wellbeing of all beings, including human beings.

Further, when the needs of other beings and our shared habitats are considered their needs are still positioned, within a sustainability framework, secondary to human's consumptive needs (*aii*). For example, recycling plastic is only valued in relation to collecting a nominal bottle deposit, and not reconsidered as generally undesirable, given that plastics are already a detriment to our oceans. Thus, a fair question is sustainability of what? In this case, recycling is sustaining a materialistic, consumptive, and domineering way of (non-well) being.

**Human beings are separate from nature.**

The construction of systemic racism, which has facilitated the dispossession and extraction of wealth from Indigenous peoples and lands the world over, is based upon the reconstitution of Europeans (and those who learn to live like them) as separate from and superior to both nature and the humans who live in harmony with it, that is, non-White,

Table 4.5

*Manifestations of the Sub-construct of Detachment from Nature*

DFN (Cosmology): The world is studied at a distance; contact with the earth, animals, and plants are severely limited. Students discover through interference that real learning occurs indoors and is composed of knowledge bases separate from life and the natural world (Grande, 2015).

| Description of Manifestation                                                                                                                                               | O/G | Ped | A   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
| a) Human beings and human needs are superior to other beings and their needs                                                                                               |     |     |     |
| ai) Nature and non-human beings are treated as agentless commodities that solely exist to consumptively serve anthropocentric needs on both personal and vocational levels | Y   | Y   | Y   |
| aii) Sustainable relations between humans and other beings assumes that other beings' needs are secondary to human's consumptive needs                                     | N   | Y   | (Y) |
| b) Human beings are separate from nature                                                                                                                                   |     |     |     |
| bi) Proper human relations are limited to anthropocentric, human constructed indoor and outdoor (rectangular spaces)                                                       | Y   | Y   | Y   |
| bii) The outdoors is treated as empty (terra nullius) until re-mapped as rectangular and/or pre-planned inside without regard to ecological impact                         | Y   | Y   | Y   |
| c) Nature is oppositional to human well-being and must be controlled and managed                                                                                           |     |     |     |
| ci) Nature is oppositional and must be controlled, and managed                                                                                                             | (Y) | Y   | (Y) |

*Note.* O/G = Objectives and/or goals; Ped = Pedagogy; A = Assessment; Y=Yes, manifestation is empirically backed in Eureka Math, Grade 6 Equations and Expressions Module; (Y) Yes, but manifestation is only evidenced in the literature review and/or the prior study.



Indigenous peoples. The specious separation of humans from nature is facilitated in two ways within mathematical texts. First, all textually sanctioned human relations are limited to anthropocentric, human constructed indoor and outdoor spaces (manifestation *bi*), which are largely rectangular (see *Humanism*, *cii* and *dii*). In addition, when mathematical concepts are applied to non-human occupied spaces the space is treated as terra nullius until it is re-mapped rectangularly and/or mapped out indoors (*bii*). In either case, the ecological impact of the remapping or planning of is not considered as, again, it is treated as terra nullius, that is, empty space.

**Nature is oppositional to human wellbeing and must be controlled and managed.**

From the perspective of colonialist consciousness, humans are not only superior to and separate from nature, but nature is framed as oppositional to human wellbeing (manifestation *ci*). The appropriate relationship between humans and nature is marked by human control over their immediate environment, which means that nature is limited to objectifiable and measurable entities that can be consumed as food (e.g. two apples), treated (speciously) as a commodity (e.g., four liters of water), or a consumable experience (e.g., one-day ski pass on a defaced mountain). Even aspects of nature that are essential to human wellbeing, such as bacteria, whom are essential to our gut biome, are framed as uniformly and categorically hostile, even though there are slightly more bacteria in human bodies than cells (Abbott, 2016).

**Independence as an Ontology of Reifying One's Hierarchical Positioning**

The mutually reinforcing sub-constructs of *DFN* and *DLP* orient students towards imagining themselves within a materialistic hierarchy of being upon which humans who

engage with (the most) mathematized disciplines sit upon its pinnacle. Ontologically, those embracing and embodying these epistemological and cosmological assumptions are assumed to not only to engage in mathematics, but to do so alone (sub-category *a*) and without relational attachments (*b*). As such, mathematics is projected as a tool that enables humans to exhibit a full subjectivity characterized by extreme self-reliance (*a*) and an extreme objectivity, detached from irrational emotions (*b*).

A corollary to this notion is the belief that anyone (even whole societies) that does not exhibit this particularly Western ontology of *Independence* are controlled and overpowered by their irrational emotions and relationships. Consequently, as argued extensively by humanistic scholars, for example, Locke and Mill, such peoples are not deserving of democracy, government-to-government relationships, or liberty, but rather tyranny, paternalistic colonialism and/or imperialism, and domination and/or extermination (Lowe, 2015).

Although not as extreme, this sentiment is still resonant within mathematical texts. *Independence*, as described, is actively rewarded and even policed within the mathematics curriculum. Of course, students cannot be controlled. Further, it should be expected that many students resist and refuse these logics. Yet, the material power differentials between teachers and students, and even, administrators and teachers cannot be ignored.

### **Extreme Self-reliance.**

Being perceived as fully human within a hierarchically stratified material reality is important to avoiding the precarity of being dominated and controlled by others. Of course, given the raced, gendered, and classed ways that our reality has been stratified,

individuals who are not White, upper classed, cisgendered, heteronormative males are exposed to the greatest precarity, despite any mathematical, or otherwise, accomplishments. Yet, within colorblind discourses, such as those promoted by the *Mathematics for All* movement, engaging in mathematics and mathematized disciplines is forwarded as a great equalizer, even in lieu of any institutional changes to the systemic oppression endemic to the ongoing structure of settler colonialism. Thus, in this meritocratic discourse, those who can demonstrate their mathematical prowess, independently, are said to empower themselves.

Similarly, being able to demonstrate extreme self-reliance, that is, *Independence* is rewarded and/or policed within the mathematics curriculum. First, almost all mathematical tasks require students to act as if they are alone in a classroom full of other people (manifestation *ai*). If students need help and if assistance is allowed, then the use of authoritative mathematical texts or class notes, albeit independently, is the next best option (*ai*). In addition, even when engaged in solving word problems, for which they are treated as the subject, it is assumed that they will not or cannot interact with those who are the object of the inquiry (*a ii*). Further, even when students are solving problems for which they are neither the subject nor the object of the situation at hand, students are often exposed to idealized examples of fictional characters engaging in extreme self-reliance by solving problems via mathematics.

### **Performing tasks detached from relationships.**

Beyond rewarding and enforcing extreme self-reliance, students are encouraged to engage in detached relationships towards teachers, other students, and the objects of problem solving as a signifier of their objective, fully actualized personhood. First,

Table 4.6

*Manifestations of the Sub-construct of Independence*

Independence (Ontology): Children are expected to be self-reliant, to complete school tasks on their own, and accept personal responsibility for their own behavior. (Grande, 2015, pp. 100-101). [The corollary to this notion is the idea that people who do not learn “independently” or even whole societies that learn more cooperatively or interdependently are less advanced in their development, a sentiment that has justified democracy for some, and tyranny for others for the past 300 years (Lowe, 2015).]

| Description of Manifestation                                                                                                                                                                                                                                                   | O/G | Ped | A   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
| a) Full subjectivity within a hierarchy of being demands that students can successfully engage supposedly universal and immutable, but particularly Western, mathematics alone.                                                                                                |     |     |     |
| ai) Tasks require students to act as if they are alone and cannot ask others for help. If students need help, they may be able to use authoritative mathematical texts or class notes to complete the task (often not the case for assessments).                               | Y   | Y   | Y   |
| aii) Practicing full subjectivity by pretending that you cannot interact with those who are the object of the inquiry to ensure a fictitious independent, detached inquiry.                                                                                                    | N   | (Y) | Y   |
| aiii) Vicarious and idealized examples of extreme self-reliance, which necessitates mathematical knowledge                                                                                                                                                                     | N   | (Y) | Y   |
| b) Performing tasks detached of relationships is a hallmark of an objective, fully actualized person within the hierarchy of being                                                                                                                                             |     |     |     |
| bi) Relationship towards teacher, subjects, and objects are impersonal and detached. Impersonal command form verbs are often used.                                                                                                                                             | N   | Y   | Y   |
| bii) No meaningful peer work necessary to complete tasks, which everyone should complete at the same pace. Language of collectivity may be used, but individual performance is still the metric of success.                                                                    | (Y) | Y   | (Y) |
| <i>Note.</i> O/G = Objectives and/or goals; Ped = Pedagogy; A = Assessment; Y=Yes, manifestation is empirically backed in Eureka Math, Grade 6 Equations and Expressions Module; (Y) Yes, but manifestation is only evidenced in the literature review and/or the prior study. |     |     |     |

mathematical tasks often involve impersonal command form verbs, which condition students to view the appropriate relationship between the objects needing mathematical problem solving and the subjects solving the problem as detached, impersonal, and non-emotional (*bi*). Second, detached relationships are furthered by the lack of meaningful peer work necessary to complete tasks, especially when individual performance remains the only metric of success (*bii*).

### **Achievement as Axiology**

The axiology of *Achievement* is not just an outflow of the other sub-constructs of colonialist consciousness, but also creates a feedback loop that justifies and naturalizes colonialist consciousness as a way of life. In the successful achievement of instrumentalist goals and the procurement of materialistic wealth, there is a reinforcement that a) power and control are the organizing principles of human life and b) the purpose of living and the measure of one's worthiness is the accumulation of material wealth.

In mathematics curriculum, Achievement as an axiology is promoted in three ways, two of which were found empirically in this curriculum. First, within this teacher-centered curriculum, *Achievement* was propagated as a value in two ways: a) through an instrumentalist orientation toward work and schooling (sub-category *a*) and b) real, vicarious, and/or imaginary competition for social and/or material capital between friends, siblings, and/or classmates (*b*).

Although not found in this curriculum, curricula with more student-centered pedagogy may promote *Achievement* by framing collaboration as necessary for success in competitive corporatized institutions (sub-category *c*). This notion is backed by Wolfmeyer's (2013) well-documented network analysis of the proliferation of corporate

interests in the development of content and practice standards within the current mathematics reform movement. More empirical research needs to be done to confirm the presence of this aspect of Achievement in other, more student-centered curricula.

### **Instrumentalist orientation toward work and schooling.**

Fundamentally, instrumentalism may be the most materially destructive aspect of colonialist consciousness. This orientation myopically directs tasks towards specific material goals and does not account for or recognize the impact these goals might have on others or the environment. In fact, processes or other alleged externalities, which are more often endemic to the goals and/or processes, are ignored.

First, students are conditioned to accept instrumentalism via the curriculum's promotion of impersonal, a priori goals (*ai*). These goals direct students towards observable and measurable results, which are, not surprisingly, disconnected from their personal interests or their community's context. Further, these goals do not consider, nor aim for a particular way of relating or allow for differences in understanding; the standardized goal is all that matters. Second, this instrumentalist way of valuing reality is taught explicitly via utilitarian cost benefit analysis, which reduces decision making to quantifiable, materialistic variables (*aii*). Third, in all expected or vicarious responses to a peer's answer, the personal state and/or feelings of said peer is treated as irrelevant (*aiii*). Instead, it is expected that the student, either through expository or explanatory writing and/or speaking, directly corrects, without any hesitation or consideration for their relationship or the classroom's culture, their peers' thinking.

Table 4.7

*Manifestations of the Sub-construct of Achievement*

**Ach (Axiology):** Success and individual worth are measured by abstract and impersonal standards of excellence whereby students are aware of being in direct competition with others. Students are encouraged to make an impact on their environment. Process is merely a means to an end; instrumentalist consequentialism (Grande, 2015).

| Description of Manifestation                                                                                                                                                                                                                            | O/G | Ped | A   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|
| a) Instrumentalist, non-relational orientation towards ways of being in relation to work or its assumed pre-cursor, that is, schooling, is idealized.                                                                                                   |     |     |     |
| ai) Goals are impersonal, decided a priori to students arrival, and direct students towards observable behavior to be rewarded in relation to measurable results, not process or ways of relating                                                       | Y   | Y   | Y   |
| aii) Utilitarian cost benefit analysis either formally or, informally, in the elevation of efficiency, productivity, and/or profitability.                                                                                                              | (Y) | (Y) | Y   |
| aiii) Personal state and/or feelings of person being corrected or critiqued do not matter in expository and/or expository writing/speaking. Results are all that matter.                                                                                | N   | Y   | Y   |
| b) Promotion of vicarious and/or imaginary competition for social or material capital between friends, siblings, and/or classmates.                                                                                                                     |     |     |     |
| bi) Competition for social or material capital is experienced vicariously by more mature characters whom students may imagine themselves becoming in the future                                                                                         | Y   | Y   | Y   |
| bii) Student are encouraged to image themselves and/or like-age fictional characters competing (or being compared),, in the present, for social or material capital, resulting in monetary benefit, commodified experiences, and/or maximum consumption | Y   | Y   | Y   |
| c) Group work and/or collaboration framed in terms of future oriented achievement in competitive, corporatized institutions                                                                                                                             |     |     |     |
| ci) Group work and problem solving for the purpose of developing the “attitudes, skills and knowledge needed by large corporations” (Wolfmeyer, 2014, p. 8).                                                                                            | (Y) | (Y) | (Y) |

*Note.* O/G = Objectives and/or goals; Ped = Pedagogy; A = Assessment; Y=Yes, manifestation is empirically backed in Eureka Math, Grade 6 Equations and Expressions Module; (Y) Yes, but manifestation is only evidenced in the literature review and/or the prior study

**Competition for social and/or material capital between friends, siblings, and/or classmates.**

Competition has a positive connotation within capitalist societies as competition is believed to encourage efficiency, quality, and fair prices via the ever-responsive supply and demand curves. However, competition in capitalism, is not surprisingly, driven towards capital (not wellbeing), which is either social or material in nature. Further, in capitalism, accumulating capital is often framed in terms of winning and losing; achieving is the goal, the value. As such, competition and achievement are interlocked, as process and value.

In mathematics curricular texts, this competition tends to manifest in two ways, but mostly through word problems. First, competition is experienced vicariously in future-oriented word problems that involve more mature characters competing within socially valued activities (*bi*). Second, competition is experienced either vicariously through like-age fictional characters or through imaginative processes, whereby students are engaged in mathematical problem solving to ensure victory for themselves or the word problem's protagonist (*bii*).

Interestingly, there may be a connection between the rise in social inequality and the commodification of personal experiences in mathematical word problems. In a society where *Achievement* serves as a feedback loop justifying and promoting the purpose of reality as the accumulation (or securing) of capital within an oppositional and hierarchical reality, the inability to own material signifiers of *Achievement*, such as homes or cars, could necessitate a crisis in the feedback loop. To avoid such a crisis, either personally or systemically, social media platforms may help evidence one's



fleeting attainment of socially valued signifiers, via uploaded pictures that display one's accumulated experiences and/or staged lifestyle. This may be an area of future study and a potential shift in coloniality's manifestations, but not its core logic.

### Summary

Naming entities in relation to ourselves is an important individual capacity and social-cultural technology that allows us humans to make sense of where we are, who we are in relation to these spaces, and how we should relate to other beings and places within said spaces. As the narrative in this chapter began, being able to identify and name the other living beings on a hiking trail has the potentiality to transform the way we internalize and make sense of (epistemology), relate to (ontology), value (axiology), and conceptualize the spaces we transverse physically or otherwise (metaphysics and cosmology). Likewise, the second-stage anti-colonial mathematics curriculum evaluation framework presented in this chapter aimed to help mathematics educators, curriculum developers, teacher educators, and even students and practitioners of mathematics to see the familiar in unfamiliar ways.

Related to this generative, rather than definitive orientation to findings, two broad findings are particularly worthy of further reflection. First, *Figure 4.1* presents Grande's (2015) *Colonialist Consciousness* both: i) as a way of life and a coherent philosophical system and ii) as a hierarchical feedback loop defined by its purpose and ideologically defended by its material transformation of reality and/or, on a more individual level, the personal *Achievement* of signifiers of power and control. Second, the findings by sub-construct specify Grande's (2015) construct both in relation to mathematics curricular texts and in relation to each other. Specifically, each sub-constructs' sub-categories with

its corresponding manifestations illuminates: i) the hegemonic nature of Western imperial epistemology both over other peoples' epistemologies and Humanistic metaphysics; ii) the interrelationship between epistemology, cosmology, systemic racism, and environmental degradation; and iii) *DFN's* and *DLP's* ideological policing of *Independence* and *Independence's* consequential impact on facilitating an Achievement orientation, which, again, ironically substantiates a non-empirically-based *Humanism*.

Taken together, the aim of this work was to re-orient our mathematical and otherwise energies to help us live well in relation to other beings and our shared habitats. To that effect, we must first know what to refuse, resist, and reimagine mathematically. In that respect, this framework humbly hopes to be a starting point on this journey. The next chapter aimed to use said framework to identify, count, and describe specific instantiations of the sub-constructs', sub-categories' manifestations for the purposes of advancing human being, other being, and our shared habitats wellbeing.

## **CHAPTER FIVE: IDENTIFYING COLONIALIST CONSCIOUSNESS WITHIN A COMMON CORE MATHEMATICS CURRICULUM**

Question two focused on the evaluation of *Eureka Math*'s Grade 7, Equations and Expressions Module (a.k.a., Module 3). This evaluation was done for the purposes of establishing the anti-colonial mathematics evaluation framework's ability to: a) identify colonialist consciousness within Common Core mathematics curriculum and b) increase our understanding of how different curricular elements work together to propagate colonialist consciousness. Specifically, this chapter answered the following question: To what extent can a Common Core mathematics curriculum be evaluated by an anti-colonial mathematics evaluation framework? To answer question two and its two sub-questions, a qualitative criterial curriculum evaluation was carried out. As discussed in the methods section, a criterial curriculum evaluation has four idealized stages: 1) the establishment of criteria, 2) the construction of standards, 3) the measuring of performance in comparison to said standards, and 4) the synthesis of data into judgments of merit (Kemmis & Stake, 1988, p. 16).

The first two stages of this study's criterial, anti-colonial curriculum evaluation of a Common Core aligned mathematics' curriculum were completed in the methods section and in addressing question one. Chapter Four, non-sequentially, focused on refining the establishment of criteria, that is, Stage One, as presented in the methods section. In Chapter 4, the thematic coding of each sub-constructs' instantiations resulted in empirically-based manifestations organized under descriptive sub-categories that also aligned with the theorization of the construct of colonialist consciousness as presented in *Figure 4.1* (See Tables 4-3-4.7.). The information presented in these Tables 4.2 to 4.7

serves as the criteria of merit for this study's evaluation. Stage Two was completed previously in the methods section with the construction of standards that signified the nature and the extent of the sub-construct's manifestation. Specifically, these standards were: explicit – criteria is explicitly written in the curriculum; implicit, teaching – criteria manifests in the implantation of the recommended pedagogy; implicit, learning – criteria manifests in the way students are expected to learn and/or perform the task or activity; and null – the criteria is not manifested.

In this chapter, Stages Three and Four of the qualitative, absolute criterial, anti-colonial mathematics curriculum evaluation were applied to *Eureka Math's* Grade 7, Module 3. As previously discussed in the methods chapter, this unit was chosen because *expressions and equations* a) are intimately linked to the genealogy of Western mathematics multi-semiotic development in relation to coloniality (O'Halloran, 2005) and b) explicitly labeled a focal point by the Common Core State Standards, given its procedural and conceptual connection to upper-level, secondary and university mathematics coursework. However, Topic C was excluded, since it focuses on traditional geometric concepts, albeit with some integration of sixth-grade-appropriate algebraic manipulations and expressions.

With the two remaining sections, that is, Topics A and B, all relevant curricular materials were coded using the criteria and standards (derived from Stages One and Two) in order to answer question two. The first part of this chapter answers the first sub-question (2a), that is: In what ways does the qualitative evaluation identify instantiations of coloniality within a 6-8 Common Core aligned mathematics curriculum unit (i.e., Eureka Math, grade 7, Module 3 – Expressions and Equations)? In answering 2a, it

completes Stage Three by presenting and discussing the sub-construct frequency, the sub-construct relative frequency, and the five detailed sub-constructs frequencies organized in rows by manifestation and in columns by curriculum component type and standard. In doing so, these frequencies, and the concurrent discussion of their embedded results illustrate the degree to which the qualitative-criterial-anti-colonial-mathematics curriculum evaluation framework identifies instantiations of coloniality.

The second part of this chapter answers the second sub-question (2b), that is: How does an anti-colonial mathematics evaluation framework highlight salient curricular elements that contribute to human and ecological (in)justices within a 6-8 Common Core aligned mathematics curriculum? This sub-question completes Stage Four, and further advances sub-question 2a by presenting and discussing how the results presented in the evaluation tables highlight salient curricular elements within the Common Core mathematics curriculum that contribute to human and ecological injustices. The results from the analysis are organized by curriculum component groups, consisting of curriculum overviews, assessments for teacher edification (e.g., exit tickets), assessments for student edification (e.g., problem sets), and lesson plans. This organization of curricular component groups by function, aimed to help illuminate how colonialist consciousness operates within a mathematics curriculum. Each evaluation table row summarizes multiple codes for each curricular component into judgments about the degree to which the manifestations instantiate itself, with respect to each sub-construct (e.g., *Humanism*) and each curricular component type (e.g., pedagogy).

## Identifying Instantiations of Coloniality

Question two essentially asks, *does the anti-colonial curriculum evaluation framework, created in question one, help us to meaningfully identify and understand instantiations of colonial logics within mathematical curricular texts?* In order to answer this larger question affirmatively, the anti-colonial curriculum evaluation framework must first be able to identify instantiations of coloniality within a Common Core mathematics curriculum. Part A of question two addresses the first part of this larger question and is presented herein.

To start Topic A and Topic B of Eureka Math's Module 3, that is *Expressions and Equations*, were coded for its manifestations of colonialist consciousness using the anti-colonial mathematics curriculum evaluation framework created in relation to question one. Topic A focuses on the procedural and conceptual aspects of generating equivalent rational expressions, while Topic B leverages the knowledge and skill goals from Topic A towards the application and conceptual interpretation of mathematical and real world problems. Coding begins with the overviews (i.e., module, Topic A, and Topic B), followed by the lessons, and their corresponding formative assessments (i.e., problem sets and exit tickets), and concluding with the cumulative and summative, mid-module assessment at the end of Topic B.

Each coded item was labeled with five descriptors, which in addition to being used for sorting purposes and table construction, further aided in the meaning making process. The first two descriptors attached to each code were its corresponding sub-construct and the sub-construct's specific manifestation code. As such, the results produced in question one, that is, Tables 4.3-4.7, were consistently referenced during

coding. The third descriptor added was directly related to Stage Three of the qualitative criterial evaluation, which involved measuring the manifestation and comparing it to the standards, that is, whether the manifestation instantiated itself explicitly, implicitly - teacher directed, or implicitly – student learning oriented. Finally, the last two descriptors were the curriculum component type that the code was embedded within (i.e., Objectives/Goals, Pedagogy, or Assessment) and the specific curricular element where the code was made (e.g., Lesson 12 – Teacher Edition).

### **Overview of Results**

Collectively, the engagement of the qualitative criterial curriculum evaluation framework resulted in the identification of 431 instantiations of colonialist consciousness. Moreover, given the specificity of the empirically-validated and theoretically-backed descriptors engaged, the 431 instantiations are able to be sorted and presented in two broad ways, both providing different meaning making opportunities. In particular, the instantiations are presented on the sub-construct level and, potentially and more narrowly, on the manifestation level.

On the sub-construct level, the instantiations can be presented as totals by curriculum component type (e.g., Pedagogy), as totals by manifestation, and/or as totals by standards, that is, the degree of manifestation (e.g., Explicit). With respect to the former, Tables 5.1 and 5.2, which are frequency and relative frequency tables, respectively present the instantiations by curriculum component type. In the following section, totals by manifestations and totals by degree of manifestation were discussed by sub-construct.

Unlike, the other tables presented in Chapter Four, Tables 5.1 and 5.2 are comparable with Tables 4.1 and 4.2, as they both organize the instantiations from their respective modules in terms of relatively more stabilized constructs, that is, curricular component types and Grande's (2015) sub-constructs. In comparing the two sets of tables, two insights emerge into the nature of colonial logics instantiations and progression within the K-12 standards based mathematics curriculum.

Table 5.1

*Frequency Table of Instantiations of Colonialist Consciousness by Sub-Construct and Curriculum Component Type*

| Sub-construct | Goals/Objectives | Pedagogy | Assessment | Total |
|---------------|------------------|----------|------------|-------|
| Humanism      | 33               | 104      | 46         | 183   |
| DLP           | 13               | 43       | 21         | 77    |
| DFN           | 0                | 11       | 10         | 21    |
| Independence  | 0                | 34       | 72         | 106   |
| Achievement   | 21               | 11       | 12         | 44    |
| Total         | 67               | 203      | 161        | 431   |

*Note.* DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature

When comparing the relative frequency of the instantiations presented in Tables 4.2 and 5.2 several differences between the Modules are noteworthy. First, for the construct *Detachment from Nature* (DFN), the instantiations were more than halved (13.3% to 4.9%). In the other direction, the results from these two tables show that the instantiations of both *Humanism* (Hum) - Pedagogy (11.1% to 24.1%) and *Detachment*



from *Local and Personal Sources of Knowledge* (DLP) - pedagogy (4.7% to 10.0%)

increased by nearly 50%. Meanwhile, the sub-constructs, *Independence* (27.8% to 24.4%) and *Achievement* (10.6% to 10.2%) remained relatively stable.

Table 5.2

*Relative Frequency Table of Instantiations of Colonialist Consciousness by Sub-Construct and Curriculum Component Type*

| Sub-construct | Goals/Objectives | Pedagogy | Assessment | Total  |
|---------------|------------------|----------|------------|--------|
| Humanism      | 7.7%             | 24.1%    | 10.7%      | 42.6%  |
| DLP           | 3.0%             | 10.0%    | 4.9%       | 17.9%  |
| DFN           | 0.0%             | 2.6%     | 2.3%       | 4.9%   |
| Independence  | 0.0%             | 7.9%     | 16.7%      | 24.4%  |
| Achievement   | 4.9%             | 2.6%     | 2.8%       | 10.2%  |
| Total         | 16.0%            | 46.7%    | 37.2%      | 100.0% |

*Note.* DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature

Although not sufficiently evidenced in this study, what may be underlying such a shift between grade levels may be related to the genealogy of colonial logics itself, which would indicate that *DFN* is more central to the forming of colonialist consciousness in earlier grades than in latter grades. As theorized by Wynter (2003), one of the key ideological facilitators of the reconstitution of humanity amongst a racialized, pseudo-scientific hierarchy of being was the construction of a dichotomized and polarized stratum of being that remade all beings on a hierarchical continuum between living and non-living. This hierarchical stratification of positioning humans at the top of living beings and reconstituting our habitat into living and non-living components placed newly decontextualized *rocks* at the bottom of the hierarchy. Of course, in between humans and

rocks were other beings, and within human beings, supposedly, more or less human beings. These human beings were speciously ranked in relation to anti-empirically constituted (a.k.a., pseudo-scientific), universalistic, uni-linear, and absolutist modernist Western conceptualizations of human culture, society, and political and economic organization, that is, by race.

Thus, given Wynter's (2003) theorization, it is possible that the shift away from *DFN* towards *DLP*-pedagogy and *Humanism*-pedagogy implicitly recognizes the success of the mathematics curriculum's work, with respect to positioning humans separate from and superior to other beings and our shared habitat during the elementary (K-6) grades. This possibility is affirmed by structures presented in Figure 4.1, which positioned *DFN* and *DLP* as important co-sub-constructs, flowing from a belief in a physical and despiritualized reality completely knowable via *Humanism*. Once students believe that there is a hierarchy of being upon which Western humans are at the top, there will be a drive within the culture produced by colonialist consciousness to prove one's own superiority by detaching oneself from local and personal sources of knowledge (*DLP*). In doing so, one is supposedly opening up to the empowering potentialities offered via the engagement of humanistic metaphysics and epistemological systems for the purpose of material wealth accumulation.

La Paperson (2010) suggested that this invitation to empowerment via the detachment of oneself from local and personal sources of knowledge is especially marked within underfunded schools attended by a majority of students of color. For those who are deemed worthy of the metropolises rewards, they are often cajoled to abandon their communities physically, emotionally, spiritually, and intellectually. Then, they are

imagined to take rewards in the empowerment offered by the metropolitan universities' powers of signification and access to and (problematic) proximity to capital distributing mechanisms (La Paperson, 2010). Again, this warrants further study, but it is particularly worthwhile as it is well-known amongst former and current educators that underfunded schools are more likely to rely on prescriptive and free curriculum, such as Eureka Math (a.k.a., EngageNY). Thus, for students who attend our most underfunded schools, this reliance is often pursued with greater fidelity and less flexibility for the infusion of local and personal experiences, knowledges, or problems.

### **Results by Sub-Construct**

On the sub-construct level, the 431 instantiations can be examined by manifestation and, if desired, by standards, which considers the degree of manifestation (e.g., Explicit). Following this path of analysis, the way colonial logics instantiates itself within mathematics curriculum can be more accurately described and understood. Therefore, a different sub-construct is represented in each table for Tables 5.3 - 5.7. Specifically, each table is organized in rows by sub-construct manifestation (e.g., *Humanism*, *ai*) and in columns, first by curriculum component type (i.e., Objectives/goals, Pedagogy, and Assessment) and, secondarily, by degree of manifestation or standards (i.e., Explicit, Implicit-Teaching, Implicit-Learning). This level of detail will allow for a potentially illuminating identification of trends with respect to the frequency and degree of intensity for each of the five sub-constructs' numerous manifestations.

#### **Humanism.**

*Humanism* is metaphysically oriented and as such is perceived either as

innocuously esoteric to seemingly commonsense. Like all texts that promote metaphysics, mathematical texts present these ideas and concepts subtly, but in a particular way that leaves its reader with a specific perception of reality. Nonetheless, this study evidences the claim that mathematical texts are central to advancing colonialist consciousness' metaphysical, humanistic orientation, as 42.5% of the colonialist consciousness' 431 manifestations, that is, 183 out of 431 manifestations, were coded with the sub-construct of *Humanism*.

In particular, two sub-categories, that is manifestation clusters *a* and *d* were prolific, making up 154 out of 183 manifestations of *Humanism* within module 3. Manifestation *a* (77 out of 154 manifestations) advances the non-empirical metaphysical claim that “all of reality is governed by mathematical principles, which can be discovered via the symbols, syntax, and logic of algebra” (See Table 5.3). Meanwhile, manifestation *d* made up another 77 out of 154 manifestations, promoting the metaphysical claim that the “understanding of and engagement with reality is limited by mathematics, not mathematics by reality” (See Table 5.3)..

Within sub-category *a*, 68 of the 77 instantiations are connected to the metaphysical manifestation *ai*, advancing the notion that “if the symbolic logic and logical processes of mathematics is correct then it is the best and most trustworthy representation of reality – immutable and universal, truth” (See Table 5.3). As indicated by its numerical prevalence, addressing this manifestation may be the most important in disrupting the metaphysics of colonialist consciousness. It is erroneously assumed within every mathematized science from biology-to-economics-to-sociology. If the researcher engages in the symbolic mathematical logic successfully, then the results are treated as

sacrosanct. However, as noted by critical sociologists tracing the application of statistics in relation to the construction of race (Zuberi & Bonilla-Silva, 2008) and to systemic functional linguists tracing the genealogical development of mathematics multi-semiotic systems in relation to colonialism development (O'Halloran, 2005), symbolic logic itself is neither neutral, nor is its engagement devoid of underlying assumptions.

For example, in the mid-module assessment, which is an assessment of all the lessons in Topic A, students were instructed to simplify the expressions " $4x - 3(x - 2y) + \frac{1}{2}(6x - 8y)$ " without any discussion regarding why contextually and/or by what theoretical assumptions these terms were combinable. A simpler example that makes the same point is  $2x + 3x + 2x + 3x$ , which simplifies, according to the symbolic logic of immutable mathematics, to  $10x$ . However, the context and the underlying theoretical assumptions behind this simplification could matter, even within colonialist, capitalistic contexts. For instance, if this expression represents the consolidation of 4 different companies' profit functions under one newly formed parent company, how do we know that the new parent company does not benefit from economies of scale (greater than  $10x$ )? Or, how do we know that combining the companies, risks a net reduction in advertising expenditures and, incidentally, profits (less than  $10x$ )?

Alternatively, and less capitalistically, these expressions could represent a young adult, their partner, and their partners' two adult parents moving in with them in order to both help raise their grandchildren and to ensure a collective well-being. Before they all move in together, they may have all worked outside of the home, but by living together, they may be able to share costs more effectively with the goal of allowing for reduced work outside the home for one partner and the partners' parents, so that they can all

Table 5.3

*Manifestations of the Sub-construct of Humanism by Curricular Components*

| Humanism (Metaphysics): Students are encouraged to believe that they are the masters of their own destinies, and that through technology and scientific inquiry, nature's unknowns can become knowable. Rejection of religion and spirituality as distortions in way of objective view of world (Grande, 2015). This implicitly both promotes the supremacy of Western science over other worldviews and place White male settlers, as their embodiment, at the top of the human hierarchy. |             |     |     |          |     |     |             |     |     |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) All of reality is governed by mathematical principles, which can be discovered via the symbols, syntax, and logic of algebra, which themselves are discovered detached from any social or historical purposes.                                                                                                                                                                                                                                                                           |             |     |     |          |     |     |             |     |     |       |
| ai) If the symbolic logic and logical processes of mathematics is correct then it is the best and most trustworthy representation of reality – immutable and universal, truth                                                                                                                                                                                                                                                                                                               | 1           | 14  | 0   | 3        | 17  | 14  | 0           | 0   | 19  | 68    |
| aii) Mathematical symbolism/operations involved in symbolic logic is portrayed as logical truths to be discovered, even though they are social and cultural products.                                                                                                                                                                                                                                                                                                                       | 3           | 4   | 0   | 1        | 1   | 0   | 0           | 0   | 0   | 9     |
| b) Like mathematics, reality is singular and objective - Human subjectivity and larger socioeconomic, political, or cultural purposes do not effect the nature of mathematical knowledge, which in being the nature of a singular reality, is universal and immutable.                                                                                                                                                                                                                      |             |     |     |          |     |     |             |     |     |       |
| bi) Mathematics is presented as universal, immutable, and detached from human and social purposes, interests, applications and power – as such it is the “purest” discipline, even though it has a genealogy tied to power and socioeconomic purposes. Rather, a suitable introductory example is presented so that readers can appreciate math’s usefulness and immutable truth, without revealing its particularistic and problematic genealogy.                                          | 0           | 4   | 0   | 1        | 4   | 1   | 0           | 0   | 3   | 13    |
| bii) Human subjectivity is erased even when human actors could/should be assumed within word problems                                                                                                                                                                                                                                                                                                                                                                                       | 0           | 0   | 0   | 0        | 0   | 1   | 0           | 0   | 4   | 5     |
| c) All of reality is material and knowable via mathematics and/or mathematized disciplines and thus, can be made predictable, mappable, controllable, and/or manipulatable via mathematics                                                                                                                                                                                                                                                                                                  |             |     |     |          |     |     |             |     |     |       |

| Description                                                                                                                                                                                                                                                               | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                                                                                                                                                           | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| ci) All of reality can be made predictable, controlled, and/or manipulated via mathematics and/or mathematized disciplines (universalizing the particular), even though casual, social-political theories underlie the selection of and relationship between variables    | 0           | 1   | 0   | 3        | 6   | 2   | 0           | 0   | 1   | 13    |
| cii) Physical reality can be reconstituted through mathematics multisemiotic nature and/or remapped as rectangular, even though most physical systems are only linear and/or curvilinear up to a certain point                                                            | 0           | 1   | 0   | 0        | 0   | 2   | 0           | 0   | 5   | 8     |
| d) Understanding of and engagement with reality is limited by mathematics, not mathematics by reality                                                                                                                                                                     |             |     |     |          |     |     |             |     |     |       |
| di) Infinite solutions to algebraic problems are presented with no regard for issues with measurement, realistic physical constraints, and/or social contexts of use                                                                                                      | 0           | 0   | 0   | 5        | 7   | 2   | 0           | 0   | 3   | 17    |
| dii) Universality and immutability of algebraized mathematics is justified by arithmetic and geometric examples, even though they are innately particular (arithmetic) and local (Euclidean)                                                                              | 0           | 5   | 0   | 7        | 16  | 7   | 5           | 0   | 6   | 46    |
| diii) The essential characteristics necessary for understanding and interacting with social and physical reality is readably quantifiable via sense perceptions with precision, reliably, and aggregated across time and contexts, despite empirical experience otherwise | 0           | 0   | 0   | 2        | 1   | 1   | 0           | 0   | 0   | 4     |
| Sub Totals                                                                                                                                                                                                                                                                | 4           | 29  | 0   | 22       | 52  | 30  | 5           | 0   | 41  | 183   |
| <b>Total</b>                                                                                                                                                                                                                                                              |             | 33  |     |          | 104 |     |             | 46  |     |       |

*Note.* Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment; Standards: E = Explicit instantiation of the manifestation, I-T = Implicit instantiation of the manifestation that is evidenced in the way that educators are expected to teach, I-L = Implicit instantiation of the manifestation that is evidenced in the way that students are expected to learn. Black cells = manifestation was theorized in chapter four to not instantiate in relation to this aspect of curriculum

spend more time with the grandchildren. This may have a net impact of one partner working more ( $3x$  to  $4x$ ), one partner not working outside of the home ( $2x$  to  $0x$ ), and one grandparent transitioning from plumbing to working at home depot ( $2x+3x$  to  $1x$ ) while saving on childcare and increasing overall wellbeing [ $-(-2x) + \text{invaluable}$ ], which collectively could be represented as  $2x + 3x + 2x + 3x \rightarrow 4x + 1x - -2x = 8x + \text{increased well being}$ . This of course may be experienced, even quantifiably, as greater than the initial  $10x$ .

Of course, if the context is finding the perimeter of a rectangle composed of toothpicks of  $x$ -length, then  $2x + 3x + 2x + 3x$  is certainly combinable and would equal a net length of  $10x$  units. Yet, this combination only works because it relies upon Euclidean geometry, which itself fails in curved 3-dimensional space. Locally, Euclidean geometry works well (from the tooth pick level to the playground) and can be used successfully due to local linearity, the empirical observation that when a curved line or plane (even on a circle or a sphere), is sufficiently enlarged its sections appear to be straight lines and/or flat planes. The danger, which was observed in 46 instantiations within Module 3 (i.e., manifestation *dii*) is when the localized, epistemological strength of Euclidean geometry or arithmetic, which itself is innately contextualized in its applications (e.g., purchasing groceries), is extended beyond its various localized and particular uses towards universalistic pronouncements.

Together, *ai* and *dii* are linked and constitute 114 out of 183 instantiations of *Humanism* and 26.5% of all manifestations of colonialist consciousness within Module 3. Although seemingly esoteric, this is the beauty of its effectiveness and, in particular, of *Humanism*'s ability to hide metaphysics behind the supposed epistemological



immutability of Western mathematized sciences themselves. Unfortunately, the seeming inaccessibility of such discussions could be overcome by engaging in interesting, theoretically deep and contextually thick examples, such as the simplified examples presented herein about business and/or family decision making for mutual wellbeing.

It was observed that 104 out of 183 instantiations of *Humanism* within Module 3 are manifested implicitly through the way educators are expected to teach the concepts (pedagogy). Of the 104 pedagogy-based manifestations of *Humanism*, half (52 of 104) are connected to the way educators frame both mathematical concepts and introduce, frame, and solve mathematical and real-world problems. Thus, the role of educators in the instantiations of *Humanism* within the curriculum is of critical importance. The support for educators in terms of less problematic curricular goals and objectives (33/183), assessments (46/183), and practice problems (30/183), would greatly aid their refusal, resistance, and/or recreation of mathematics curricula.

The reasons for the relative minimization of manifestation clusters *b* and *c* are unknown, but may have two potential sources. First, given manifestation cluster *a*'s prolific advancement of the notion that "reality is governed by mathematical principles," manifestation clusters *b*'s and *c*'s claims, that is, that "reality is singular and objective" and that "all of reality is material and knowable via mathematics," may just seem implicitly true. Alternatively, sub-categories *b* and *c* may simply manifest more evidently in advanced secondary courses where mathematics tends to be more symbolic and procedural. This symbolic and procedural treatment of mathematics tends towards an under examination of mathematics' social and cultural origins (sub-category *b*) and tends to project the improvable assumptions that all of reality is, unqualifiedly knowable,

predictable, controllable, and manipulatable (sub-category *c*). For example, it may be the case that manifestation *cii*, that is, the belief and practice that “physical reality can be reconstituted through mathematics,” may manifest in later curricula, as manifestations of *DFN*, reciprocally, becomes less prolific.

Obviously, one could argue that in teaching youth, simplifications are inevitable. However, what we choose to simplify, what is compromised in the process, and how it is presented indicate which aspects of our culture are most elemental to our orientation towards physical and social reality, that is, our metaphysics. In this case, it is clear that *Humanism*, as instantiated within this module and elsewhere advances the supremacy, universality, and immutability of mathematics in interpreting reality. When this is internalized by youth, non-mathematized, but empirical personal and local sources of knowledge are greatly diminished (*DLP*) and a rejection of spirituality and religion as superstitious follows. Further, as discussed herein, *Humanism* facilitates and rationalizes a Detachment from Nature (*DFN*) that concurrently provides the root justifications for racism and advances the modernist, anthropocentric overconsumption of other beings and our shared habitats.

### **Detachment from local and personal sources of knowledge.**

In module 3, *DLP* constituted 17.9% of the instantiations of colonialist consciousness. Manifestations of *DLP* represent the ways in which students are cajoled to detach themselves from local and personal sources of knowledge. Of the 77 instantiations of *DLP*, 50.6% (39/77) manifested as *bi*, that is, “Personal knowledge, experiences, ways of being minimized in preference for using the multisemiotic nature of math (graphs, tables, algebra, language) to re-constitute the ‘real world,’ what counts as a problem

within the real world, and reasonable solutions to said problems” (See Table 5.4). As such, manifestation *bi* are the focus of this section’s discussion, even though manifestation sub-categories *a* (15/77) and *c* (17/77) are discussed, albeit in less detail.

The abundance of the manifestation *bi* within Module 3 (9% of all instantiations) may make sense intuitively to mathematics education practitioners, given the degree to which instructors are implored to make mathematics more relevant to students. Unfortunately, as demonstrated herein, mathematics is not simply made more relevant, but made to replace the more commonplace ways of resolving quantitative problems. As such, the examples presented herein make mathematics seem ubiquitous and its problem solving techniques as the logic replacement to inferiorly positioned, intuitive or commonplace ways of problem solving.

In line with the overall trend for *DLP* (64/77), 35 out of 39 instantiations of *bi* can be found in the word problems within lesson plans, problem sets, and/or other assessments. Yet, unlike some other manifestations, such as *ci*, that is, “privileging authoritative, decontextualized, and seemingly objective speech acts and policing context-dependent, contingent, and relational discourse associated with colloquial ways of speaking,” only 14 of *bi*’s 39 instantiations were teacher directed, versus 9 of *ci*’s 13 instantiations. As such, students are cajoled, largely by their own engagement with word problems as 20 out of 39 instantiations manifested as *Implicit-Learning*. Part of the apparent non-necessity for explicit or teacher-directed, implicit projection of manifestation *bi* may be its strong links to the *Humanist* notion that mathematics is everywhere, can predict everything, and is immutable.

Nonetheless, in this module, the word problems range from ludicrous to convincing reconstitutions of reality. Laughably, some problems call upon students to share a chocolate cake amongst friends, not in terms of slices, but instead by pounds of cake (see Lesson 9), while others ask students to imagine a family who buys two boxes of popcorn, per person, per movie (see Lesson 4). Other problems present mathematics as the prudent way to resolve any situation that can be reconstituted quantitatively, whether it is buying a sweater, buying concert tickets with all of your allowance money (Lesson 15), or tracking how much time you spend playing video games (Lesson 4).

More insidiously, other problems reconstitute reality itself, such as remapping the physical area in one's home by using algebra to solve something as commonplace as hanging two new posters, evenly spaced on one's wall using the equation  $14 = x + 4 + x + 4 + x$  (simplified as  $8 + 3x = 14$ ; see Lesson 7). Some require a much more dangerous and factually dubious reconceptualization of physical, even biological reality. For example, in Lesson 14, an imagined youth goes with their grandfather to the doctor's office, where she is told by a nurse that, for a normal blood pressure, "the upper limit of his systolic blood pressure is equal to half his age increased by 110" or 148mmHG. By all measures, this "normal blood pressure" is categorizable as Stage 2 Hypertension – necessitating medicine and/or lifestyle changes (American Heart Association, 2019). Rather than being normal, such a population level average is more indicative of a society with a heart disease crisis; not something to be normalized via mathematics. Nonetheless, it re-represents what is reasonable, even if we know that our elders are not as physically well as they could be.

Manifestation sub-categories *a* and *c*, together, position Western mathematics as

Table 5.4

*Manifestations of the Sub-construct of DLP by Curricular Components*

DLP (Epistemology): Children and reservoirs of local knowledge with which they come to school are not perceived as sufficient or valid foundations of real or universal knowledge. Students are cajoled to accept modern worldview in place of their local knowledge/worldviews. (Grande, 2015). Peoples' ways of knowing and being that deviate from or are not associated with a modernist, Western worldview are stratified as inferior.

| Description                                                                                                                                                                                                                                                                                                                | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                                                                                                                                                                                                            | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) Standardized Western <i>mathematized</i> knowledge is the valid foundation and proper starting point for knowledge construction and decision making; knowledge of community and local knowledge, experiences, preferences, or relationships unnecessary for application in real world                                   |             |     |     |          |     |     |             |     |     |       |
| ai) Standardized mathematical knowledge, which also encapsulates standardized habits of thought and action, is all students need to know to solve quantitatively-oriented, real-world problems.                                                                                                                            | 4           | 0   | 0   | 2        | 1   | 0   | 0           | 0   | 0   | 7     |
| aii) The logic and supremacy of mathematics dictates the sequence of knowledge to be taught (teacher-centered), prioritizing mathematical knowledge and its sequential symbolic, algebraic development.                                                                                                                    | 4           | 0   | 0   | 0        | 0   | 2   | 0           | 0   | 0   | 6     |
| aiii) Real math understanding can only come from formal use of Western mathematics logical, symbolic structure. No acknowledgement of the assimilation of other cultures mathematics within Western mathematics, nor the existence of parallel mathematics from other cultures, peoples, and/or places for other purposes. | 0           | 1   | 0   | 0        | 1   | 0   | 0           | 0   | 0   | 2     |
| b) Mathematics is everywhere, universal, and superior to personal, tacit, and other, explicitly cultural ways of knowing, which are often found in communities. These other knowledge bases are minimized and replaced by mathematical ways of knowing as progress                                                         |             |     |     |          |     |     |             |     |     |       |
| bi) Personal knowledge, experiences, ways of being minimized in preference for using the multisemiotic nature of math                                                                                                                                                                                                      | 0           | 4   | 0   | 1        | 14  | 5   | 0           | 0   | 15  | 39    |

| Description                                                                                                                                                                                             | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                                                                                         | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| (graphs, tables, algebra, language) to re-constitute the “real world,” what counts as a problem within the real world, and reasonable solutions to said problems.                                       |             |     |     |          |     |     |             |     |     |       |
| bii) Tacit knowledge, often found in communities, speciously minimized/ignored in favor of engaging with reality, unrealistically (and often incompetently) via mathematics as personal capital.        | 0           | 0   | 0   | 0        | 3   | 0   | 0           | 0   | 2   | 5     |
| biii) Non-Western mathematical examples are presented superficially, using a problematic trait approach to race/culture, only to made valid via Western mathematics.                                    | 0           | 0   | 0   | 0        | 1   | 0   | 0           | 0   | 0   | 1     |
| c) This way of knowing is deceptively positioned as available to anyone and everyone who engages in its authoritative, decontextualized, and seemingly objective discursive patterns                    |             |     |     |          |     |     |             |     |     |       |
| ci) Privileging authoritative, decontextualized, and seemingly objective speech acts and policing context-dependent, contingent, and relational discourse associated with colloquial ways of speaking.  | 0           | 0   | 0   | 1        | 9   | 1   | 0           | 0   | 2   | 13    |
| cii) Superficial inclusion of non-Western names and superficial inclusion of women and people of colors perspective, experiences, concerns and/or desires in mathematized problems and problem solving. | 0           | 0   | 0   | 0        | 2   | 0   | 0           | 0   | 2   | 4     |
| Sub Totals                                                                                                                                                                                              | 8           | 5   | 0   | 4        | 31  | 8   | 0           | 0   | 21  | 77    |
| <b>Total</b>                                                                                                                                                                                            |             | 13  |     |          | 43  |     |             | 21  |     |       |

*Note.* Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment; Standards: E = Explicit instantiation of the manifestation, I-T = Implicit instantiation of the manifestation that is evidenced in the way that educators are expected to teach, I-L = Implicit instantiation of the manifestation that is evidenced in the way that students are expected to learn. Black cells = manifestation was theorized in chapter four to not instantiate in relation to this aspect of curriculum

the superior starting point of all valid knowledge construction, while ironically advancing this superior way of knowing as democratically available to all who engage in its discursive patterns. Unlike, manifestation *bi*, manifestations *ai* and *aii*, which position Western mathematics as the sole knowledgebase necessary for solving quantitatively-oriented problems, and as the proper origin and logic for sequencing said learning experiences are largely instantiated in objectives/goals (8/13) rather than pedagogy or assessment. In contrast, manifestation sub-category *c* lacks any instantiations within objectives and goals, largely due to the potential resistance to the explicit or implicit introduction of ostensibly hegemonic and paternalistic learning goals aimed at distancing students from their local and personal sources of meaning making.

Interestingly, similar to *Humanism*, the importance of educators in directly instantiating *DLP* is evidenced in the observation that 31 out of 77 of the instantiations were implicit in the teaching of the content. As such, teachers have a serious role in considering how to reconstitute the problems we look at, how reality is reconstituted, and how this may or may not recruit students away from local and personal sources of knowledge. Of course, a more direct question may be, “how can we include students’ local and personal sources of knowledge within our mathematics classrooms? It is unclear, if the current Common Core State Standards allow for this, or if teachers are prepared to invert traditional pedagogical structures to allow students, and their communities, sources of knowledge and ways of being into our schools.

### **Detachment from nature.**

As discussed, in relation to Humanism and in relation to Figure 4.1, *Detachment from Nature* (DFN) is closely linked to both *Humanism* (Hum) and *Detachment from*

*Local and Personal Sources of Knowledge* (DLP). As hypothesized in the introduction, the relative lack of instantiations from *Detachment from Nature* may be the result of a maturation within the curriculum away from *DFN* towards *Humanism* and *DLP*; in particular, *Humanism cii, dii, and diii*. Nonetheless, instantiations of *DFN* constitute 4.9% of all manifestations of colonialist consciousness with roughly half found in pedagogy (11/21) and roughly half found in assessment (10/21). The lack of instantiations of *DFN* in objectives and goals may be a result of the predictable resistance to a *DFN*-related goal in an epoch often described as the Anthropocene, that is, an age defined by humanity's devastating reconstitution of our environment.

Specifically, there are two thematic elements within word problems, one in which “nature and non-human beings are treated as agentless commodities that solely exist to consumptively serve anthropocentric needs on both personal and vocational levels” (*ai*) and a less conspicuous theme wherein “proper human relations are limited to anthropocentric, human constructed indoor and outdoor (rectangular spaces)” (*bi*). The first sub-category, *ai*, treats nature and other beings consumptively as food or entertainment. These word problems include an “owner of an exotic animal exhibit” trying to maximize their profits at a carnival, a cook quantifying cows (who are typically fed an unnatural diet of antibiotics and corn as they stand in their own excrement) as pounds of beef, and individuals enjoying ecotourism in a fuel guzzling submarine, even as fossil-fuel, driven climate change accelerates coral bleaching.

Adding to this orientation away from nature is the setting of the word problems, which all involve anthropocentric indoor and outdoor environments (*bi*). Although most word problems assumed that the protagonists are indoors, or even that mathematized



solutions to outdoor spaces are solved indoors, almost all explicitly outdoor settings are in spaces completely shaped by humans. For example, problems involve deciding on what kind of Internet connection to purchase on a cruise ship, the construction of a rectangular water fountain, and a farmer constructing a fence, ostensibly to keep the rest of nature out.

Not surprisingly, *aii* and *bii* both assume that nature lacks autonomy or worth outside of human purposes. For example, the assumption that human needs are above the needs of other beings, and our shared habitats (*aii*) is instantiated in problems like the one found in Lesson 6, where students are encouraged to calculate, as is often done in market-based capitalism, the discounted cost of clothes. However, these costs do not represent the true cost of the clothes, that is, the ecological cost of producing cotton or the human costs of exploitative working conditions, but instead only calculates a numerical price that may maximize profits via the promotion of greater consumption.

### **Independence**

Potentially more than any other subject matter, engaging in mathematics is assumed to be a solitary activity. Of the four core subjects, science has laboratory experiments and projects; ELA and history have Socratic seminars; while mathematics is caricatured by solitary problem sets, quizzes, and tests. Of course, there are other, less didactic approaches to teaching mathematics. However, even more collaborative approaches, such as the Guided-Reading-inspired Guided Mathematics, assumes that all students will be individually responsible for completing a menu of options and will be graded based on solitary assessments.

This tendency towards solitary, self-reliant behavior is also found within this

Table 5.5

*Manifestations of the Sub-construct of DFN by Curricular Components*

| DFN (Cosmology): The world is studied at a distance; contact with the earth, animals, and plants are severely limited. Students discover through interference that real learning occurs indoors and is composed of knowledge bases separate from life and the natural world (Grande, 2015). |             |     |     |          |     |     |             |     |     |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                 | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                             | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) Human beings and human needs are superior to other beings and their needs                                                                                                                                                                                                                |             |     |     |          |     |     |             |     |     |       |
| ai) Nature and non-human beings are treated as agentless commodities that solely exist to consumptively serve anthropocentric needs on both personal and vocational levels                                                                                                                  | 0           | 0   | 0   | 1        | 3   | 1   | 0           | 0   | 3   | 8     |
| aii) Sustainable relations between humans and other beings assumes that other beings’ needs are secondary to human’s consumptive needs, which are often implicitly limitless                                                                                                                | 0           | 0   | 0   | 0        | 1   | 0   | 0           | 0   | 2   | 3     |
| b) Human beings are separate from nature                                                                                                                                                                                                                                                    |             |     |     |          |     |     |             |     |     |       |
| bi) Proper human relations are limited to anthropocentric, human constructed indoor and outdoor (rectangular spaces)                                                                                                                                                                        | 0           | 0   | 0   | 0        | 2   | 2   | 0           | 0   | 3   | 7     |
| bii) The outdoors is treated as empty (terra nullius) until re-mapped as rectangular and/or pre-planned inside without regard to ecological impact                                                                                                                                          | 0           | 0   | 0   | 0        | 1   | 0   | 0           | 0   | 1   | 2     |
| c) Nature is oppositional to human wellbeing and must be controlled and managed                                                                                                                                                                                                             |             |     |     |          |     |     |             |     |     |       |
| ci) Nature is oppositional and must be controlled, and managed                                                                                                                                                                                                                              | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 1   | 1     |
| Sub Totals                                                                                                                                                                                                                                                                                  | 0           | 0   | 0   | 1        | 7   | 3   | 0           | 2   | 8   | 21    |
| Total                                                                                                                                                                                                                                                                                       |             | 0   |     |          | 11  |     |             | 10  |     |       |

*Note.* Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment; Standards: E = Explicit instantiation of the manifestation, I-T = Implicit instantiation of the manifestation that is evidenced in the way that educators are expected to teach, I-L = Implicit instantiation of the manifestation that is evidenced in the way that students are expected to learn. Black cells = manifestation was theorized in chapter four to not instantiate in relation to this aspect of curriculum

curriculum, as *Independence* alone constitutes 24.6% (101/431) of all instantiations of coloniality. Two manifestations in particular make up about 9.5% of all instantiations each, that is, *ai* and *bi*. The first, *ai* (41/106), describes tasks that “require students to act as if they are alone and cannot ask others for help,” with 31 out of 41 being implicitly related to the completion of assignments and 5 of 41 being explicitly stated with respect to the completion of the example problems within lessons. Additionally, examples and exercises within lessons, exit tickets, problem sets, and summative assessments used *impersonal command form verbs* a total of 42 times. Collectively, the use of impersonal command form verbs and the expectation for solitary work and work products has the effect of creating impersonal and detached relationships between teacher, students, and objects within the curriculum.

Although not as prolific, two manifestation types are potentially useful themes to identify within word problems, that is, *aii* and *aiii*. For example, *aii* asks the problem solver to pretend that they could not interact with those who are the object of inquiry and as such idealizes the fictitious ideal of an independent, detached inquirer. Although *aii* only constitutes 15/106 instantiations of *Independence*, its presence within particular problem sets was weighty, as was the case in the problem sets for Lessons 8 and 9 where they made up at least five word problems in each problem set. Examples of word problems, where an identified individual could have directly answered the problem being solved, included questions aimed at determining the age of two known siblings, calculating how many children are in a known family based on the total cost of museum tickets, estimating how much a known person spent on their horse, or figuring out the cost of the pens sold at a known person’s fundraiser. Although these problems may seem

Table 5.6

*Manifestations of the Sub-construct of Independence by Curricular Components*

| Independence (Ontology): Children are expected to be self-reliant, to complete school tasks on their own, and accept personal responsibility for their own behavior. (Grande, 2015, pp. 100-101). [The corollary to this notion is the idea that people who do not learn “independently” or even whole societies that learn more cooperatively or interdependently are less advanced in their development, a sentiment that has justified democracy for some, and tyranny for others for the past 300 years (Lowe, 2015).] |             |     |     |          |     |     |             |     |     |       |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) Full subjectivity within a hierarchy of being demands that students can successfully engage supposedly universal and immutable, but particularly Western, mathematics alone.                                                                                                                                                                                                                                                                                                                                            |             |     |     |          |     |     |             |     |     |       |
| ai) Tasks require students to act as if they are alone and cannot ask others for help. If students need help, they may be able to use authoritative mathematical texts or class notes to complete the task (often not the case for assessments).                                                                                                                                                                                                                                                                           | 0           | 0   | 0   | 5        | 1   | 3   | 1           | 0   | 31  | 41    |
| aii) Practicing full subjectivity by pretending that you cannot interact with those who are the object of the inquiry to ensure a fictitious independent, detached inquiry.                                                                                                                                                                                                                                                                                                                                                | 0           | 0   | 0   | 0        | 6   | 2   | 0           | 0   | 7   | 15    |
| aiii) Vicarious and idealized examples of extreme self-reliance, which necessitates mathematical knowledge                                                                                                                                                                                                                                                                                                                                                                                                                 | 0           | 0   | 0   | 0        | 1   | 1   | 0           | 0   | 5   | 7     |
| b) Performing tasks detached of relationships is a hallmark of an objective, fully actualized person within the hierarchy of being                                                                                                                                                                                                                                                                                                                                                                                         |             |     |     |          |     |     |             |     |     |       |
| bi) Relationship towards teacher, subjects, and objects are impersonal and detached. Impersonal command form verbs are often used.                                                                                                                                                                                                                                                                                                                                                                                         | 0           | 0   | 0   | 2        | 0   | 12  | 0           | 0   | 28  | 42    |
| bii) No meaningful peer work necessary to complete tasks, which everyone should complete at the same pace. Language of collectivity may be used, but individual performance is still the metric of success.                                                                                                                                                                                                                                                                                                                | 0           | 0   | 0   | 0        | 0   | 1   | 0           | 0   | 0   | 1     |
| Sub Totals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 0           | 0   | 0   | 7        | 8   | 19  | 1           | 0   | 71  |       |
| <b>Total</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |             | 0   |     |          | 34  |     |             | 72  |     | 106   |

*Note.* Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment; Standards: E = Explicit instantiation of the manifestation, I-T = Implicit instantiation of the manifestation that is evidenced in the way that educators are expected to teach, I-L = Implicit instantiation of the manifestation that is evidenced in the way that students are expected to learn. Black cells = manifestation was theorized in chapter four to not instantiate in relation to this aspect of curriculum

ludicrous as presented herein, when framed as “age word problems” they are highly identifiable and, in practice, commonly doled out in classrooms as engaging logic-oriented word problems. However, they are hardly real-world problems, especially since in the real world, you would simply ask a pair of siblings their age and skip the riddle.

When examining the lessons’ objectives and goals, 0/106 of the instantiations of *Independence* can be found. Although mathematics has a reputation for manifesting *Independence* as construed by Grande (2015), these orientations towards learning do not fit well within the espoused college and career goals of the Common Core State Standards. Instead, *Independence* is policed and punished Implicitly by learners themselves, as *Implicit-Learning* constitutes 79/106 instantiations across pedagogy and assessment and 71/106 instantiations in assessment alone.

### **Achievement.**

The axiology of *Achievement* not only rewards those who embrace the precepts of *Humanism*, but those who do so instrumentally. Composing 10.2% of all instantiations of coloniality, 27 of the 44 instantiations for *Achievement* are captured by manifestation *ai*, that is, “goals are impersonal, decided a priori to students arrival, and direct students towards observable behavior to be rewarded in relation to measurable results, not process or ways of relating”. Unlike *Detachment from Nature*, manifestations of *Achievement*, in particular *ai*, is explicitly present in goals and objectives, consisting of 16 out of 27 instances of *ai* itself.

Although the consequentialist disposition found in *ai* may in fact permeate education more broadly, there are three word problem themes that promote the axiology of *Achievement* in mathematics education itself: *aii*, *bi*, and *bii* (15/44). First, *aii* gestures

Table 5.7

*Manifestations of the Sub-construct of Achievement by Curricular Components*

| Achievement (Axiology): Success and individual worth are measured by abstract and impersonal standards of excellence whereby students are aware of being in direct competition with others. Students are encouraged to make an impact on their environment. Process is merely a means to an end; instrumentalist consequentialism (Grande, 2015). |             |     |     |          |     |     |             |     |     |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                                                                       | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                                                                                   | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) Instrumentalist, non-relational orientation towards ways of being in relation to work or its assumed pre-cursor, that is, schooling, is idealized.                                                                                                                                                                                             |             |     |     |          |     |     |             |     |     |       |
| ai) Goals are impersonal, decided a priori to students arrival, and direct students towards observable behavior to be rewarded in relation to measurable results, not process or ways of relating                                                                                                                                                 | 16          | 2   | 0   | 1        | 2   | 4   | 1           | 0   | 1   | 27    |
| aii) Utilitarian cost benefit analysis either formally or, informally, in the elevation of efficiency, productivity, and/or profitability.                                                                                                                                                                                                        | 1           | 2   | 0   | 0        | 0   | 0   | 0           | 0   | 2   | 5     |
| aiii) Personal state and/or feelings of person being corrected or critiqued do not matter in expository and/or expository writing/speaking. Results are all that matter.                                                                                                                                                                          | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 2   | 2     |
| b) Promotion of vicarious and/or imaginary competition for social or material capital between friends, siblings, and/or classmates.                                                                                                                                                                                                               |             |     |     |          |     |     |             |     |     |       |
| bi) Competition for social or material capital is experienced vicariously by more mature characters whom students may imagine themselves becoming in the future                                                                                                                                                                                   | 0           | 0   | 0   | 0        | 3   | 0   | 0           | 1   | 2   | 6     |
| bii) Student are encouraged to image themselves and/or like-age fictional characters competing (or being compared), in the present, for social or material capital, resulting in monetary benefit, commodified experiences, and/or maximum consumption                                                                                            | 0           | 0   | 0   | 0        | 1   | 0   | 0           | 0   | 3   | 4     |
| c) Group work and/or collaboration framed in terms of future oriented achievement in competitive, corporatized institutions                                                                                                                                                                                                                       |             |     |     |          |     |     |             |     |     |       |

|                                                                                                                                                              |    |    |   |   |    |   |   |    |    |    |   |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|----|----|---|---|----|---|---|----|----|----|---|
| ci) Group work and problem solving for the purpose of developing the “attitudes, skills and knowledge needed by large corporations” (Wolfmeyer, 2014, p. 8). | 0  | 0  | 0 | 0 | 0  | 0 | 0 | 0  | 0  | 0  | 0 |
| Sub Totals                                                                                                                                                   | 17 | 4  | 0 | 1 | 6  | 4 | 1 | 1  | 10 |    |   |
| <b>Total</b>                                                                                                                                                 |    | 21 |   |   | 11 |   |   | 12 |    | 44 |   |

*Note.* Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment; Standards: E = Explicit instantiation of the manifestation, I-T = Implicit instantiation of the manifestation that is evidenced in the way that educators are expected to teach, I-L = Implicit instantiation of the manifestation that is evidenced in the way that students are expected to learn. Black cells = manifestation was theorized in chapter four to not instantiate in relation to this aspect of curriculum



towards opening up mathematics to different problem solving methodologies, while quickly closing such possibilities by introducing two methods and asking “which method is more efficient?” Second, *bi* and *bii* encourages students to engage in vicarious competitions for social and/or material capital, albeit the former in the future and the latter in the present. Interestingly, even though colonial logics have driven towards the accumulation of capital, many of these problems encourage students to commodify experiences as achievements. For example, in Lesson 9, students are led through a lengthy example where they help Fred and Sam commodify their sociologically valued 138.2 mile (and 20 plus hour) bike-run-athon by assisting in the precise calculation of their distances and times to completion. This calculated data, of course, is the commoditized product and caché of competitive, control-oriented, Western social activities.

### **Evaluating to Identify and Understand Colonial Logics in Mathematical Texts**

The second part of this chapter aimed to identify the salient curricular elements that contribute to human and ecological injustices within mathematics curriculum. In doing so, this section aimed to make judgments of merit with respect to whether a curricular element contributes to colonialist consciousness. Further, if a curricular element is judged to contribute to colonialist consciousness, then the results represented in the four evaluation tables in this section aim to identify what manifestation(s) of colonialist consciousness it instantiates (e.g., *Humanism* and *Independence*), where in the curriculum it manifests (i.e., objectives/goals, pedagogy, assessment), and to what degree

(a.k.a., standard) those manifestations are instantiated (i.e., explicit, implicit in teaching, implicit in learning).

In order to facilitate the elucidation of salient curricular elements and their contribution to the construction of colonialist consciousness, the curricular components are organized in groupings by function: module and topic overviews (e.g., Topic A overview), lesson plans and materials, assessments for teacher edification, and assessments for student edification. These groupings try to match curriculum component groups with curricular types, that is, objectives/goals, pedagogy, and assessments. In line with this, *overview of the lesson sets* is imagined to most closely match objectives/goals, *lesson plans and materials* is imagined to most closely reflect pedagogy, and both *assessments for teacher edification* and *assessments for student edification* are most representative of assessments.

The decision to separate the latter two, assessment for teacher edification and assessment for student edification was, in part, a reframing of assessments as formative versus summative. Most often, the key difference between the terms formative versus summative assessments is whether or not a student is graded. If we are to consider moving away from an *Achievement* orientation, a better distinction between assessment types may be – “who is learning from this assessment?” Ideally, if schooling is about understanding and learning, not teaching and grades, then even when a student is being graded (i.e., summative assessment), someone (e.g., the teacher, curriculum director) is hopefully learning from the process.

## **Overviews**

Three overviews within Module 3 were coded for this study: Module Overview,

Topic A Overview, and Topic B Overview. Ostensibly, the purpose of each overview is to provide instructors with a birds-eye-view of the objectives/goals, teaching strategies, sequencing of the mathematics content, and, in the case of the Module Overview, how the content will be assessed. Thus, teachers are provided with a roadmap for the sections ahead and are guided to see how the content and pedagogy builds in relation to each other.

Overall, the overviews, predictably, given their comprehensiveness, disproportionally represented 14.6% of all instantiations of colonialist consciousness. However, these instantiations were almost exclusively clustered within three sub-constructs: *Humanism*, *Detachment from Local and Personal Sources of Knowledge*, and *Achievement*. Interestingly, *Detachment from Nature* and *Independence* were neither explicitly nor implicitly engaged within the objectives/goals or the pedagogy within overviews. However, *DFN* and *Independence* were not absent from the whole curriculum. Rather, as will be discussed, *DFN* was implicitly present within approximately half of the lessons, while *Independence* was consistently reinforced in every lesson either explicitly or implicitly.

Why *Detachment from Nature* and *Independence* is neither explicitly nor implicitly discussed in relation to objectives/goals or pedagogy is unclear, but curious. Of course, it may reflect the aforementioned disrepute of both promoting a less than amicable orientation towards nature or the criticism of hyper-individualization within an age of increasing detachments from both our environment and other people. Alternatively, this may be a more capitalistic reflection of the perceived insignificance of our environment (beyond its material value) and the shift away from pure individualism

Table 5.8

*Evaluation of Overviews*

| Curriculum Component | Objectives/ Goals |     |     |   |   | Pedagogy |     |     |   |   | Assessment |     |     |   |   | Subtotal |
|----------------------|-------------------|-----|-----|---|---|----------|-----|-----|---|---|------------|-----|-----|---|---|----------|
|                      | H                 | DLP | DFN | I | A | H        | DLP | DFN | I | A | H          | DLP | DFN | I | A |          |
| Module Overview      |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 41       |
| Topic Overview A     |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 9        |
| Topic Overview B     |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 13       |
| Total                |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 63       |

*Note.* Subheadings: H = Humanism, DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature, I = Independence, A = Achievement; Cell coding via grey scale colors (with or without diagonals): Black cell = Sub-construct instantiated itself explicitly within this curricular component, Dark grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that educators are expected to teach, Dark grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that educators are expected to teach, Light grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that students are expected to learn, Light grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that students are expected to learn.

towards an idealization of semi-individualistic, hyper-synergized, corporate teams who compete globally for material signifiers of status. A third option is that *Independence* and *Detachment from Nature* have been so ingrained in the assumed curricular experiences of students that it needs no further emphasis. Of course, any of these conjectures, interesting as they may be, is beyond the scope of this study, but worthy of future inquiry.

However, other curricular components, implicitly and explicitly do manifest *DFN* and *Independence*, without it needing to be implicitly or explicitly discussed in the overview. This indicates that *Humanism*, *DLP*, and *Achievement* alone may be sufficient in the framing of a curriculum's goals/objectives and pedagogy in order to allow for the full range of instantiations of colonialist consciousness. Given the pathway presented in Figure 4.1, this observation illustrates one minimalist pathway for maintaining colonialist consciousness, which flowing from *Humanism* to *DLP* may be able to, with *Achievement* as the axiological reward system, skim over *Independence* (and skip *DFN*) to complete the feedback loop of colonialist consciousness. As such, caution should be taken in subtractive approaches, rather than radical and holistic approaches to curricular change as removing elements of colonialist consciousness may not be enough to sufficiently resist, refuse, or reimagine a curriculum beyond colonialist consciousness. In the case of this study, removing individualism and *DFN* from the framing was insufficient.

Further, even explicitly collaborative, outdoor-based curricula should not be considered inherently anti-colonial, as they may still (be able to) promote the metaphysics (*Humanism*), epistemology (*DLP*), and axiology (*Achievement*) of colonialist consciousness sufficiently to replicate colonialist consciousness as a way of life. Rather, the results of this study indicate that even when positioned outdoors,

practitioners should carefully contemplate how to explicitly address the metaphysical, humanistic assumptions and *Humanism*'s corresponding tendency to speciously negate local and personal sources of knowledge (*DLP*). As discussed earlier, this connection is deep, as one of the particularities of the West's metaphysics is both its denial of metaphysics (i.e., *Humanism*) and its hegemonic forwarding of its own epistemology as universal, all-knowing (albeit, in the long run) and superior to all other ways of knowing (i.e., *DLP*). In fact, it seems to be the rule, not the exception that outdoor curriculums assumes that Western, mathematized sciences are the truest and most appropriate lens for understanding and engaging with the outdoors, rather than local and more personal (even Indigenous) ways of knowing (*DLP*).

## **Lessons**

Given this study's focus on expressions and equations, lessons in Topic A and Topic B were included in this evaluation. Module 3's lessons are found within the teacher edition, which also subsumes all of the content in *Student File A*. Not surprisingly, the teacher edition, in contrast to the student file, includes instructions, time estimates, and thus pedagogical guidance on class activities. As such, both the intended curriculum's implicit and explicit objectives/goals and pedagogy can be ascertained from this file. In evaluating these files, the lessons collectively represented 48.3% (208/431) of all the instantiations of colonialist consciousness.

Predictably, the sub-constructs evaluated as present in the overview were also reflected in the evaluation of the lessons' objectives and pedagogy. However, the lessons' pedagogy proved to include a broader instantiation of sub-constructs, which were not accounted for in either the overview's, nor the lessons' own objectives/goals. With

Table 5.9

*Evaluation of Lessons*

| Curriculum Component       | Objectives/ Goals |     |     |   |    | Pedagogy        |      |         |         |         | Assessment |     |     |   |   | Subtotal |
|----------------------------|-------------------|-----|-----|---|----|-----------------|------|---------|---------|---------|------------|-----|-----|---|---|----------|
|                            | H                 | DLP | DFN | I | A  | H               | DLP  | DFN     | I       | A       | H          | DLP | DFN | I | A |          |
| Lesson 1 – Teacher Edition | ai, aii           |     |     |   | ai | ai, ci, di, dii | ci   |         | bi      | ai      |            |     |     |   |   | 23       |
| Lesson 2 – Teacher Edition |                   |     |     |   |    | aii, bi         | bi   |         |         | aii     |            |     |     |   |   | 15       |
| Lesson 3 – Teacher Edition | dii               | bi  |     |   |    |                 | bii  | bi, bii | ai, aii |         |            |     |     |   |   | 16       |
| Lesson 4 – Teacher Edition |                   |     |     |   |    |                 |      |         |         |         |            |     |     |   |   | 17       |
| Lesson 5 – Teacher Edition |                   |     |     |   |    |                 | aiii |         |         |         |            |     |     |   |   | 13       |
| Lesson 6 – Teacher Edition |                   |     |     |   |    | dii             |      | ai, aii |         |         |            |     |     |   |   | 15       |
| Lesson 7 – Teacher Edition |                   |     |     |   |    |                 |      |         |         | bi, bii |            |     |     |   |   | 20       |
| Lesson 8 – Teacher Edition |                   |     |     |   |    |                 | cii  |         |         |         |            |     |     |   |   | 19       |

| Curriculum Component        | Objectives/ Goals |     |     |   |   | Pedagogy |      |     |      |   | Assessment |     |     |   |   | Subtotal |
|-----------------------------|-------------------|-----|-----|---|---|----------|------|-----|------|---|------------|-----|-----|---|---|----------|
|                             | H                 | DLP | DFN | I | A | H        | DLP  | DFN | I    | A | H          | DLP | DFN | I | A |          |
| Lesson 9 – Teacher Edition  |                   |     |     |   |   | bii      |      |     | bii  |   |            |     |     |   |   | 13       |
| Lesson 10 – Teacher Edition | bi                |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 8        |
| Lesson 11 – Teacher Edition |                   |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 5        |
| Lesson 12 – Teacher Edition |                   |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 7        |
| Lesson 13 – Teacher Edition |                   |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 11       |
| Lesson 14 - Teacher Edition |                   |     |     |   |   |          | biii |     | aiii |   |            |     |     |   |   | 11       |
| Lesson 15 – Teacher Edition |                   |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 15       |
| Total                       |                   |     |     |   |   |          |      |     |      |   |            |     |     |   |   | 208      |

*Note.* Subheadings: H = Humanism, DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature, I = Independence, A = Achievement; Cell coding via grey scale colors (with or without diagonals): Black cell = Sub-construct instantiated itself explicitly within this curricular component, Dark grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that educators are expected to teach, Dark grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that educators are expected to teach, Light grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that students are expected to learn, Light grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that students are expected to learn; For italicized letters with roman numerals please reference Tables 5.3 to 5.7 in relation to its corresponding sub-headings, sub-construct.



respect, to the lessons' objectives and goals, *Achievement* was also prominent in the lessons' *student outcomes*, manifesting in 15 out of 15 lessons, 13 explicitly and 2 implicitly in the way teaching was intended. Interestingly, on the other end of the feedback loop, *Humanism* was also present in 14 out of 15 lessons, although more subtly, as only 1 of 15 was explicitly written and the other 13 student outcomes were implicit regarding how teachers might teach the lesson. Similar to the overview, *DLP* was present, but unlike the overview, less explicitly. *DLP*'s instantiations were mostly implicit in the way they would be taught, such as in the case of using an expression to "shed light on the problem," or to reconstitute "the context of a word problem" rather than to understand and solve it with local, personal, or tacit knowledge found in one's community.

However, with the theoretical feedback loop's ends (i.e., *Humanism* and *Achievement*) deeply entrenched in the objectives and goals of the lessons, the full range of colonialist logic's instantiations manifested in the curriculum even with the absence of *DFN*'s and *Independence*'s manifestations in any curricular components' objectives/goals. Although, they are not the most prolific manifestations, *Independence* and *DFN* had significant instantiations within the curriculum, with *Independence* being the second most evaluated sub-construct (14/15 lessons) and *DFN* appearing in almost every lesson where the application of standardized, Western mathematical concepts were expected (and in 7/15 lessons overall). The prevalence of *Independence*, despite its absence in the framing of objectives and goals, is suspect and reveals both its importance ontologically in the instantiation of colonialist consciousness, while also revealing that the non-prescriptive, ontological framing of goals and objectives is insufficient for guaranteeing a more collaborative curriculum. In addition, as will be seen with other sub-

constructs, *Independence*'s full manifestation of its clusters *a* and *b* were accomplished through its instantiation within word problems, which promoted vicarious *Independence* and, the impersonal command form used in instructions, which oriented students towards a detached relationship to teachers, other students, and subjects of inquiry alike.

Further, the prevalence of *DFN* in almost every lesson dealing with the application of Western mathematical concepts, demonstrates the importance of word problems in the propagation of colonialist consciousness. Evidently, word problems are miniature stories with gigantic and problematic metaphysical (*Humanism*), epistemological (*DLP*), ontological (*Independence*), axiological (*Achievement*) and, in relation to *DFN*, cosmological implications. For within these word problems, 4 out of 5 of *DFN*'s unique manifestation types were present (all but *ci*), thus, fully representing clusters *a* and *b*, which promote the belief that human beings (and our needs) are superior to other beings (and their needs) and the belief that human beings are separately from nature, respectively. As such, even though *DFN* was only evaluated to be present in roughly half (7/15) lessons, it is one of the most robustly represented sub-constructs. This further underscores the potential for further evaluation and for the generative reconstitution of word problems within mathematics curriculums.

Nonetheless, pedagogically, *Humanism* and *DLP*, which were evaluated as present within the objectives and goals, were also two of the most broadly and deeply instantiated sub-constructs. In relation to its representativeness within objects and goals, *DLP*, like *DFN*, seems overrepresented. However, even more broadly than *DFN*, much of *DLP*'s manifestation comes in the form of the pedagogical framing of concepts, the wording of instructions, and the reconstitution of contexts within exercises and word

problems themselves. Consequently, 6 of 8 of *DLP*'s manifestations are present within the curriculum and each of *DLP*'s manifestation clusters are at least partially, if not fully represented. *Humanism*, on the other hand, is both prolific within the objectives and goals and in the lesson plans pedagogically with 8 out of 9 of its manifestations presents (see Table 5.10). The evident manifestation of *Humanism*, especially in relation to equations and expressions cannot be understated, which is only further reflected in the assessments.

*Achievement* on the other hand, while consistently embedded within the objectives/goals as *ai*, is paradoxically, more sporadically, but still broadly represented pedagogically. Specifically, similar to *DFN*, *Independence*, and *DLP*, word problems offer *Achievement* a secondary avenue for expression, with two out of three of its manifestation clusters represented pedagogically. Through word problems, instrumentalist, non-relational orientation towards ways of being (cluster *a*) and the promotion of vicarious and/or imagining competition for social or material capital (cluster *b*) were strongly promoted.

Altogether, even though only four lessons manifested all of the sub-constructs concurrently, (i.e., Lessons 4,7,9, and 14) these lessons successfully propagated colonialist consciousness. The role of word problems in the promotion of *DLP*, *DFN*, *Independence*, and *Achievement* is nuanced in impactful ways. Rather than merely being engaged in the real world, questions need to be raised in terms of what these problems are engaging students in and, which real world it hopes to replicate and/or reconstitute. However, these manifestations do go beyond word problems to include the way content is presented pedagogically, particularly in relation to *Humanism* and *DLP*. Therein, more rigorous philosophical conversations about the limits of our knowledge (epistemology

Table 5.10

*Proportion of Manifestations Instantiated to Total Manifestations by Curriculum Component Group and Aspects of Curriculum*

| Curriculum Component Groups                         | Overview                      |                                       |           |           | Lessons                 |                                      |   |           | Assessments         |     |                                  |   |                     |     |                                      |           |
|-----------------------------------------------------|-------------------------------|---------------------------------------|-----------|-----------|-------------------------|--------------------------------------|---|-----------|---------------------|-----|----------------------------------|---|---------------------|-----|--------------------------------------|-----------|
|                                                     |                               |                                       |           |           |                         |                                      |   |           | Teacher Edification |     |                                  |   | Student Edification |     |                                      |           |
| Aspects of Curriculum                               | O/G                           | Ped                                   | A         | T         | O/G                     | Ped                                  | A | T         | O/G                 | Ped | A                                | T | O/G                 | Ped | A                                    | T         |
| Humanism<br>(9 manifestations: clusters a, b, c, d) | 5<br>(ai, aii, bi, cii, dii,) | 7<br>(ai, aii, bi, ci, di, dii, diii) | 0         | 8<br>of 9 | 4<br>(ai, aii, bi, dii) | 7<br>(ai, aii, bi, bii, ci, di, dii) | 0 | 7<br>of 9 | 0                   | 0   | 6<br>(ai, bi, bii, cii, di, dii) |   | 0                   | 0   | 7<br>(ai, bi, bii, ci, cii, di, dii) | 7<br>of 9 |
| DLP<br>(8 manifestations: clusters a, b, c)         | 3<br>(ai, aii, aiii,)         | 4<br>(ai, bi, bii, ci)                | 0         | 6<br>of 8 | 1 (bi)                  | 6<br>(ai, aii, aiii, bi, bii, ci)    | 0 | 6<br>of 8 | 0                   | 0   | 3<br>(bi, bii, cii)              |   | 0                   | 0   | 3<br>(bi, ci, cii)                   | 4<br>of 8 |
| DFN<br>(5 manifestations: clusters a, b, c)         | 0                             | 0                                     | 0         | 0<br>of 5 | 0                       | 4<br>(ai, aii, bi, bii)              | 0 | 4<br>of 5 | 0                   | 0   | 2<br>(aii, bi)                   |   | 0                   | 0   | 4<br>(ai, aii, bi, ci)               | 4<br>of 5 |
| Independence<br>(6 manifestations: clusters a, b)   | 0                             | 0                                     | 1<br>(ai) | 1<br>of 6 | 0                       | 5<br>(ai, aii, aiii, bi, bii)        | 0 | 5<br>of 6 | 0                   | 0   | 4<br>(ai, aii, aiii, bi)         |   | 0                   | 0   | 4<br>(ai, aii, aiii, bi)             | 4<br>of 6 |
| Achievement<br>(6 manifestations:                   | 1<br>(ai)                     | 1<br>(aii)                            | 1<br>(ai) | 2<br>of 6 | 1<br>(ai)               | 4<br>(ai, aii, bi, bii)              | 0 | 4<br>of 6 | 0                   | 0   | 3<br>(aii, aiii,                 |   | 0                   | 0   | 5<br>(ai, aii, aiii, bi,             | 5<br>of 6 |

| clusters a, b, c)                                                                                                                                                                                                                                                                                                                                                                                    | bii) | bii) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|
| <i>Note.</i> Curricular Components: O/G = Objectives and/or goals, Ped = Pedagogy, A = Assessment, T = Total by Curriculum Component Group; Sub-constructs: DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature; For italicized letters with roman numerals please reference Tables 5.3 to 5.7 in relation to its corresponding sub-headings, sub-construct. |      |      |

and *DLP*) and the fundamental assumptions being made and being advanced (metaphysics and *Humanism*) need to be illuminated, interrogated, and possibly, replaced, with and by students.

### **Assessments**

All of the assessments found in Topic A and Topic B were included in evaluation tables 5.11 and 5.12. As noted in the introduction, the evaluations are grouped in terms of who learns the most from the process and/or results of completing the assessments: the teacher or the student. The *assessments for teacher edification* include the exit tickets for Lessons one through fifteen and the mid-module assessment, which comprehensively assesses the content from Lessons one to fifteen. The *assessments for student edification* include Lesson two sprints and the problem sets for Lessons one through fifteen, the latter of which are to be completed in out-of-classroom time.

Overall, the manifestations of colonialist consciousness within the assessments mirrored the manifestations within the lessons. When differences did emerge, they largely resulted from the fact that lessons involves both practice problems and the pedagogical framing of the content, while assessment explicitly provides students with procedural problems and/or word problems for students to answer either as formative feedback or evidence of their level of understanding about a mathematical concept. As such, with the exception of *Achievement*, all other sub-constructs were manifested more broadly and deeper within the lesson plans.

One area where assessments did include a broader array of manifestation types than Lessons was in relation to word problems. Specifically, the assessments, but not the Lessons included word-problem-based manifestations *Hum, ci*; *DFN, ci*; *DLP, cii*; and

Table 5.11

*Evaluation of Assessments, Edifying Feedback for Teachers: Exit Tickets and Mid Module Assessment*

| Curriculum Component    | Objectives/ Goals |     |     |   |   | Pedagogy |     |     |   |   | Assessment |         |     |        |      | Subtotal |
|-------------------------|-------------------|-----|-----|---|---|----------|-----|-----|---|---|------------|---------|-----|--------|------|----------|
|                         | H                 | DLP | DFN | I | A | H        | DLP | DFN | I | A | H          | DLP     | DFN | I      | A    |          |
| Lesson 1 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   | ai         |         |     | ai, bi |      | 3        |
| Lesson 2 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   | dii        |         |     |        |      | 4        |
| Lesson 3 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   | di         | bii     | bi  |        |      | 6        |
| Lesson 4 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   |            |         |     |        |      | 3        |
| Lesson 5 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   |            |         |     |        |      | 3        |
| Lesson 6 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   |            |         |     | aii    | aiii | 5        |
| Lesson 7 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   |            |         |     | aiii   |      | 4        |
| Lesson 8 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   |            |         |     |        |      | 3        |
| Lesson 9 – Exit Ticket  |                   |     |     |   |   |          |     |     |   |   | bii        |         |     |        | bii  | 4        |
| Lesson 10 – Exit Ticket |                   |     |     |   |   |          |     |     |   |   | cii        |         |     |        |      | 3        |
| Lesson 11 – Exit Ticket |                   |     |     |   |   |          |     |     |   |   |            |         |     |        |      | 3        |
| Lesson 12 – Exit Ticket |                   |     |     |   |   |          |     |     |   |   |            |         |     |        |      | 3        |
| Lesson 13 – Exit Ticket |                   |     |     |   |   |          |     |     |   |   |            | bi, cii |     |        |      | 5        |
| Lesson 14–              |                   |     |     |   |   |          |     |     |   |   |            |         |     |        | aii  | 3        |

| Curriculum Component    | Objectives/ Goals |     |     |   |   | Pedagogy |     |     |   |   | Assessment |     |     |   |   | Subtotal |
|-------------------------|-------------------|-----|-----|---|---|----------|-----|-----|---|---|------------|-----|-----|---|---|----------|
|                         | H                 | DLP | DFN | I | A | H        | DLP | DFN | I | A | H          | DLP | DFN | I | A |          |
| Exit Ticket             |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   |          |
| Lesson 15 – Exit Ticket |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 3        |
| Mid Module Assessment   |                   |     |     |   |   |          |     |     |   |   | bi         |     | aii |   |   | 17       |
| Total                   |                   |     |     |   |   |          |     |     |   |   |            |     |     |   |   | 72       |

*Note.* Subheadings: H = Humanism, DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature, I = Independence, A = Achievement; Cell coding via grey scale colors (with or without diagonals): Black cell = Sub-construct instantiated itself explicitly within this curricular component, Dark grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that educators are expected to teach, Dark grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that educators are expected to teach, Light grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that students are expected to learn, Light grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that students are expected to learn; For italicized letters with roman numerals please reference Tables 5.3 to 5.7 in relation to its corresponding sub-headings, sub-construct



Table 5.12

*Evaluation of Assessments, Edifying Feedback for Students: Problem Sets and Sprints*

| Curriculum Component   | Objectives/ Goals |     |     |   |   | Pedagogy |     |     |   |   | Assessment |        |     |      |              | Subtotal |
|------------------------|-------------------|-----|-----|---|---|----------|-----|-----|---|---|------------|--------|-----|------|--------------|----------|
|                        | H                 | DLP | DFN | I | A | H        | DLP | DFN | I | A | H          | DLP    | DFN | I    | A            |          |
| Lesson 1 – Problem Set |                   |     |     |   |   |          |     |     |   |   | ai, dii    |        |     |      | ai,bi, aiii, | 6        |
| Lesson 2 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            | bi, ci |     |      |              | 10       |
| Lesson 2 Sprints       |                   |     |     |   |   |          |     |     |   |   |            |        |     |      | ai           | 3        |
| Lesson 3 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |        |     |      | bii          | 6        |
| Lesson 4 – Problem Set |                   |     |     |   |   |          |     |     |   |   | bi         |        |     |      | aii          | 7        |
| Lesson 5 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |        |     |      |              | 3        |
| Lesson 6 – Problem Set |                   |     |     |   |   |          |     |     |   |   | bii        |        |     |      |              | 4        |
| Lesson 7 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |        |     |      |              | 3        |
| Lesson 8 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |        |     |      |              | 5        |
| Lesson 9 –             |                   |     |     |   |   |          |     |     |   |   | ci         | cii    | ai  | aiii | aii,         | 8        |

| Curriculum Component    | Objectives/ Goals |     |     |   |   | Pedagogy |     |     |   |   | Assessment |     |        |   |    | Subtotal |
|-------------------------|-------------------|-----|-----|---|---|----------|-----|-----|---|---|------------|-----|--------|---|----|----------|
|                         | H                 | DLP | DFN | I | A | H        | DLP | DFN | I | A | H          | DLP | DFN    | I | A  |          |
| Problem Set             |                   |     |     |   |   |          |     |     |   |   |            |     |        |   | bi |          |
| Lesson 10 – Problem Set |                   |     |     |   |   |          |     |     |   |   | cii        |     |        |   |    | 4        |
| Lesson 11 – Problem Set |                   |     |     |   |   |          |     |     |   |   | di         |     |        |   |    | 4        |
| Lesson 12 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |     | ai     |   |    | 6        |
| Lesson 13 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |     | bi, ci |   |    | 5        |
| Lesson 14 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |     | aii    |   |    | 7        |
| Lesson 15 – Problem Set |                   |     |     |   |   |          |     |     |   |   |            |     |        |   |    | 7        |
| Total                   |                   |     |     |   |   |          |     |     |   |   |            |     |        |   |    | 88       |

*Note.* Subheadings: H = Humanism, DLP = Detachment from local and personal sources of knowledge, DFN = Detachment from Nature, I = Independence, A = Achievement; Cell coding via grey scale colors (with or without diagonals): Black cell = Sub-construct instantiated itself explicitly within this curricular component, Dark grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that educators are expected to teach, Dark grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that educators are expected to teach, Light grey cell with diagonal = Sub-construct instantiated itself both explicitly and implicitly in the way that students are expected to learn, Light grey cell without diagonal = Sub-construct instantiated itself implicitly in the way that students are expected to learn; For italicized letters with roman numerals please reference Tables 5.3 to 5.7 in relation to its corresponding sub-headings, sub-construct.

*Ach*, *aiii* (See Table 5.10). However, lessons did (and assessments did not) include *Independence*, *bii*, which is a problem-type related to critiquing the reasoning of others, but without regard to their personal state, prior experiences, or your relationship with them. Given that assessments are assumed to be completed independently, it does mean that rather than these manifestations being directed by the teacher explicitly or implicitly, students are required to, at least tentatively, accept the colonialist precepts of these problems if they are to succeed academically in mathematics class. It is possible that some students' resistance to completing mathematics coursework may occur as a result of the problem sets, exit tickets, and/or unit assessments promotion of additional elements of *Humanism*, *DLP*, *DFN*, and *Achievement* that are deeply antithetical to their communities' ways of conceptualizing and engaging with reality.

In addition, lessons differ from assessments in lessons relatively stronger emphasis and capacity for utilizing both text and, in particular, the teacher's instruction (I-T v. I-L), to promote the more ideological manifestations of these sub-constructs. This is especially true, as *Humanism*, *aii*, *DLP's cluster a* (i.e., *ai*, *aii*, and *aiii*), and *DFN bii* were only present within the lessons. *Humanism aii* and *DLP's cluster a* work similarly, in that one advances mathematical symbolism and its symbolic logic as platonic truths, while the other promotes Western mathematized knowledge as the valid foundation and proper starting point for knowledge construction and decision making, respectively. *DFN bii*, although it could be represented within word problems, focuses on the reconceptualization of land as *terra nullius* and the reconstitution of spaces as rectangular and right-angled, even though physical reality is largely composed of circular objects (e.g., cylinders, spheres, cones).

Within the assessments, although both largely manifesting colonialist consciousness implicitly in the learning process, the assessments for student edification represented the broadest manifestation of colonialist consciousness across the assessment items. This was particularly true, in relation to *DFN* and *Achievement*, where each sub-construct had two more manifestations in assessments for student edification versus assessments for teacher edification. However, with respect to *Humanism*, *DLP*, and *Independence*, there did not appear to be any meaningful difference between the assessment types. Overall, this indicates that the Problem Sets were a stronger reflection of the lesson themselves, while exit tickets represented the bare minimum of what teachers expected students to know in Module 3. Given the centrality of *Humanism* and *DLP* to the overviews and lessons objectives and goals, ensuring that these, at least were achieved is not only logical, but reinforces their core importance to the establishment of colonialist consciousness. As might be expected, *DFN*, *Achievement*, and *Independence* are important, but all three can be reinforced implicitly and sufficiently via positivistic and behaviorist mechanisms, that is, individual grades, while the former two can be reinforced also via graded word problems. In contrast, it could be argued that *Humanism*'s and *DLP*'s more ideological manifestations need to be reinforced both consistently and deeply in the objectives/goals, pedagogy, and assessments.

### **Summary**

The goal of this chapter was to apply the anti-colonial mathematics curriculum evaluation framework for two purposes: a) to identify instantiations of coloniality within mathematics curriculum texts and b) to highlight salient curricular elements that contribute to human and ecological (in)justices. With these goals in mind there were five

key findings of this chapter. The first two findings were in relation to the former purpose and the remaining three findings were in relation to the latter purpose.

First, the anti-colonial mathematics curriculum evaluation framework was highly illuminating as 431 instantiations were found across 15 lessons, resulting in approximately 25 instantiations per lesson and its corresponding assessments. Second, and related to this, although 33 of 34 manifestations across the five subcategories contained at least one instantiation (Achievement, *ci* was the exception – it relates to student-centered curricula only), instantiations of each sub-construct were highly concentrated in the top one or two manifestations per sub-construct. For instance, the top manifestation for the five sub-constructs made up 42.7% of all instantiations, while the top 5 manifestations overall constituted 54.8% of all instantiations. Further, the top two manifestations per sub-construct, that is, one-third of all manifestations totaled over two-thirds of all instantiations. Thus, the manifestation of colonialist consciousness, although broad and varied within the curriculum, was also disproportionate and concentrated in the following 10 manifestations: *Humanism*, *ai* and *dii*; *DLP*, *bi* and *ci*; *DFN*, *ai* and *bi*; *Ind*, *ai* and *bi*; *Ach*, *ai* and *bi*.

Findings three through five, for their part, move beyond the identification of instantiations of coloniality towards understanding the particular ways in which certain curricular elements work together to contribute to human and ecological (in)justices via colonialist consciousness. Third, as evidenced in *Table 5.10*'s comparison of manifestation counts by curriculum component group, colonialist consciousness can fully instantiate itself beyond the explicit and implicit objectives/goals of a curriculum. Specifically, and discussed in relation to *Figure 4.1*, *DFN* and *Independence* were not

evident within the explicit nor the implicit objectives/goals of the curriculum, but colonialist consciousness was still able to complete its positive feedback loop and thus propagate within the lessons and assessments by moving from *Humanism* to *DLP* to *Achievement* and back. As such, this finding should give pause to incremental and, especially, subtractive approaches to curriculum changes. For example, critical place conscious outdoor curriculums that do not address the materiality of settler colonialism, Indigenous sovereignty, and the deep structures of colonialist consciousness may find themselves fully replicating a colonialist consciousness that amounts to little more than “settler moves to innocence” (Tuck & Yang, 2012).

Fourth, each sub-construct has preferred curricular components within which it propagates. For example, while *Humanism* and *DLP* are both deeply embedded within the way Western mathematics presents its abstracted goals and objectives, these sub-constructs largely take shape both in the way content is conceptually presented and in the way the “real-world” is constituted in word problems. Meanwhile, *DFN* and *Independence* are never explicitly present in goals or objectives, but are both mostly found in word problems, with *Independence* also manifesting equally in the prolific use of command form verbs in mathematical instructions. Interestingly, *Achievement* occupies a middle ground, being explicitly omnipresent in objectives and goals for overviews and lessons alike, it also largely manifests in word problems.

Fifth and related to the aforementioned, word problems, which are meant to be what makes mathematics relevant to the “real world” is a major vehicle for a robust, rather than skeletal propagation of colonialist consciousness. Thus, quintessentially critical questions about what constitutes the real world, what is possible in that real

world, whose real world it represents, and whom this real world benefits are all relevant questions. More to this study's purposes however are questions about how this vicarious and/or imagined re-construction of the real world naturalizes coloniality via mathematics. In answering these preliminary questions, we can begin imagining how these real-world problems may be re-shaped to resist and refuse settler colonialism and re-imagine mathematics for human being, other being, and our shared habitats wellbeing.

## CHAPTER SIX: APPLYING A CRITICAL MATHEMATICS EVALUATION

### FRAMEWORK

The purpose of question three was to use curriculum evaluation to help re-conceptualize critical mathematics' ideological foundation from an anti-colonial stance. In order to answer this question, *Eureka Math's* Grade 7, Module 3 Equations and Expressions Module was reevaluated using the critical mathematics curriculum evaluation framework presented in the methods chapter of this study (See Table 3.5.). In this chapter, both the results of the reevaluation and a comparison of these results to the results from the anti-colonial mathematics curriculum evaluation were presented. In particular, the aforementioned comparison of evaluation results allowed for the illumination of specific ideological instantiations within mathematics curriculum that may need to be reconceptualized, if critical mathematics is to serve the dual purposes of human and ecological justice.

Similar to the anti-colonial curriculum evaluation of Module 3, the reevaluation of the curriculum using a critical mathematics evaluation framework also followed the same four idealized stages of a qualitative, criterial curriculum evaluation. First, this evaluation's criteria of merit were presented, in tabular form, within the literature review's Table 3.5. This table presents a coherent approach to teaching critical mathematics and is a composite of its founders and long-standing leaders' perspectives on teaching mathematics for justice (Powell, 2012; Gutstein, 2006; Frankenstein, 2012). Specifically, critical mathematics, as a conceptual construct, consists of three sub-constructs (e.g., *Reform Based Mathematics*), each with two to three



categories (e.g., *Teaching for Understanding* and *Real World Application*), which are used as the criteria for this analysis.

Second, the standards for the reevaluation were parallel to the standards for the anti-colonial curriculum evaluation, which are: explicit; implicit, teaching; implicit, learning; and null. In general, these standards indicate the degree to which a sub-construct or its categories manifest within particular curricular elements. Further, similar to the anti-colonial curriculum evaluation, stage three involved coding Module 3, Topic A's and Topic B's curricular components in relation to the criteria and standards, while stage four involved synthesizing the data into judgments of merit as seen in Tables 6.3-6.6.

This chapter consists of two parts. In the first section, the results of the criticalmathematics evaluation are presented, first, by curricular component groups (e.g., lesson plans), and second, by sub-construct categories (e.g., *Respect for Community and Cultural Knowledge*). In the second section, a comparison between the results of the critical mathematics and anti-colonial curriculum evaluations were discussed by critical mathematics sub-construct categories (e.g., *Teaching for Understanding*). In addition, the second section concurrently discussed, by category, the potential implications for reforming criticalmathematics at its foundations for greater human and ecological justice. As such, the second section directly answers the question: "How does the curriculum evaluation help re-conceptualize criticalmathematics' ideological foundation from an anti-colonial stance to better serve the dual purposes of human and ecological justice in mathematics education?"

## Results of Criticalmathematics Evaluation

In total there were, superficially, 216 instantiations of criticalmathematics within Module 3 (See Tables 6.1 and 6.2). However, as discussed herein, of these 216 instantiations, only 100 instantiations embraced criticalmathematics' core principles. Specifically, all 100 of these instantiations related to two of *Reform Based Mathematics, Teaching for Understanding's* (RBM-TFU) manifestations, that is, promoting *conceptual understanding* (RBM-TFU, i) and *student meaning making* (RBM-TFU, ili). Even “*Real-World*” *Application* (RBM-TFU), a category of the sub-construct *Reform Based Mathematics*, failed to engage students in using mathematical skills and content knowledge to grapple with any one of many real world examples of systemic oppression. Rather, all 65 real world examples, although in line with reform based mathematics, were not aligned with the criticalmathematics vision of how mathematics should engage the “real world.”

In relation to *Sociocultural Approaches to Learning* (sub-construct SC), all 51 instantiations were particularly superficial. Of the 46 examples from the *Respect for Student and Community Knowledge and Ways of Being* (category SC-RSC), none went further than equity as inclusion, that is, including female, lower-income, and/or people of color characters within word problems. In spite of this aspect, the majority of the characters included in word problems were either White (84.7%), male (59.9%), and/or middle- to upper-income (49.1% and 47.2%, respectively). Further, neither ethnomathematics as the acknowledgment of past/present contributions of people of color to Western Mathematics, nor ethnomathematics as the acknowledgment or engagement of non-Western peoples' ways of knowing and being mathematically were (e.g., Mayan

Table 6.1.

*Frequency Table of Manifestations of Critical Mathematics by Sub-Construct Category*

| Sub-construct                           | Category            | Goals/Objectives | Pedagogy | Assessment | Total |
|-----------------------------------------|---------------------|------------------|----------|------------|-------|
| Reform Based Mathematics (RBM)          | TFU                 | 24               | 65       | 11         | 100   |
|                                         | RWA                 | 11               | 35       | 19         | 65    |
| Sociocultural Approach to Learning (SC) | RSC                 | 0                | 21       | 25         | 46    |
|                                         | E                   | 0                | 0        | 0          | 0     |
|                                         | IPS                 | 0                | 5        | 0          | 5     |
| Critical Consciousness Raising (CCR)    | Critical Reflection | 0                | 0        | 0          | 0     |
|                                         | Political Efficacy  | 0                | 0        | 0          | 0     |
|                                         | Critical Action     | 0                | 0        | 0          | 0     |
| Total                                   |                     | 35               | 126      | 55         | 216   |

*Note.* Categories: TFU = Teaching for Understanding, RWA = “Real-World” application, RSC = Respect for student and community knowledge and ways of being, E = Ethnomathematics, IPS = Inverting Pedagogical Structures

Table 6.2.

*Relative Frequency Table of Manifestations of Critical Mathematics by Sub-Construct Category*

| Sub-construct                           | Category            | Goals/Objectives | Pedagogy | Assessment | Total  |
|-----------------------------------------|---------------------|------------------|----------|------------|--------|
| Reform Based Mathematics (RBM)          | TFU                 | 11.1%            | 30.1%    | 5.1%       | 46.3%  |
|                                         | RWA                 | 5.1%             | 16.2%    | 8.8%       | 30.1%  |
| Sociocultural Approach to Learning (SC) | RSC                 | 0.0%             | 9.7%     | 11.6%      | 21.3%  |
|                                         | E                   | 0.0%             | 0.0%     | 0.0%       | 0.0%   |
|                                         | IPS                 | 0.0%             | 2.3%     | 0.0%       | 2.3%   |
| Critical Consciousness Raising (CCR)    | Critical Reflection | 0.0%             | 0.0%     | 0.0%       | 0.0%   |
|                                         | Political Efficacy  | 0.0%             | 0.0%     | 0.0%       | 0.0%   |
|                                         | Critical Action     | 0.0%             | 0.0%     | 0.0%       | 0.0%   |
| Total                                   |                     | 16.2%            | 58.3%    | 25.5%      | 100.0% |

*Note.* Categories: TFU = Teaching for Understanding, RWA = “Real-World” application, RSC = Respect for student and community knowledge and ways of being, E = Ethnomathematics, IPS = Inverting Pedagogical Structures

mathematics) present within the curriculum.

The 5 other instantiations of *SC* were evidenced in relation to *Inverting Pedagogical Structures* (category SC-IPS). All five instantiations were manifested in the sub-construct *Students have the opportunity to make meaning together about the content* (SC-IPS, bi). However, in relation to IPS, *bi* has the lowest entry level of all five manifestation types and, in isolation from the other manifestations (i.e., bii-bv), lacks a compelling impact on students' classroom experiences.

With respect to the sub-construct *Critical Consciousness Raising* (CCR), the quintessential sub-construct of a true criticalmathematics curriculum, Module 3 contained no instantiations from any one of CCR's three categories. In tandem with the superficial and disproportionality invalidating instantiations of sub-construct SC and the oppressively narrow portrayal of the "real-world" in *RBM-RWA*, this curriculum is not, nor was it intended to be an exemplar criticalmathematics curriculum. Nonetheless, as a Common Core State Standards aligned curriculum, it exhibits strong instantiations of *Reform Based Mathematics via Teaching for Understanding*. This reveals a foundational weakness in criticalmathematics capacity to illuminate, critique, and reshape the instantiations of colonialist consciousness embedded within the curriculum's author selections, sequencing choices, presentations, framing, and conceptualization of mathematics.

### **Results by Curricular Component Group**

As this was not a criticalmathematics curriculum by name, nor in spirit, but rather a Common Core State Standards aligned curriculum, it is unsurprising that the evaluation evidenced strong manifestations in *Teaching for Understanding (RBM-TFU)* and a

Reform Based Mathematics' approach to *Real World Application (RBM-RWA)*. Nowhere was this focus clearer than in the curriculum component group of *Overviews*. Starting with the *Module Overview*, *RBM-RWA* was explicitly present in both the *Objectives/Goals* and the *Pedagogy*, while *RBM-TFU* was explicit in the *Objectives/Goals* and implied in the teaching methods (*I-T*). Flowing from the *Module Overview*, the *Topic Overviews A* and *B* also exhibited, either explicitly or implicitly via the teaching methods prescribed, *RBM-TFU* and *RBM-RWA*. In particular, *RBM-RWA* was an explicit pedagogical approach in each overview.

In line with this, all of the *Lessons* (see Table 6.4) also promoted *RBM-TFU* and/or *RBM-RWA*. Within the *Lessons*, while these two categories sometimes manifested explicitly, most instantiations were either implicitly via the prescribed teaching methods (*I-T*) or implicitly in relation to the ways students are expected to learn (*I-L*). While *RBM-TFU* was the only category manifested within the *Objective/Goals*, and mostly in relation to the way the lessons would be taught (*I-T*), both *RBM-TFU* and *RBM-RWA* were extensively present within the lessons. In seven out of fifteen lessons, *RBM-TFU* and *RBM-RWA* were present concurrently, while in the other eight lessons, at least one of the two categories was present. For its part, *RBM-TFU* had a stronger manifestation within the first half of the Module as after the eighth lesson there were not any conceptual approaches to teaching mathematics. In contrast, while *RBM-RWA* was present throughout the module, it was instantiated with greater frequency and variation from lesson eight through fifteen.

In relation to the two *Assessment* (see Tables 6.5-6.6) groupings, the manifestations of *Assessments – Students (A-S)*, that is the Problem Sets, more closely

aligned with the pedagogical focus of the *Lessons* group than *Assessments – Teachers* (A-T) . For example, the *Assessments* (A-T) that provided teachers with actionable information, that is the exit tickets and the mid-module assessment, were evaluated only to exhibit *Teaching for Understanding* in two out of fifteen instances, versus seven out of fifteen of the lessons’ problem sets. Further, only three out of fifteen exit tickets versus seven out of fifteen of the lessons’ problem sets, included reform-based interpretations of *Real World Applications*.

As discussed above, attempts at teaching with a *Sociocultural Approach* were evident, but were nonetheless an insufficient and inadequate instantiation of *Respect for Student and Community Knowledge and Ways of Being* (SC-RSC). This Module’s approach did not go beyond the non-proportional, under-inclusion of characters with respect to gender, race, or class and, at best, ignored trying to address heteronormativity and/or ableism. Nonetheless, even in this insufficient and inadequate manner, only the lessons and problem sets offered a format that allowed for the introduction of characters, discussion of mathematics in relation to “real-world” contexts, and, as such, easy access to introducing or validating something other than the modernist and Western ways of knowing and being within the classroom. In relation to this inadequate and insufficient approach, only five out of fifteen *Lessons*, five out of fifteen *problem sets*, and one out of fifteen *exit tickets* included people of color, women, and/or low-income characters.

Interestingly, the mid-module assessment was the only *Assessment* (I-T) that provided teachers with data that mirrored the lesson plans and, consequently, the problem sets with respect to *RBM-TFU*, *RBM-RWA*, and *SC-RSC*. This, of course, is appropriate as students should only be assessed on what they were taught and worked on during the

Table 6.3

*Evaluation of Overviews*

| Curriculum Component | Objectives/ Goals |         |     |     |     | Pedagogy |      |     |     |     | Assessment |     |     |     |    | Total |  |     |  |
|----------------------|-------------------|---------|-----|-----|-----|----------|------|-----|-----|-----|------------|-----|-----|-----|----|-------|--|-----|--|
|                      | RBM               |         | SC  |     |     | CCR      | RBM  |     | SC  |     |            | CCR | RBM |     | SC |       |  | CCR |  |
|                      | TFU               | RWA     | RSC | IPS | TFU |          | RWA  | RSC | IPS | TFU | RWA        |     | RSC | IPS |    |       |  |     |  |
| Module Overview      | C, M              | G       |     |     |     | C, M     | G, T |     |     |     |            |     |     |     |    |       |  | 23  |  |
| Topic Overview A     | M                 |         |     |     |     | C, M     | G    |     |     |     |            |     |     |     |    |       |  | 4   |  |
| Topic Overview B     | C, M              | C, F, G |     |     |     | M        | T    |     |     |     |            |     |     |     |    |       |  | 9   |  |
|                      |                   |         |     |     |     |          |      |     |     |     |            |     |     |     |    |       |  | 36  |  |

*Note. Note.* Headings – Level 1, sub-constructs: RBM = Reform Based Mathematics, SC = Sociocultural Approach to Teaching, CC = Critical Consciousness; Headings – Level 2, categories: TFU = Teaching for Understanding, RWA = “Real-World” application, RSC = Respect for student and community knowledge and ways of being, E = Ethnomathematics, IPS = Inverting Pedagogical Structures; Letters in Cells, Manifestations: TFU, C = Conceptual, M = Meaning making; RWA, G = General, C = Competitive, F = Fundraising/Donations, T = Traditional

Table 6.4

*Evaluation of Lessons*

| Curriculum Component       | Objectives/ Goals |     |         |     |     | Pedagogy |            |          |     |     | Assessment |     |         |     |     | Total |
|----------------------------|-------------------|-----|---------|-----|-----|----------|------------|----------|-----|-----|------------|-----|---------|-----|-----|-------|
|                            | RBM               |     | SC      |     | CCR | RBM      |            | SC       |     | CCR | RBM        |     | SC      |     | CCR |       |
|                            | TFU               | RWA | RS<br>C | IPS |     | TFU      | RWA        | RSC      | IPS |     | TFU        | RWA | RS<br>C | IPS |     |       |
| Lesson 1 – Teacher Edition | M                 |     |         |     |     | C,M      |            |          | S   |     |            |     |         |     |     | 18    |
| Lesson 2 – Teacher Edition | M                 |     |         |     |     | C, M     | F          |          |     |     |            |     |         |     |     | 7     |
| Lesson 3 – Teacher Edition | C                 |     |         |     |     | C, M     | B, C       |          |     |     |            |     |         |     |     | 16    |
| Lesson 4 – Teacher Edition | C, M              |     |         |     |     | C        | C          |          |     |     |            |     |         |     |     | 5     |
| Lesson 5 – Teacher Edition |                   |     |         |     |     | M        | O, T       | WPOC     | S   |     |            |     |         |     |     | 6     |
| Lesson 6 – Teacher Edition |                   |     |         |     |     | M        | C, T       |          |     |     |            |     |         |     |     | 7     |
| Lesson 7 – Teacher Edition | M                 |     |         |     |     | C        | B, C       |          |     |     |            |     |         |     |     | 8     |
| Lesson 8 – Teacher Edition | M                 |     |         |     |     | C        | B, D, F, S | WPOC, MF |     |     |            |     |         |     |     | 11    |
| Lesson 9 –                 |                   |     |         |     |     |          | C, H,      | WPOC     | S   |     |            |     |         |     |     | 9     |



| Curriculum Component        | Objectives/ Goals |     |    |     |         | Pedagogy |         |      |     |         | Assessment |    |    |     |         | Total |   |
|-----------------------------|-------------------|-----|----|-----|---------|----------|---------|------|-----|---------|------------|----|----|-----|---------|-------|---|
|                             | RBM               |     | SC |     | CC<br>R | RBM      |         | SC   |     | CC<br>R | RBM        |    | SC |     | CC<br>R |       |   |
|                             | TF                | RWA | RS | IPS |         | TFU      | RWA     | RSC  | IPS |         | TF         | RW | RS | IPS |         |       |   |
|                             | U                 |     | C  |     |         |          |         |      |     |         | U          | A  | C  |     |         |       |   |
| Teacher Edition             |                   |     |    |     |         | T        |         |      |     |         |            |    |    |     |         |       |   |
| Lesson 10 – Teacher Edition | C, M              |     |    |     |         | M        |         |      |     |         |            |    |    |     |         | 4     |   |
| Lesson 11 – Teacher Edition | M                 |     |    |     |         | M        |         |      |     |         |            |    |    |     |         | 3     |   |
| Lesson 12 – Teacher Edition | M                 |     |    |     |         | M        |         |      |     | S       |            |    |    |     | 3       |       |   |
| Lesson 13 – Teacher Edition | M                 |     |    |     |         |          | C, F    | POC  |     |         |            |    |    |     | 4       |       |   |
| Lesson 14 - Teacher Edition | M                 |     |    |     |         |          | C, S, F |      |     |         |            |    |    |     |         |       | 5 |
| Lesson 15 – Teacher Edition | M                 |     |    |     |         |          | C, B    | WPOC |     |         |            |    |    |     | 6       |       |   |
|                             |                   |     |    |     |         |          |         |      |     |         |            |    |    |     |         | 112   |   |

*Note.* Headings – Level 1, sub-constructs: RBM = Reform Based Mathematics, SC = Sociocultural Approach to Teaching, CC = Critical Consciousness; Headings – Level 2, categories: TFU = Teaching for Understanding, RWA = “Real-World” application, RSC = Respect for student and community knowledge and ways of being, E = Ethnomathematics, IPS = Inverting Pedagogical Structures; Letters in Cells, Manifestations: TFU, C = Conceptual, M = Meaning making; RWA, G = General, B = Building, P = Products/Services sold, C = Competitive, D = Fundraising/Donations, I = Future oriented imaginings, H = Health, S = School, T = Traditional, O = Other; RSC, POC = Person of Color, WPOC = White and People of Color, MF = Male and Female; IPS, S = Student-centered teaching.

Table 6.5

*Evaluation of Assessments-Teachers (A-T)*

| Curriculum Component    | Objectives/ Goals |         |         |         |         | Pedagogy |         |         |         |         | Assessment |         |      |         |         | Total |
|-------------------------|-------------------|---------|---------|---------|---------|----------|---------|---------|---------|---------|------------|---------|------|---------|---------|-------|
|                         | RBM               |         | SC      |         | CC<br>R | RBM      |         | SC      |         | CC<br>R | RBM        |         | SC   |         | CC<br>R |       |
|                         | TF<br>U           | RW<br>A | RS<br>C | IP<br>S |         | TFU      | RW<br>A | RS<br>C | IP<br>S |         | TF<br>U    | RW<br>A | RSC  | IP<br>S |         |       |
| Lesson 1 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 2 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 3 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         | C          | B       |      |         |         | 3     |
| Lesson 4 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 5 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 6 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         | M          |         |      |         |         | 1     |
| Lesson 7 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 8 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            | S       |      |         |         | 1     |
| Lesson 9 – Exit Ticket  |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 10 – Exit Ticket |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 11 – Exit Ticket |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 12 – Exit Ticket |                   |         |         |         |         |          |         |         |         |         |            |         |      |         |         | 0     |
| Lesson 13 –             |                   |         |         |         |         |          |         |         |         |         |            |         | WPOC |         |         | 1     |

| Curriculum<br>Component    | Objectives/ Goals |    |    |    |         | Pedagogy |    |    |    |    | Assessment |      |      |      |    | Total |
|----------------------------|-------------------|----|----|----|---------|----------|----|----|----|----|------------|------|------|------|----|-------|
|                            | RBM               |    | SC |    | CC<br>R | RBM      |    | SC |    |    | RBM        |      | SC   |      |    |       |
|                            | TF                | RW | RS | IP |         | TFU      | RW | RS | IP | TF | RW         | RSC  | IP   | CC   |    |       |
|                            | U                 | A  | C  | S  |         |          | A  | C  | S  | U  | A          |      | S    | R    |    |       |
| Exit Ticket                |                   |    |    |    |         |          |    |    |    |    |            |      |      | , ML |    |       |
| Lesson 14–<br>Exit Ticket  |                   |    |    |    |         |          |    |    |    |    |            | C    |      |      | 1  |       |
| Lesson 15 –<br>Exit Ticket |                   |    |    |    |         |          |    |    |    |    |            |      |      |      | 0  |       |
| Mid Module<br>Assessment   |                   |    |    |    |         |          |    |    |    |    | M          | B, C | WPOC |      | 6  |       |
|                            |                   |    |    |    |         |          |    |    |    |    |            |      |      | , F  |    |       |
|                            |                   |    |    |    |         |          |    |    |    |    |            |      |      |      | 13 |       |

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Table 6.6

*Evaluation of Assessments-Students (A-S)*

| Curriculum Component    | Objectives/ Goals |    |    |    |     | Pedagogy |    |    |    |    | Assessment |      |                 |    |  | Total |     |
|-------------------------|-------------------|----|----|----|-----|----------|----|----|----|----|------------|------|-----------------|----|--|-------|-----|
|                         | RBM               |    | SC |    | CCR | RBM      |    | SC |    |    | RBM        |      | SC              |    |  |       | CCR |
|                         | TF                | RW | RS | IP |     | TFU      | RW | RS | IP | TF | RWA        | RS   | IP              |    |  |       |     |
|                         | U                 | A  | C  | S  |     |          | A  | C  | S  | U  |            | C    | S               |    |  |       |     |
| Lesson 1 – Problem Set  |                   |    |    |    |     |          |    |    |    |    | M          |      |                 |    |  | 1     |     |
| Lesson 2 – Problem Set  |                   |    |    |    |     |          |    |    |    |    | M          |      |                 |    |  | 1     |     |
| Lesson 2 Sprints        |                   |    |    |    |     |          |    |    |    |    |            |      |                 |    |  | 0     |     |
| Lesson 3 – Problem Set  |                   |    |    |    |     |          |    |    |    |    | C          | A    |                 |    |  | 3     |     |
| Lesson 4 – Problem Set  |                   |    |    |    |     |          |    |    |    |    | C          | C    |                 |    |  | 2     |     |
| Lesson 5 – Problem Set  |                   |    |    |    |     |          |    |    |    |    |            |      |                 |    |  | 0     |     |
| Lesson 6 – Problem Set  |                   |    |    |    |     |          |    |    |    |    |            | T    |                 |    |  | 1     |     |
| Lesson 7 – Problem Set  |                   |    |    |    |     |          |    |    |    |    | C          |      |                 |    |  | 1     |     |
| Lesson 8 – Problem Set  |                   |    |    |    |     |          |    |    |    |    |            | C, S | WP<br>OC,<br>MF |    |  | 5     |     |
| Lesson 9 – Problem Set  |                   |    |    |    |     |          |    |    |    |    |            | C    |                 |    |  | 1     |     |
| Lesson 10 – Problem Set |                   |    |    |    |     |          |    |    |    |    | M          |      |                 |    |  | 1     |     |
| Lesson 11 – Problem Set |                   |    |    |    |     |          |    |    |    |    | M          |      |                 |    |  | 1     |     |
| Lesson 12 –             |                   |    |    |    |     |          |    |    |    |    |            |      |                 | WP |  | 1     |     |

| Curriculum<br>Component    | Objectives/ Goals |    |    |    |         | Pedagogy |    |    |    |    | Assessment |            |                                  |    |     | Total |
|----------------------------|-------------------|----|----|----|---------|----------|----|----|----|----|------------|------------|----------------------------------|----|-----|-------|
|                            | RBM               |    | SC |    | CC<br>R | RBM      |    | SC |    |    | RBM        |            | SC                               |    |     |       |
|                            | TF                | RW | RS | IP |         | TFU      | RW | RS | IP | CC | TF         | RWA        | RS                               | IP | CCR |       |
|                            | U                 | A  | C  | S  |         |          | A  | C  | S  | R  | U          |            | C                                | S  |     |       |
| Problem Set                |                   |    |    |    |         |          |    |    |    |    |            |            | OC,<br>MN                        |    |     |       |
| Lesson 13 –<br>Problem Set |                   |    |    |    |         |          |    |    |    |    |            |            | WP<br>OC                         |    | 1   |       |
| Lesson 14–<br>Problem Set  |                   |    |    |    |         |          |    |    |    |    |            | C, D,<br>H | E,<br>F,<br>WP<br>OC,<br>ML<br>, |    | 7   |       |
| Lesson 15 –<br>Problem Set |                   |    |    |    |         |          |    |    |    |    |            | C          | WP<br>OC                         |    | 4   |       |
|                            |                   |    |    |    |         |          |    |    |    |    |            |            |                                  |    | 30  |       |

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completion of the Module. However, it is noteworthy that this Module's exit tickets, as is common in their general usage within mathematics education, are typically more procedural and less application oriented. Although this allows students to complete them quickly before the end of class, it does indicate that what the teacher will re-teach and provide additional supports for is not going to be application or process focused, but rather outcome focused. In such a scenario, as is this Module, it is unlikely and, indeed, it is not evidenced that there would be any meaningful instantiation of *SC-RSC*, *RBM-RWA* (from a critical mathematics perspective), nor any of *Critical Consciousness Raising's* (CCR) categories.

Instead, what emerges is a curriculum that prioritizes conceptual understanding of mathematics abstractly, and later attaches students' emerging procedural fluency to, largely, "real-world," upper to middle-income, White contexts. In many aspects, this conceptual focus is outstandingly laudable when compared to many other mathematics curricula. However, this approach has many pitfalls, beyond the one already mentioned, as "teaching conceptually" is not an innately harmless, nor neutral teaching stance. Instead, as evidenced in Chapter 5, the way mathematics is conceptualized, sequenced, presented, framed, and positioned, relative to other ways of knowing and being, may directly contribute to colonialist consciousness, especially in relation to the sub-constructs *Humanism* (metaphysics) and *Detachment from Local and Personal Sources of Knowledge* (epistemology). In the sections that follow this potentially surprising finding were extrapolated further.

## Results by Sub-construct Categories

This section presents the results of the criticalmathematics evaluation by sub-construct category (e.g., *Teaching for Understanding*), to illuminate the specific ways in which these sub-constructs manifested within the curriculum. In conjunction with the prior discussion of the instantiations by curriculum component groupings, this section builds upon that analysis to help facilitate a deeper comparison between criticalmathematics and anti-colonial theory. For each sub-construct category that instantiated itself within the curriculum, manifestation statements were constructed based on evidence from the literature review, thematic coding, and the analytical memos. In Tables 6.7 to 6.10, each categories' manifestations are presented in rows while the curriculum facets are presented in columns, with each column having sub-groups for each standard (i.e., E, I-T, and I-L).

Although three sub-constructs, with eight total categories, were conceptualized in this criticalmathematics evaluation framework, only two *Reform Based Mathematics* categories (i.e., *RBM-TFU* and *RBM-RWA*) and two *Sociocultural Approaches to Learning's* categories (*SC-RSC* and *SC-IPS*, but not *SC-E*) are presented. Interestingly, sub-construct *SC's Ethnomathematics* (*SC-E*) and sub-construct *Critical Consciousness Raisings* three categories were not evident and, as such, were not included in this discussion. Again, this absence is more about the nature of this curricular text and its superficial inclusivity of people of color and women within this settler colony's stratified and neoliberal, status quo.

## Teaching for Understanding (TFU)

Teaching for understanding, from a critical mathematics perspective, was theorized in three ways: promoting *conceptual understanding* over the rote memorization of procedures (*TFU, i*), *applying mathematics in a relevant way* based on student experiences and interests (*TFU, ii*), and creating opportunities for students to *create their own meaning* about mathematical concepts (*TFU, iii*). As *TFU, i* and *iii* are most aligned with reform-based mathematics and *TFU, ii* adds a critical mathematics perspective to *Teaching for Understanding*. The former (*TFU, i* and *iii*) accounted for 46.3% of all instantiations, while *TFU, ii* was not evidenced throughout the Module. In addition, in line with these sub-constructs focus on teaching, roughly two-thirds of the instantiations for conceptual understanding (*TFU, i*) and meaning making (*TFU, iii*) was discernible in Pedagogy, whereas approximately one-quarter manifested in objectives and goals and one-tenth in Assessments.

Three main conceptual-oriented pedagogical approaches (*TFU, i*) characterized teaching for conceptual understanding in this module. First, most algebraic properties were taught by scaffolding students through procedural arithmetic sequences. These sequences were meant to activate and transfer students' prior knowledge of arithmetic properties towards, presumably, universally generalizable algebraic properties.

Second, algebraic expressions and equations were taught using two kinds of visual, rectangular area models. In both of these models, unknown values were represented as an unknown length of a rectangular side. Bar models were longer and rectangular, but roughly proportional rectangular area models that represented expressions and equations. Vertically bisected rectangular area models, some



proportional and some not, were used to represent the distributive property, arithmetically and algebraically. Although not explicitly activated, this latter visualization is reminiscent of the vertically and horizontally bisected partial product area models often used in fourth and fifth grades to visually represent multi-digit multiplication.

Third, and least conceptually oriented of the three involved using protractors with proportional visualizations of angle relationships to model solving equations. In these examples, students used the properties of angles, non-contextually, to create equations where the angles summed to 180, 360, and/or were equal to another (set of) angle(s). These proportional geometric visualizations could then be checked using a protractor, as they were intentionally and explicitly drawn to scale.

Often building from this conceptual understanding, and with at least one strategy overlapping with it, were three key pedagogical and curricular strategies for meaning making (TFU, iii). The most common approach, which also overlapped with *TFU, i*, used arithmetic to make meaning about an algebraic property, expression, and/or equation. In particular, arithmetic was utilized to *prove* that an equation or geometrical relationship was *true* and/or to look for patterns in relationships. The two other strategies were sharing and/or comparing different problem solving strategies and contextually interpreting the solution to a problem. Both strategies involved either students communicating with a classmate one-on-one or writing a response, presumably for the teacher to check.

Of course, the absence of *TFU, ii* is indicative of this curriculum's strictly reform-based orientation. *Module 3* certainly could have included objectives, pedagogical approaches, or assessment opportunities that solicited and engaged students in applying

mathematical content and skills in ways that were particularly meaningful to them and their local contexts without compromising on *TFU, i* or *TFU, iii*. For example, instead of contextually interpreting the solution to a given-problem, students could provide contexts for a given expression and/or equation and then discuss the domain (i.e., x-values) for which this expression and/or equation is useful. This could allow students to bring their own interests and repertoires of cultural practices into the mathematics classroom and potentially create space to validate and engage their *Local and Personal Sources of Knowledge*. Further, their construction of situations, using given expressions and equations, could allow teachers to underscore the social-cultural and historical nature of the purposes, usages, and development of mathematics, thus resisting *Humanism*.

#### **“Real-world” Application (RWA)**

Providing students with opportunities to engage in “real-world” applications of mathematical concepts is one of three aspects of rigor within the Common Core State Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2010). Critical mathematics also aims to engage students in the “real-world” applications of mathematical concepts. However, critical mathematicians hope to achieve this goal in relation to the illumination and/or transformation of how power, opportunity, precarity, voice, and/or well-being is distributed within systems of oppression. As such, this category of (sub-construct) Reform Based Mathematics has two clusters of manifestations: “*Real-world*” application in critical mathematics and Reform-based “*Real-world*” application.

Overall, all of the 65 instantiations of “*Real-world*” applications within Module 3 were found within the manifestation cluster Reform-based, “*Real-world*” applications.

Table 6.7

*Teaching for Understanding: Frequencies by Manifestation and Aspects of Curriculum*

**Reform Based Mathematics - Teach for Understanding (TFU):** Teaching with a focus on conceptual understanding and meaningful application, rather than algorithmic and rote procedural fluency. Focus on building from students prior knowledge and experiences. Allowing students opportunities to construct their own understanding of mathematical content.

| Description                                                                                                                                                         | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                                                     | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| i) <i>Conceptual</i> understanding is promoted, not algorithm or rote procedural fluency                                                                            | 4           | 2   | 0   | 4        | 17  | 9   | 0           | 0   | 5   | 41    |
| ii) Effort is made to solicit and engage students in <i>applying</i> mathematical content and skills in ways meaningful to the particular students in the classroom | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| iii) Students create their own <i>meaning</i> about mathematical concepts                                                                                           | 8           | 10  | 0   | 6        | 20  | 9   | 0           | 0   | 6   | 59    |
| Sub Totals                                                                                                                                                          | 12          | 12  | 0   | 10       | 37  | 18  | 0           | 0   | 10  | 100   |

*Note.* Obj / Goals = Objectives and Goals

The manifestations presented within this cluster, *bi* to *bx* (See Table 6.8), were constructed via thematic coding using descriptive, rather than evaluative terminology. Of the 65 instantiations, 23 manifested as solving real-world problems related to the buying/selling of products or services. Another ten instantiations were related to building, improving, or renovating physical spaces and/or structures or construction. All other specific manifestations were six or less: competition between characters, fundraising or collecting donations, engaging in future-oriented college/career activities, measuring health outcomes, and solving school-based problems. Finally, eleven instantiations merely mentioned real-world applications generally without any further specification. Not surprisingly, nine of these eleven *general* instantiations were found in the objectives/goals.

Given that “real-world” problems aim at engaging students with mathematics it is sensible that over half of all instantiations were found in Pedagogy and another third were found in Assessments. Interestingly, while buying goods or services (*biii*) made up approximately half of the instantiations within Assessments, they constituted only one-third of the instantiations within Pedagogy. Problems involving building, improving, or renovating physical spaces and/or structures (*bii*) had the reverse trend, as these problems were one-third of the problems in Pedagogy and not-even one-sixth of the problems in Assessment. However, Pedagogy generally had a more diverse array of problems than Assessments. Ironically, though, part of this diversity consists of Pedagogy’s greater inclusion of “Traditional” word problems (five versus one), which some may argue is important for students to be *exposed* to in preparation for high-stake, standardized gate keepers (e.g., PARCC assessment)

From a criticalmathematics perspective, the problems presented may be worthwhile, as similar problems may appear on high-stakes, standardized-gatekeeper tests, but they fall short of a fuller conceptualization of mathematics for justice. Beyond teaching mathematics for justice by providing students access to rigorous curriculum, criticalmathematicians aim to use mathematics to illuminate, better understand, act upon, and transform the real-world systemic harms of a sociopolitical nature. Manifestation *ai* in *RBM-RWA* focuses on these kinds of real-world problems. As show in Table 6.8, there was no instantiations of manifestation *ai* within any aspect of the curriculum.

Although the fundraising and health-related problems could be elevated to exhibit manifestation *ai*, they did not. For example, the health-related problem below could be reformatted to critique the population-level epidemic of heart disease from a variety of critical angles:

*Systolic blood pressure is the higher number in a blood pressure reading. It is measured as the heart muscle contracts. Heather was with her grandfather when he had his blood pressure checked. The nurse told him that the upper limit of his systolic blood pressure is equal to half his age increased by 110.*

As made clear by the American Heart Association, anyone hoping to avoid stroke, heart failure, heart attack, angina, peripheral artery disease, kidney disease/failure and/or vision loss needs to maintain a blood pressure of less than 120 (American Heart Association, 2016). Based on this formula, on average, anyone over 20-years-old should expect to have a medically abnormal blood pressure. This should sound ludicrous, but within our anthropocentric, capitalistic, and racist food system, which promotes profits over human beings, other beings, and our shared habitats' wellbeing, this is the new normal.

As such, this word problem, rather than asking what would be considered a “normal” blood pressure for her 76 year-old grandfather (i.e., an unhealthy 148mmHG), this problem could be a starting point for a broader inquiry into the root causes and/or impacts of the sociopolitical dysfunction causing them. For instance, students could use this heuristic (i.e., 110 plus half your age) to transition into discussing equations to model disparate health outcomes by race, model the impacts of our anthropocentric and ecologically devastating agribusiness industry, and calculate the excess deaths caused by their hegemonic exportation of the Western diet both within the settler colony and beyond. Truly, these are real-world problems that, unless we actually treat them as real-world problems, will continue to be the real-world problems of our students’ futures.

Further, depending on student interest, this problem could merge into a related, but broader discussion into well-being. For, far from being natural, maintaining blood pressure below 120, is possible and well documented within people’s and nations following a non-Western, plant-based diet (Nutrition Facts, n.d.). This is not surprising, as Indigenous peoples have deep, empirical knowledge of places and how to live well in them. However, given the quantitative discrepancies between Indigenous and White settler health outcomes, this ontological inversion could provide a touchstone for discussing the genealogy and omnipresence of settler colonial structures. These settler structures, the ongoing investment in them, the profits driven from them, the debt(s) owed to Indigenous and Black peoples, and its impact on other beings and our shared habitats could and should be illuminated quantitatively for generative purposes.

### **Respect for Student and Community Knowledge and Ways of Being (RSC)**

From a sociocultural perspective, criticalmathematicians aim to create a classroom

Table 6.8

*“Real-world” Application: Frequencies by Manifestation and Aspects of Curriculum*

| <b>Reform Based Mathematics – “Real-world” application (RWA):</b> A focus on teaching, motivating, and engaging mathematical concepts through real-world applications. In the context of critical mathematics, the analyses of unjust systems of oppression provide limitless “real-world” applications of mathematics, problem solving practice, and contextualized opportunities to understand mathematical concepts. |             |     |     |          |     |     |             |     |     |       |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                                                                                                                                             | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                                                                                                                                                         | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) “Real-world” application in Criticalmathematics                                                                                                                                                                                                                                                                                                                                                                      |             |     |     |          |     |     |             |     |     |       |
| ai) Sociopolitical issues - these real-world problems expose and/or ask students to engage in radical/critical analysis of systems of oppressions that create socioeconomic and political issues and their manifestations using mathematical skills and content knowledge.                                                                                                                                              | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| b) Reform-Based “Real-world” application                                                                                                                                                                                                                                                                                                                                                                                |             |     |     |          |     |     |             |     |     |       |
| bi) General – real-world applications are generally mentioned or promoted without any further specification                                                                                                                                                                                                                                                                                                             | 8           | 1   | 0   | 2        | 0   | 0   | 0           | 0   | 0   | 11    |
| bii) Building – real-world problem involves building, improving, or renovating physical spaces and/or structures                                                                                                                                                                                                                                                                                                        | 0           | 0   | 0   | 0        | 4   | 3   | 0           | 0   | 3   | 10    |
| biii) Buying/selling products or services                                                                                                                                                                                                                                                                                                                                                                               | 1           | 0   | 0   | 0        | 6   | 6   | 0           | 0   | 10  | 23    |
| biv) Competitive – these real-world problems assume that the students in the word problem or the students in the class are directly or indirectly competing with each                                                                                                                                                                                                                                                   | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 1   | 1     |
| bv) Fundraising/ Donations – these real-world problems involve the raising of funds from private individuals for public services or the publics’ benefit                                                                                                                                                                                                                                                                | 0           | 0   | 0   | 0        | 1   | 0   | 0           | 0   | 1   | 2     |
| bvi) Future oriented – these real-world problems ask the student to imagine themselves or the characters in the word problems doing future oriented tasks related, largely, to college                                                                                                                                                                                                                                  | 1           | 0   | 0   | 0        | 1   | 3   | 0           | 0   | 0   | 5     |

| Description                                                                                                                          | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|--------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                      | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| and career goals                                                                                                                     |             |     |     |          |     |     |             |     |     |       |
| bvii) Health – these real-world problems focus on understanding, evaluating, or solving health-related issues.                       | 0           | 0   | 0   | 0        | 0   | 1   | 0           | 0   | 1   | 2     |
| bviii) School – these real-world problems focus on school-based problems only relevant to school contexts, teachers, and/or students | 0           | 0   | 0   | 0        | 2   | 0   | 0           | 0   | 2   | 4     |
| bix) “Traditional” – these real-world problems focus on solving for speed, time, or distance and/or area and perimeter;              | 0           | 0   | 0   | 2        | 0   | 3   | 0           | 0   | 1   | 6     |
| bx) Other                                                                                                                            | 0           | 0   | 0   | 0        | 0   | 1   | 0           | 0   | 0   | 1     |
| Sub Totals                                                                                                                           | 10          | 1   | 0   | 4        | 14  | 17  | 0           | 0   | 19  | 65    |

*Note.* Obj / Goals = Objectives and Goal



context that demonstrates respect for their students and their communities' ways of knowing and being. This is conceptualized to happen in two broad ways: by engaging students' ways of knowing and being within the classroom context (*ai*) and through either the proportional or disproportionate, but inclusive representation of peoples by race, class, gender, sexual orientation, and/or ability in textual examples (*aii*). As shown in Table 6.9, manifestation cluster *a* was not evidenced within Module 3. Further, even though manifestation cluster *b*, which could be characterized as justice as inclusion, did instantiate within this module, as shown through Tables 6.10 to 6.12, it was insufficiently instantiated.

### ***Justice as inclusion.***

Manifestation cluster *aii*, instantiated itself, albeit insufficiently, within the word problems found in lesson plans (i.e., Pedagogy) and problem sets (i.e., Assessments). Collectively, these word problems presented a “real-world” that was 84.7% White, 49.1% high income, 59.09% cis-gendered male, and, ostensibly, given the lack of alternatives, straight and able bodied. This is in stark contrast to the population estimates provided and/or imputed in Tables 6.10 to 6.12 from governmental, academic, non-profit, and/or polling services' data sources.

### ***Racial inclusion?***

Race, racial identity, and/or racial signifiers (e.g., having a Hispanicized, rather than an Anglicized last name) were never discussed openly within Module 3 itself, nor were they discussed vicariously via its word problems' characters. Thus, the observed percent by race presented in Table 6.9 were estimated inferentially. Specifically, percent proportions by race were imputed by first creating rows compiled from the first names

Table 6.9

*Respect for Student and Community Knowledge and Ways of Being: Instantiations frequencies by Manifestation and Aspects of Curriculum*

| <b>Sociocultural approach to learning – Respect for student and community knowledge and ways of being (RSC):</b> Less focus is placed on transforming the individual student, while concerted attention is given to analyzing and transforming the ways classrooms as a sociocultural context, (under/over) privilege certain ways of being and knowing in relation to others (Gutiérrez, 2013, p. 38). Students ways of knowing/being are meaningfully engaged to advance understanding of the content |             |     |     |          |     |     |             |     |     |       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
| Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| a) All students and, their respective communities, ways of knowing and being are systematically and meaningfully engaged within the mathematics curriculum                                                                                                                                                                                                                                                                                                                                              |             |     |     |          |     |     |             |     |     |       |
| ai) Students ways of knowing are meaningfully engaged to advance student understanding of the content                                                                                                                                                                                                                                                                                                                                                                                                   | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| aii) Students ways of being are meaningfully engaged to advance student understanding of the content                                                                                                                                                                                                                                                                                                                                                                                                    | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| b) The examples used in class have characters who represent the proportional characteristics of all student populations                                                                                                                                                                                                                                                                                                                                                                                 |             |     |     |          |     |     |             |     |     |       |
| bi) Race – When names are used people of color are represented in the examples and exercises                                                                                                                                                                                                                                                                                                                                                                                                            | 0           | 0   | 0   | 0        | 2   | 6   | 0           | 0   | 11  | 19    |
| bii) Gender – When names and personal pronouns are used in examples and exercises Women and/or non-conforming gender identities are included                                                                                                                                                                                                                                                                                                                                                            | 0           | 0   | 0   | 0        | 4   | 9   | 0           | 0   | 12  | 25    |
| biii) Sexuality – LGBTQ people are implicitly or explicitly included in the examples and/or exercises                                                                                                                                                                                                                                                                                                                                                                                                   | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| biii) Ability – People who are stratified as disabled are included and able-bodiedness is considered in the context of the examples and/or exercises                                                                                                                                                                                                                                                                                                                                                    | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| biv) Class – The contexts provided in the examples and exercises assume low and or middle/low-income families and/or individuals                                                                                                                                                                                                                                                                                                                                                                        | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 2   | 2     |
| Sub Totals                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 0           | 0   | 0   | 0        | 6   | 15  | 0           | 0   | 25  | 46*   |

*Note.* Obj/Goals = Objectives and Goals

used in Module 3, then by aligning each name with imported columns from a study that computed the proportion of people in the United States with one of 4,250 first names, by race (Tzioumis, 2018), and finally by computing averages for each column, that is, racial categories. The six racial categories utilized in this study, as is the case with the sociopolitical construction of race itself, are specious, federally prescribed, and mutually exclusive racial categories, which includes the racialized and race-defying, Hispanic origin (a.k.a., Latinx) group.

In addition, the population estimates by race of US citizens and other documented students, aged 0-17 in Table 6.9, were obtained from the Federal Interagency Forum on Child and Family Statistics, and as such, were necessarily non-inclusive of undocumented students (Federal Interagency Forum on Child and Family Statistics, 2019). Another potential difference between the observed percent and the population estimate is that the latter is based off of home mortgage data, which although not statistically significant different from census data, represents a different age range (a.k.a., generation) with potentially different naming conventions. Nonetheless, as the curriculum is written by adults of a mortgage-obtaining age, it does reveal the authors' *real-world* and the *real-world* they imagine the intended students to participate in via the intended curriculum.

With all of these assumptions in mind, a comparison between the curriculum author's intended real-world and a population estimate of the US' racially-stratified real-world was undertaken. To aide in this examination, Table 6.10 presents the percent difference and a ratio between the observed and the population estimate. In examining both sets of derived data, it is very apparent that White people are overrepresented by a

factor of 1.68 or an absolute difference of 34.2%. Whereas American Indian and Alaskan Native, Black, Latinx, and multiracial peoples were severely underrepresented and were present at only one-fourth, one-third, one-fifth, and one-twentieth of their actual population proportions, respectively. The only group to be represented proportionally in relation to their population estimates was Asian Americans.

Table 6.10.

*Observed Relative Frequency by Race versus Population Estimates and New Ph.Ds. in Mathematics*

|                                             | American<br>Indian and<br>Alaskan<br>Native | Black | Latinx | Multiracial | Asian/<br>Pacific<br>Islander | White |
|---------------------------------------------|---------------------------------------------|-------|--------|-------------|-------------------------------|-------|
| Observed<br>Percent                         | 0.2%                                        | 4.2%  | 5.3%   | 0.2%        | 5.3%                          | 84.7% |
| Population<br>Estimate<br>(Ages 0-<br>17)   | 0.8%                                        | 13.6% | 25.3%  | 4.5%        | 5.3%                          | 50.5% |
| Absolute<br>percent<br>difference           | -0.6%                                       | -9.4% | -20.0% | -4.3%       | 0.04%                         | 34.2% |
| Ratio of<br>Observed<br>to Pop.<br>Estimate | 0.25                                        | 0.31  | 0.21   | 0.05        | 1.01                          | 1.68  |
| New Math<br>Ph.Ds.                          | 1.0%                                        | 3.2%  | 4.9%   | NI          | 8.2%                          | 82.7% |

Conservatively, in comparing the observed percent in Module 3 to the American Mathematical Society's data on new Ph.Ds. in mathematics, the implicit racial make-up of the characters in word problems in Module 3 roughly matched each other (2017). As shown in Table 6.10, this curriculum is less inclusive, in relation to American Indians and Alaskan Natives and Asian Americans, while only marginally more inclusive of Black

and Latinx peoples. By any standard, this is not justice as inclusion. Mathematics and mathematical sciences are notoriously comprised of White males, and Module 3 replicates this composition within the text.

*Inclusion by gender?*

Gender pronouns, on the other hand, were utilized throughout the curriculum and as such were at least implicitly omnipresent. Every time a character appeared, their gender was deduced either from the gender pronoun the author chose or by referencing the Social Security Administration's *Popularity of a Name* database (Social Security Administration, n.d.). When a gender pronoun was not used and the name does not have a clear gender-assignment, then the name was considered to be gender non-binary. Of course, this method excludes the possibility that a character with a given female name, identifies as a male, vice-versa, or genderqueer. However, while it is unknown if the author intended for word problem characters to be called by their preferred gender pronoun and/or their preferred name is unknown, the author also made no explicit use of common gender non-binary pronouns, for example, ze, hir, hers, himself.

Table 6.11 also uses 2016 data from the census that disaggregates data by age and sex. For this table, as the age ranges of 0 to 17 were not available, the age ranges of 0 to 19 were selected to maintain some degree of comparability between Tables 6.10 and 6.11. However, the government data is based on sex and not gender. As such, the government data does not provide any data on the proportion of transgender and/or gender non-conforming students within the population. A study by Rider et al (2018), which has provided the most comprehensive study on the health and care utilization of transgender and gender non-conforming youth to date, also contained empirically-based,

population estimates for these youth. The population estimates presented in Table 6.10 are based off of calculations integrating the United States Census Bureau (n.d) and Rider et al. (2018) study data.

Table 6.11.

*Observed Relative Frequency by Gender versus Population Estimates and New PhDs in Mathematics*

|                                             | Gender<br>Non-Binary<br>Name, no<br>gender<br>pronoun | Female<br>Character | Male<br>Character |
|---------------------------------------------|-------------------------------------------------------|---------------------|-------------------|
| Observed<br>Percent/<br>Count               | 3.03%                                                 | 37.88%              | 59.09%            |
| Population<br>Estimate                      | 2.7%                                                  | 47.2%               | 50.1%             |
| Absolute<br>percent<br>difference           | 0.3%                                                  | -9.3%               | 9.0%              |
| Ratio of<br>Observed<br>to Pop.<br>Estimate | 1.12                                                  | 0.80                | 1.18              |
| New Math<br>Ph.Ds.                          | 0.2%                                                  | 27.2%               | 72.6%             |

As evidenced in Table 6.11, female characters were underrepresented in Module 3 by 9.3 percentage points, while male characters were overrepresented by almost the same amount. Surprisingly, the proportion of gender-neutral names assigned to characters within Module 3 rose slightly above the population estimate. However, given the lack of evidence for Module 3's intentional gender non-binary inclusion, this is also just as likely happenstance. Further, given that only one-fourth of all US citizens and permanent residents receiving PhDs between 2016 to 2017 identify as women, this module evidences little effort to redress the lack of inclusion by gender or race within

mathematics (American Mathematical Society, 2017). Consequently, Module 3 does little to reshape the White and male image of mathematics, mathematics education, or the imagined Eurocentric history of mathematics as a universal and uni-linear process.

*Inclusion by class?*

Class, like race, was never explicitly discussed in the curriculum. However, its representations were estimated by counting the frequencies of scenarios where the monetary value of the activity was provided or could be inferred. These frequencies were grouped as activities that people with high, middle, and/or low incomes may be able to participate in. Undoubtedly, these frequencies would benefit from more comprehensively and collaboratively vetted criteria. As such, two researchers may reasonably disagree with Table 6.12's conclusions. With this in mind, the goal in presenting this herein is to offer a table of values that may be generative for increasingly deeper conversations about class, capitalism, their intersections with gender and race, and their collective instantiation within mathematics curriculum.

Generally, when costs were included or could be inferred, they involved activities, services, and/or products that required the characters to spend significantly. This may have made for quantitatively more *rigorous* word problems, but it also reinforced the position of high and middle income students within the curriculum. For example, the example below exhibits a family who is evidentially financially flush, spending well over \$100 at the movies theater at a time:

*Xander goes to the movies with his family. Each family member buys a ticket and two boxes of popcorn. If there are five members of his family, let  $t$  represent the cost of a ticket and  $p$  represent the cost of a box of popcorn. Write two different*

*expressions that represent the total amount his family spent. Explain how each expression describes the situation in a different way (Teacher Edition, p. 71).*

Table 6.12.

*Observed Relative Frequency by Income Level versus Population Estimates*

| Income Level                       | High Income (>600% poverty threshold) | Middle Income (>600 of poverty threshold to medium income) | Low Income (poverty and medium income) (<100% poverty threshold) |
|------------------------------------|---------------------------------------|------------------------------------------------------------|------------------------------------------------------------------|
| Observed Percent/Count             | 49.1%                                 | 47.2%                                                      | 3.8%                                                             |
| Population Estimate                | 16.1%                                 | 36.9%                                                      | 47.0%                                                            |
| Absolute percent difference        | 33.0%                                 | 10.3%                                                      | -43.2%                                                           |
| Ratio of Observed to Pop. Estimate | 3.05                                  | 1.28                                                       | 0.08                                                             |

Other upper income examples included, trips to the Caribbean, spending \$68 purchasing movies, having a \$38 per week allowance, attending piano practice, and having a dog sitter. In fact, there were only two examples where characters *may* have had a lower income: one character had a bank account with a balance of \$500 and another character was a waiter on Saturdays. However, as many educators can attest to, both of these characters may simply be two professional educators who live week-to-week and/or who work a second job at night or on the weekends. Overall, Table 6.12 indicates that 49.1% and 47.2% of all word problems involving costs, implicitly or explicitly catered



towards the spending habits of high to middle income people, respectively. If this is a reasonable estimate, then high income characters were observed at three times their estimated rate within the population (Federal Interagency Forum on Child and Family Statistics, n.d.). Meanwhile, a combined 23 of the middle- and high-income instantiations would need to be shifted to low income instantiations if low income wage earners and their children, who make up 47% of the school age population, are to be proportionally represented within Module 3 (Federal Interagency Forum on Child and Family Statistics, n.d.).

*Other inclusions or exclusions?*

Both heteronormativity and ableism were, like race and class, not redressed, nor addressed. However, like class, ableism was observed by the numerous activities that made no accommodations for those with what Federal Interagency Forum on Child and Family Statistics characterizes as *activity limitations* and/or *depression or emotional difficulty*, who collectively make up 11%, 13%, and 5% of students, respectively (2019). Far from being at the margins, these students may make up to almost one-third of the school-age population (Federal Interagency Forum on Child and Family Statistics, 2019). Their inclusion as characters within algebraic word problems could easily fit into a variety of scenarios. For example, an algebraic equation could be created to compare the total cost of paying to see a cognitive-behavioral mental health professional in the US (health insurance is a fixed cost and co-pays are variable cost) versus the fixed cost of treating mental health within a socialized health care system. Additionally, scenarios already provided in the curriculum, such as mini golf, are required to be at least 50% accessible by wheelchairs via the American with Disability Act (United States Access

Board, 2017). From a critical mathematics perspective, the angle measurement problems used in the curriculum could be readily transformed to check for wheelchair accessibility in terms of course incline and/or decline, that is, angle measures.

Further, heteronormativity, although not explicitly reinforced, was implicitly guarded from any potential inferences of same-sex or gender-non-conforming romances between characters. Two examples stand out in particular, but both, as will be exemplified below could be easily transformed. First, in one problem “Jenny invited Gianna to go watch a movie with her,…” dramatic pause, as their first date? No, Jenny unromantically and unambiguously invited Gianna to go with her, “family.” Second, and more explicitly and transactionally: “[Margo’s] friend Carissa wants to store a box of her belongings in Margo’s storage unit and tells her that she will pay her \$1 toward the processing fee and \$3 for every month that she keeps the box in storage.” The relative absurdity of charging and collecting a \$1 transaction fee and a \$3 per month from a friend is compared to the plausibility of an alternative scenario: “Margo rents a storage unit, which she stores with Carissa, her partner.” Not only, would both examples redress heteronormativity, but allow acknowledge that the future is increasingly identifying as LGBTQIA with 2.4% of Baby Boomers, 3.5% of Gen Xers, and 8.2% of Millennials identifying as LGBT (Gallup, 2018).

### **Inverting Pedagogical Structures (IPS)**

One way that teachers can engage students’ and their communities’ sociocultural and linguistic resources within a classroom is by inverting pedagogical structures. In inverting pedagogical structures, students can make meaning together, make choices about the tasks they complete, shape the process in reaching a pre-defined end, reshape or

re-define the end goal, and/or define their own goals (See Table 6.13, manifestation cluster *b*). Each one of these approaches involves increasing input and decision making from students and, as such, would more likely require and allow students to engage and bring their sociocultural and linguistic resources to curricular tasks.

This approach aligns with *SC-RSC* manifestation cluster *a*, which was not evidenced in Module 3, and Gutiérrez's and Rogoff's (2003) conceptualization of culture. Specifically, Gutiérrez and Rogoff (2003) rebuff the racialized trait approach to students' culture(s), in favor of a conceptualization of students' culture(s) as a dynamic set of repertoires of cultural practices that emerge from an individual's interaction within communities located in specific places. Instead, IPS may call for teachers to engage in critical cross-cultural conversations with students, focused on a mutual understanding and co-illumination (de Sousa Santos, 2008).

Unfortunately, this Module does not exemplify, to any real degree, the *Inversion of Pedagogical Structures*. Rather, there are only five pedagogical instantiations, all of which requires the least input and decision making from students (See Table 6.13). Although it might seem more challenging pedagogically, allowing student choice, resources, and structure can start with project based learning opportunities. Most of the criticalmathematics examples already presented assume a project-based learning approach to learning (e.g., connecting heart rate heuristics, factory farming, and Indigenous lands) and could offer a workable starting point.

However, from a criticalmathematics perspective, it would be ideal if the curriculum took a Freirean approach to learning to read and write the world mathematically (Gutstein, 2006). The Freirean perspective and project-based learning

Table 6.13

*Inverting Pedagogical Structures: Frequencies by Manifestation and Aspects of Curriculum*

**Sociocultural approach to learning – Inverting pedagogical structures (IPS):** Student-centered teaching with a primacy of Freirean approaches to engaging students through their context.

| Description                                                                                                                                        | Obj / Goals |     |     | Pedagogy |     |     | Assessments |     |     | Total |
|----------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----|-----|----------|-----|-----|-------------|-----|-----|-------|
|                                                                                                                                                    | E           | I-T | I-L | E        | I-T | I-L | E           | I-T | I-L |       |
| ai) Freirean pedagogical approaches are engaged to read and write the world via mathematics through collectivist, consciousness-raising activities | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| b) Student-centered teaching is engaged                                                                                                            |             |     |     |          |     |     |             |     |     |       |
| bi) Students have the opportunity to make meaning together about the content                                                                       | 0           | 0   | 0   | 1        | 0   | 4   | 0           | 0   | 0   | 5     |
| bii) Students have choice in the selection of tasks related to demonstrating their understanding of the content                                    | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| biii) Students have the ability to shape the process involved in solving a pre-defined end goal related to the content                             | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| biv) Students have the ability to select and/or (re-)shape the end product desired as evidence of their understanding of the content               | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| bv) Students have the ability to define their own end goal(s) in relation to the content                                                           | 0           | 0   | 0   | 0        | 0   | 0   | 0           | 0   | 0   | 0     |
| Sub Totals                                                                                                                                         | 0           | 0   | 0   | 1        | 0   | 4   | 0           | 0   | 0   | 5     |

(PBL) approaches are not mutually exclusive. Instead, teachers may use PBL to support students in using mathematics to co-illuminate social, political, and economic issues that either unfairly benefit or harm their communities. Again, unfortunately, there was no evidence of manifestation *a* within this module (See Table 6.13).

### **Missed Opportunities: Non-instantiated Categories**

As alluded to elsewhere critical consciousness raising is the hallmark of criticalmathematics teaching and learning. Although several example topics were presented in *RBM-RWA*, none were found in this curriculum. This is an existential mistake, as climate change will only exacerbate human- and other-being stratification, while human- and other-being stratification will continually naturalize the imperial and settler colonial relations driving climate change. Criticalmathematics has much to offer in helping teachers and students to learn together for humans, other beings, and our shared habitats' future well-being.

Ethnomathematics, that is, the identification of mathematics as social cultural tool and way of thinking shaped by place and larger sociopolitical (and cosmological) purposes, could offer both a rebuffing of the hierarchical stratification of non-European peoples and the opportunity to rethink our purposes for doing mathematics. Unfortunately, ethnomathematics and its principles were not represented within module 3. Examples could have included the Iranian origins of algebra and the observation that the astronomical calculations performed by the Mayans were more advanced than those of the circumnavigating and algebra-borrowing Spaniards who invaded their wealthy nation.

## **A Comparison of Criticalmathematics and an Anti-colonial Mathematics Curriculum Evaluations**

Criticalmathematics has the laudable goal of illuminating, acting upon, and transforming sociopolitical and economic injustices through the engagement of mathematics. As theorized in the literature review and evidenced herein, criticalmathematics is dangerously uncritical of Western mathematics' genealogy and ongoing philosophical assumptions. This is a serious abrogation of criticalmathematics' abilities. This abrogation is evident in its inability to critique and its wholesale acceptance of *Reform Based Mathematics'* construction of *Teaching for Understanding*. Further, criticalmathematics fails to identify the insidious ways in which anthropocentrism instantiates itself within Reform Based Mathematics' Real World Applications. In general, this follows criticalmathematics' trend of imagining human justice and ecological justice as separate and parallel, not intertwined and inseparable genealogically or theoretically in relation to settler colonialism and imperialism.

First, criticalmathematics is uncritical of *Teaching for Understanding's* promotion of *Humanism* and *Detachment from Local and Personal Sources of Knowledge*. This is especially problematic, as these two sub-constructs of colonialist consciousness are deeply linked and overlapping aspects of its philosophical system and the promotion of a settler colonial way of life, that is, metaphysics and epistemology. Specifically, this is accomplished by the transference of the epistemological strength of arithmetic and Euclidean geometry, which ironically emerges from its contextualized and physically local nature. Pedagogically, this means that when using area models and arithmetic patterns to justify algebra's properties, the simplification of algebraic expressions, and/or

the solution for algebraic equations critical epistemological and metaphysical questions must be raised.

For example, for what domain and range of values does this algebraic expression or equation hold in this particular context? When do algebraic properties fail to successfully model the situation at hand? Does the commutative property always work? Can you really get paid  $1000 + 2000$  or  $2000 + 1000$  over the next two months and still pay your bills on time equally as well? Similarly, Euclidean geometry only works up to a certain point as it does not take gravity into account. This does not mean that it is not useful, but like algebraic expression and equations: when does it work and to what extent? Without asking these questions, the universality and immutability of Western mathematics, which undergirds the purported supremacy of Western science over all other ways of knowing and being, will remain unchallenged. Without challenging this supremacy, the implicit justification and rationalization of the Western project of material wealth accumulation will continue to existentially threaten the wellbeing of human beings, other beings, and our shared habitats.

Second, criticalmathematics, from an anti-colonial stance, is too accepting of justice as inclusion into the settler colony and is unable to identify anthropocentrism in relation to *Reform Based Mathematics' Real World Applications*. This failure of criticalmathematics, to more deeply critique *Real World Applications*, may contribute to a collective *Detachment from Nature, Independence, and Achievement* orientations, all of which are deeply problematic. Reform Based Mathematics justifies its complicity in relation to the acknowledgement of the material gate-keeper of high stakes, standardized testing. Although a non-trivial gate-keeper, focusing on getting students through this *gate*

invests too deeply in a theory of change that only advances the reproduction of mathematical application for consumptive, competitive, anthropocentric, and, at times, simply trite reasons. For example, it is hard to understand how solving consumer math problems, comparing the efficiency of mathematical algorithms, constructing water fountains, or scuba diving in the Caribbean will prepare the youth for the unprecedented challenges that our future generations will face due to climate change and ecological devastation. These impersonal, non-meaningful, and non-transformative tasks, which students are asked to solve with extreme self-reliance, only promotes an instrumentalist orientation towards school and work (*Achievement*) and a detached and overly self-reliant relationship towards others (*Independence*).

In addition, critical mathematics is unable to identify how *Real World Applications* promote a *Detachment from Nature*. In fact, many word problems that promote a *Detachment from Nature* are also considered rigorous. For example, in lesson 14, students were implored to help the *owner of an exotic animal exhibit* manage his costs so that he may achieve his desired profit margin. This rigorous inequality problem involved a negative decimal coefficient, necessitating both decimal division and the reversal of the inequality, but also treated animals (and nature) as agentless commodities whose needs are secondary to humans. While the treatment of nature as an agentless commodity cannot continue as it threatens the wellbeing of all life on Earth, one could be easily forgiven in the future for forgetting how to do decimal division or solving an inequality with ease. Further, all examples were limited to anthropocentric, human constructed indoor and outdoor rectangular spaces, the latter of which are treated as empty (*terra nullius*) until acted upon by a mathematical, Westernized person. Nowhere



were ancient forests or other non-human spaces inquired about mathematically, either in an impulse to show respect, protect, and/or understand these spaces.

However, even Western texts such as *The Hidden Life of Trees* could offer insights that could offer appreciation and even opportunities for the engagement with critical mathematics in a non-anthropocentric way (Wohlleben, 2016). For instance, someone could analyze the *Quilted Northern* toilet paper commercial offering to plant three trees for every felled mature tree. However, as beneficial as this ratio seems, it does not take account of three facts about trees. To begin, unlike humans, trees not only continue to grow as they age, but since they are roughly circular, they grow at an increasing rate as they age ( $\frac{dy}{dx} \pi r^2 \cdot dx = 2\pi r$ ). Further, trees have a longer and slower-paced childhood than humans, which help their outer bark develop densely into an impermeable barrier to disease and injury. Together, these two facts, means that one felled mature tree is not equivalent to three immature trees in terms of growth (and carbon sequestration) per year. Thus, *one* (mature tree) may be greater than *three* (immature trees) for a very long time, maybe up to a few hundred years. In addition, out of all the young trees that are planted or that sprout from a parent tree, very few survive to replace the parent tree, thus one may be to less than one. It may take decades for a lone surviving tree to reach the same width of the felled tree, and hundreds of years for it to reach the same height, and thus for the surviving tree to reach a one-to-one ratio. This underscores the necessity of protecting ancient, old-growth forests, which a different approach to teaching ratios and proportions could promote.

Finally, in relation to what is evidenced in this study, *Respect for student and community knowledge and ways of being's (RSC)* manifestation cluster *a*,

criticalmathematics fails to critique justice as inclusion adequately. Instead, there is an implicit assumption that once there is a proportional representation within sociopolitical and economic institutions that the democratic structures of the United States will have the solvency and flexibility to redress and adapt to the needs of all peoples. Of course, for Indigenous nations and nation peoples' within the United States, sovereignty, not inclusion into settler institutions is sought after (Grande, 2015). Further, many Black folks and (other) Peoples of Color are dubious of the United States historical or present moral or material solvency (Ani, 1994; Bell 1993). Nonetheless, this theory of change, that is, inclusion of individuals in order to transform institutions, both ignores how power circulates and is replicated via institutions, while placing the burden of change on those who are continuously and extractively stratified within said systems.

Although much could and has been said about the problematic issues related critical consciousness raising, this was not evidenced within this evaluation. In order to address this sub-construct an explicitly criticalmathematics curriculum would need to be analyzed. In the interim, excellent critiques of raising critical consciousness are offered by Grande (2015) and Tuck and Yang (2012).

### **Summary**

Chapter Six sought to evaluate a 7<sup>th</sup> grade, Eureka Math, Common Core mathematics' module from the perspective of criticalmathematics in order to compare its findings with that of an anti-colonial mathematics curriculum evaluation framework. This was done for the propose of illuminating the ways in which criticalmathematics may need to be re-conceptualized to better serve the dual purposes of human and ecological justice. As such, this chapter was organized into two sections: a) one presenting the findings of

the criticalmathematics evaluation and b) the other section comparing the results of the criticalmathematics and the anti-colonial curriculum evaluations.

With respect to the criticalmathematics evaluation, this curriculum evidenced a strong *Reform Based* orientation, but failed to evidence a robust manifestation of any other aspect of criticalmathematics. In fact, the hallmark sub-construct of criticalmathematics, that is, *Critical Consciousness Raising* (CCR) was not evidenced anywhere in the curriculum. In addition, *Sociocultural Approaches to Learning*, which is often framed as a secondary, but an idealized complement to CCR, manifested inadequately and superficially in relation to *Respect for Students and Community Sources of Knowledge* and sporadically and insufficiently in relation to *Inverting Pedagogical Structures*. Most problematically, from a criticalmathematics perspective, the word problems in this module evidenced a “real-world” that was 84.7% White, 49.1% high income, 59.09% cis-gendered male, and, ostensibly, given the lack of alternatives, straight and able bodied. As such, traditional orientations towards justice within criticalmathematics justice, that is justice as the redistribution of resources and justice as inclusion, were not evidenced herein.

However, given the strong manifestations of sub-construct *Reform Based Mathematics*, a comparison between criticalmathematics and the anti-colonial mathematics curriculum evaluation frameworks was possible in the chapter’s second section. As theorized in the literature review and evidenced herein, three aspects of criticalmathematics were found to be particularly problematic. These three aspects were: a) its promotion of *Humanism* and *Detachment from Sources of Local and Personal Knowledge* (DLP), b) its inability to problematize *Detachment from Nature* (DFN), and

c) its intertwined capitulation to the demands of high-stakes testing and justice as inclusion.

First, the *Overviews*, the pedagogy within the *Lessons*, and the assessment-aspect of *Problem Sets* evidenced both criticalmathematics' categories *RBM-RWA* and *RBM-TFU*, but also and problematically, colonialist consciousness' sub-constructs *Humanism* and *DLP*. Specifically, this was related to the authors' selection, sequencing, presentation, framing, and conceptualization of mathematics in such a way that universalizes mathematics as the immutable representation of reality (*Humanism* - metaphysics) and as the superior way of creating meaning about said reality (*DLP* - epistemology). This more generally links to Criticalmathematics inability and, often, unwillingness to take a critical stance in relation to Western mathematics itself. This is deeply problematic for, as evidenced in this study's literature review, Western mathematics development is inseparable from the rise of Western, specifically British, imperialism and settler colonialism. Thus, although some individual, European mathematicians may be personally implicated, many Western mathematicians worked within a system of funding and rewards that implicitly oriented their life's energy towards developing mathematics to dispossess and transport Indigenous peoples of their land, labor, and life for the purpose of European's material wealth accumulation. Unfortunately, Western mathematics continues to develop in this direction and this fact must be addressed head on. As evidenced in this chapter Criticalmathematics is dangerously unprepared to raise these existential issues.

Second, although criticalmathematics through sub-construct *CCR* has the capacity to interrogate environmental issues as specific events and outcomes, unlike colonialist

consciousness, criticalmathematics generally lacks the ability to critique ecological crises as a crisis of metaphysics, ontology, and/or axiology (Wildcat, 2009; Grande, 2015). As such, criticalmathematics lacks the ideologically solvency necessary to uproot the intertwined projects of human stratification and ecological disarticulation for the purposes of material wealth accumulation. Rather, as evidenced in this chapter, criticalmathematics is willing to promote anthropocentric word problems involving destructive relationships with other beings and our shared habitats, so long as they are procedurally rigorous.

Third, and building from this last example, criticalmathematics is overly complicit in allowing the objectives of high-stakes testing to shape the pedagogy and objectives within our secondary classrooms. This failure is evident most clearly in criticalmathematics inability and unwillingness to critique word problems that manifest Reform Based, *Real World Applications*. For example, so long as a word problem promotes the kind of linguistic and procedural rigor necessary for student's readiness for high-stakes standardized testing, the word problem is categorically exempted from further critique. However, based on the analysis in Chapter 5 it is clear that many of these word problems that evidence *RBM-RWA*, also promote colonialist consciousness. Ironically, in advocating for students' ability to surpass systemic gate keepers, such as high-stakes assessments, we both comply with an assessment that presumes the desirability for (a dubiously) meritocratic system of human stratification and perpetuates the ideological underpinnings of such a problematic system. Rather, than simply dismissing the materiality of such high stakes assessments on students ability to access resources now, we could acknowledge this desire while planning more deeply and

systematically for the future. To take a new twist on a beloved idiom, *we should not put the cart's haul, before the horse's hay (or the hay's habitat)*. In other words, we should not put the stratifying needs of a system of material wealth accumulation before the needs of our fellow human beings, non-human beings, and our shared habitats. Until criticalmathematics more squarely addresses this complicity, it will be unable to live up to its fullest potentials.

## **CHAPTER SEVEN: SUMMARY, CONCLUSIONS, AND IMPLICATIONS**

Chapters four, five, and six of this study presented findings from the development and engagement of two absolute criterial qualitative curriculum evaluation frameworks, one based on anti-colonial theory and the other in the tradition of critical mathematics. This chapter presents a summary of the study, discusses its most salient findings, and suggests conclusions, implications, and directions for future research.

### **Summary of the Study**

The dual purposes of this study were to concretize coloniality within mathematics curriculum and to re-conceptualize critical mathematics' ideological foundations by specifying Grande's (2015) conceptualization of colonialist consciousness into an anti-colonial mathematics curriculum evaluations framework. The three goals related to these dual purposes are to: a) construct a qualitative, absolute criterial, anti-colonial mathematics curriculum evaluation framework, b) engage the evaluation framework to illuminate the ways coloniality manifests itself within a Common Core mathematics curriculum, and c) compare the results of an anti-colonial and a critical mathematics evaluation to suggest how critical mathematics' may be reformed at its ideological core. All of this was done with the goal of advancing the indivisible goal of promoting the wellbeing of all beings (human and otherwise) and our shared habitats.

The theoretical basis for the specification of Grande's (2015) conceptualization of critical consciousness for mathematics curriculum evaluation was developed within the literature review. The literature review had two specific purposes: a) to present a possible history of the development of Western Mathematics in relation to British imperialism and Anglo-settler colonialism and b) to position the current study within both the literature on

critical, criterial curriculum evaluation and teaching mathematics for justice. Overall, the review of the literature evidenced that Western mathematics is not a universal and apolitical project, but rather critically central to advancing British goals, and eventually, Anglo-American goals of settler colonialism, first in Northern Ireland, then North America and beyond. Further, the literature review positioned the current study as unique amongst other critical, qualitative mathematics curriculum evaluations, both in its focus on critical mathematics and its focus on settler colonialism. Within critical mathematics, this study is unique in its centering of critical Indigenous scholars' theorizations, and, as such, its ability to ideologically and institutionally interrogate Western mathematics education in relation to colonialist consciousness and the omnipresent structures of settler colonialism, respectively.

From the theoretical basis established in the literature review, this study raised and responded to three research questions:

- How can both the results of a prior mathematics curriculum evaluation, based on Grande's (2015) conceptualization of colonialist consciousness and a literature review of the genealogy of Western imperialism, settler colonialism, and Western mathematics, be used to specify Grande's conceptualization of colonialist consciousness to create an anti-colonial mathematics evaluation framework?
- To what extent can a Common Core mathematics curriculum be evaluated by an anti-colonial mathematics evaluation framework?
  - In what ways does the qualitative evaluation identify instantiations of coloniality within a Grade 6-8 Common Core aligned mathematics



curriculum unit (i.e., Eureka Math, Grade 7, Module 3 – Expressions and Equations)?

- How does an anti-colonial mathematics evaluation framework highlight salient curricular elements that contribute to human and ecological (in)justices within a Grade 6-8 Common Core aligned mathematics curriculum?
- How does the curriculum evaluation help re-conceptualize critical mathematics' ideological foundation from an anti-colonial stance to better serve the dual purposes of human and ecological justice in mathematics education?

Collectively, these three questions and two sub-questions aimed to better illuminate, understand, resist, and refuse coloniality in relation to Western Mathematics and critical mathematics.

In answering these three questions, this study applied a qualitative, absolute criterial curriculum evaluation (Kemmis and Stake, 1988). Specifically, there are four idealized steps in an absolute criterial curriculum evaluation:

- 1) Establish the criteria of merit,
- 2) Construct standards,
- 3) Measure performance and compare it to said standards,
- 4) Synthesize and integrate data into judgments of merit (Fournier, 1995, p.16)

In answering this study's three research questions, two complete cycles of absolute criterial curriculum evaluations were completed with respect to *Eureka Math's* seventh grade module on expressions and equations. Questions one and two overlapped to complete the first criterial curriculum evaluation cycle. These two questions aimed to use

the evaluation process to illuminate coloniality within Western mathematics curriculum by specifying Grande's (2015) conceptualization of critical consciousness to Western mathematics education.

The second criterial curriculum evaluation cycle answered question three. The criteria of merit for this evaluation cycle were built from the theorizations of the founders and leaders of criticalmathematics in the United States within the Literature Review. After completing an anti-colonial and a criticalmathematics criterial curriculum evaluation, a comparison of anti-colonial theory and criticalmathematics ideological foundations were possible. This was done in an effort to better understand how criticalmathematics may be re-conceptualized to promote a non-anthropocentric understanding of justice that takes account of the deep structures of settler colonialism.

To answer question one and thus develop an anti-colonial curriculum evaluation framework that can be used as question two's criteria of merit, *Eureka Math's* grade six module was analyzed using Table 3.4 as the initial coding schemata. Table 3.4 is organized by colonialist consciousness' five sub-constructs. Its columns were organized by aspects of curriculum (i.e., objectives/goals, pedagogy, and assessments) and were populated by provisionally and thematically coding the results of a prior empirical study and this study's literature review. Once constructed, Table 3.4 was used as the provisional coding schema to analyze the grade six expressions and equations module. The codes emerging from this analysis were then thematically coded (Onwuegbuzie, 2016, p. 138), as manifestations by sub-construct, then aspects of curriculum (i.e., objectives/goals, pedagogy, and/or assessment), then thematically clustered into sub-categories. These results were presented in Table 4.3 through Table 4.7.

While question one developed the criteria of merit (i.e., step one) and as the standards for both evaluations cycles were presented in the *Methodology* (i.e., step two), question two, completed the evaluation cycle by engaging in steps three and four. Question two's findings from the analysis of *Eureka Math's* grade seven expressions and equations module are presented in Tables 5.3 through 5.7. First, using Tables 4.3 through 4.7 (i.e., Step 1) and the standards developed in the methodology (i.e., Step 2), that is, explicit, implicit-teaching, implicit learning, and null, each instantiation of colonialist consciousness was coded in the following sequence: sub-construct, sub-construct manifestation code, aspect of curriculum, and then standard (i.e., Step 3). From there, the data was synthesized and integrated into the Tables by sub-construct and by curriculum component type (i.e., overviews, lesson plans, assessments – teacher feedback, assessments – student feedback) and discussed (i.e., Step 4)

To answer question three, both the *Criticalmathematics Curriculum Evaluation Framework* presented in Table 3.5 (step one) and the standards constructed for question two (step two) were used to analyze *Eureka Math's* grade seven expressions and equations module. Like question two, each instantiation of criticalmathematics was coded in the following sequence: sub-construct category, category manifestation code, aspect of curriculum, and then standard (i.e., step 3). From there, the data was synthesized and integrated into tables by sub-construct category and by curriculum component type (i.e., overviews, lesson plans, assessments – teacher feedback, assessments – student feedback) and discussed.

Two main data sources were analyzed to answer these research questions. First, grades six and seven, 2015 *Eureka Math* (a.k.a., EngageNY) equation and expressions

modules were downloaded from *Eureka Math's* free, open-access curriculum login portal. Specifically, within each module, the overviews, the lesson plans, the exit tickets, the problem sets, sprints, and the mid- and/or end-of-unit assessments were analyzed. The second data source emerged from the process of memoing, which occurred throughout the initial and thematic coding processes, and led to the construction of analytical memos. These memos included columns titled curriculum component, Grande's framework, critical mathematics, other thoughts, and codes/category. Space below each memo was reserved for recording insights resulting from the process of coding.

In this study, the analysis of the two data sources largely involved the construction and discussion of frequency and relative frequency tables. Although the analysis involved frequencies and/or relative frequencies, the study did not use, nor did it follow the epistemological assumptions of inferential statistics. Rather, the (relative) frequencies presented are descriptive and were meant to aide in elucidating both the degree to which these manifestations instantiated themselves (i.e., standards) and the locations of these manifestations within the curriculum (i.e., curricular components and/or aspects of curriculum). For each question, an overall frequency and relative frequency table by sub-construct and/or sub-construct category was presented. For question one, the results were listed as manifestations under each sub-construct and marked as present "Y", theoretically present "(Y)", or not present "N". For questions two and three, the results were presented in frequency tables for each sub-construct (category) and for each curricular component type. Overall, each set of tables presented and supported the discussion of each research questions' results.

## Discussion of Findings

The raising of these three research questions emanated from the desire to illuminate, resist, and refuse the ways that coloniality manifests itself within English-language, Western mathematics curriculum texts. This was done in the hopes that mathematics can be re-imagined for the wellbeing of human beings, other beings, and our shared habitats. Collectively, the findings not only describe manifestations of colonialist consciousness in mathematics curricular texts, but also confirm broad theoretical observations about the nature of settler colonialism and/or imperialism. All in all, the findings hoped to offer a generative, rather than a definitive stance, towards re-orienting our energies towards our inter-being, wellbeing. This was done in resistance and refusal of the inseparably racist, heteronormative, sexist, classist, ableist, anthropocentric, and wealth and well-being extractive nature of settler colonialism in the United States.

### Question One

In answering question one, three central findings were evidenced: two related to the construction of an updated evaluation framework and one related to the ways that colonialist consciousness manifests in curricula. In relation to the first two findings, Figure 4.1 represented the sub-constructs of colonialist consciousness as a coherent philosophical system and Tables 4.3 to 4.7 presented the descriptive manifestations for all five sub-constructs of colonialist consciousness. In relation to the third finding, the Common Core's *aspects of rigor* were put in relation to both aspects of curriculum and the sub-constructs of colonialist consciousness.

Colonialist consciousness is not a static construct, but rather a dynamic and self-replicating philosophical system whose logic is remarkably consistent. As noted in

Figure 4.1, *Humanism*, like all metaphysical systems, has improvable assumptions. However, unlike other metaphysical systems *Humanism* is non-empirically-based and has been refined on human, rather than ecological timescales for the purposes of advancing the European project of material wealth accumulation. The ability for *Humanism* to hide this fact stems from its relationship to *DLP* and *Achievement*. *DLP*, in particular, blurs the line between metaphysics and epistemology for the purpose of universalizing Western ways of knowing as supreme. Meanwhile, *Achievement* leverages the material signifiers of power and control to justify the improvable and necrophiliac assumptions of a despiritualized and thoroughly materialistic metaphysics. This positive feedback loop naturalizes an unnatural world whose life ways are constantly being reconstituted for material wealth accumulation.

Second, evidence emerging from question one's findings advanced the claim that colonialist consciousness' sub-constructs' instantiations are describable and can be organized into meaningful, thematic clusters, that is, sub-categories. These sub-categories aim to describe the particular and specific ways in which colonialist consciousness manifests itself within mathematics curriculum. Overall, from these sub-categories, there were 34 manifestations across all five sub-constructs.

The most impactful of all of these sub-constructs was *Humanism*, with 34.7% of all instantiations. *Humanism* consisted of four sub-categories with at least two manifestation codes per sub-category. Collectively, these manifestations oriented students towards viewing mathematics as the universal and immutable language of the universe. Closely related to *Humanism* were the mutually reinforcing sub-constructs of *DFN* and *DLP* (See Figure 4.1). In particular, the manifestations of *DFN's* and *DLP's* sub-

categories reveal how mathematics curriculum orients students towards imagining themselves within a materialistic hierarchy of being. Within this hierarchy, humans who engage with (the most) mathematized disciplines sit upon its pinnacle. Ontologically, those embracing and embodying these epistemological and cosmological assumptions are further cajoled via curricular manifestations that reward doing math alone and without relational attachments, that is, exhibiting *Independence*. Flowing from *Independence*, which itself flows from *DLP* and *DFN*, curricular manifestations of colonialist consciousness further orient students towards power and control (Ani, 1994) via an *Achievement* that rewards utilitarian, consequentialist, and materialistic behavior. As alluded to already, *Achievement's* manifestations complete a positive feedback loop of colonialist consciousness by rewarding the kinds of values that support the material and unnatural reconstitution of physical reality in the shape of the non-empirical, metaphysical assumptions of *Humanism* (See Figure 4.1).

Further, the findings for question one can be discussed in relation to the Common Core State Standards' aspects of rigor, that is, conceptual understanding, procedural fluency, and application of mathematics to real-world contexts (National Governors Association Center for Best Practices, Council of Chief State School Officers, n.d.). *Humanism's* metaphysics was mostly advanced via attempts to illustrate, instruct, and assess students' conceptual understanding of symbolic mathematics apart from its sociocultural, political and economic origins. Meanwhile, despite *Humanism's* and *DLP's* close connection, only half of *DLP's* manifestations were also related to the supremacy of symbolic and procedural mathematics. The other half of *DLP's* manifestations was related to the application of mathematics in ways that relegated other, more local and

personal ways of knowing as less trustworthy. *DFN* exclusively manifested in applications projecting human needs as separate, superior, and even oppositional to the needs of other beings. *Independence* and *Achievement* are different from the other sub-constructs, in their dual tendency towards applications that involve vicarious actions (of self-sufficiency and competitiveness) and the ways they expect students and teachers to relate with each other within the mathematics classroom. Of course, the latter characterization of *Independence* and *Achievement* is the least unique to mathematics curriculum of all the other manifestations. For more details, see *Tables 4.3 to 4.7*.

### **Question Two**

In answering question two, the evaluation framework produced in relation to question one provided was utilized and, in doing so, provided evidence that it is possible to use a quantitative, absolute criterial evaluation framework to identify instantiations of colonialist consciousness. Overall, 431 instantiations were found with at least one instantiation for 33 out of the 34 manifestations. Interestingly, even with a nearly full manifestation of each sub-construct across the curriculum overall, certain sub-constructs were more closely connected to specific curricular elements than others.

In particular, two salient findings, both related to the framework's ability to connect colonialist consciousness' sub-constructs to specific curricular elements help illuminate how colonialist consciousness is replicated itself. First, there was evidence that colonialist consciousness is able to propagate itself fully in curriculum materials without the sub-constructs of *DFN* and *Independence* as explicit or implicit curricular goals/objectives. This, of course, highlights a potential (minimal) feedback loop for colonialist consciousness reproduction: *Humanism*, to *DLP*, to *Achievement*. This should



give pause to curriculums that aim to address colonialist consciousness in subtractive ways, for example, constructivist and student-centered curriculums that reject *Independence* and/or place-based, outdoor curriculums that minimize *DFN*. Instead, this evidences that more radical and comprehensive curricular changes are necessary to resist and refuse colonialist consciousness.

The need for radical change was implied in the subtle and unexpected ways in which colonialist consciousness replicates itself: in the framing of conceptually-oriented pedagogy and application-oriented, “real-world” problems. Of course, conceptually-oriented approaches to mathematics are laudable in comparison to procedural, algorithmic approaches taught in a rote manner. However, this study evidence’s significant issues in relation to what *concepts* are being propagated in these conceptually-oriented approaches to mathematics, beyond a highly visible set of procedures. *Humanism*, for example, largely manifests in the way algebraic properties are conceptually built off of arithmetic and Euclidean geometry, which are taught in an unqualified and universal manner (*dii*) and then applied as a symbolic language whose logical results are treated as universal truths (*ai*). Ironically, a potential amelioration of this problem may start with not going beyond the contextualized nature of arithmetic and Euclidean Geometry (as both draw their epistemic strength from their engagement with particularistic human purposes), but rather dwelling in the particular. In doing so we could put meaningful limits on when and in what ways the symbolic logic of algebra is generative within our limited, human perception of reality.

In addition, this study evidences that “Real world” word problems are mini stories with major metaphysical, cosmological, epistemological, ontological, and axiological

implications. This study evidences 17 manifestations out of 34 in which “real world” word problems manifest colonialist consciousness: *Humanism, bii*; *Humanism, ci*; *Humanism, cii*; *Humanism, dii*; *DLP, ai*; *DLP, bi*; *DLP, bii*; *DLP, cii*; *DFN, ai*; *DFN, aii*; *DFN, bi*; *DFN, bii*; *DFN, ci*; *Ind, aii*; *DFN, aiii*; *Ach, aii*; *Ach, bi*; and *Ach, bii*. Again, although potentially laudable from the perspectives of increasing student engagement or promoting deeper, more context-dependent thinking, this list of manifestation codes does give generative space to reflection for resist, refuse, and re-imagine.

### **Question Three**

Question three’s most salient findings emerged from a comparison of the results of two absolute, criterial qualitative curriculum evaluations. The first set of results emerged from question two’s anti-colonial curriculum evaluation and the other set of findings emerge from a criticalmathematics evaluation framework. This comparison allows for the illumination of the ways in which criticalmathematics must re-conceptualize itself for anti-colonial purposes. Specifically, three key problem areas must be addressed if criticalmathematics is to advance their anti-colonial stance: a) its inability to critique Western mathematics continued relationship to coloniality, b) its inability to illuminate our intertwined ecological and human crises as an ontological, metaphysical, and/or axiological problem, and c) its complicity with *Reform Based Mathematics’* alignment with systems of human stratification.

First, criticalmathematics is unable to illuminate or critique the problematic nature of the metaphysical and epistemological assumptions inherent within Common Core mathematics presentation of conceptual and procedural aspects of mathematics. In

particular, it was evidenced that criticalmathematics needs to reconsider how it uses arithmetic and geometry, which is innately particularistic, to ironically advance universalistic and immutable symbolic, algebraic mathematics. Instead, this study evidences the potential for re-introducing human contexts, human purposes, natural systems, and the needs of other beings as a way to particularize and put limits on the applicability of mathematical conceptualizations and their generalizations in relation to procedural process.

Second, criticalmathematics inadequacies manifest through the kinds of application-oriented word problems used as teaching examples and/or assessment questions. In particular, the evidence related to question three evidenced that criticalmathematics categorically excludes Reform Based, *Real World Applications* from critique due to criticalmathematics' concern for preparing students for high-stakes testing. Of course, the desire of criticalmathematics to address systemic barriers to students' ability to access meaningful work and resources for wellness is admirable. Yet, there is not evidence that criticalmathematics is able to critique *Real World Applications*, many of which, ideologically, advance the very colonial logics that materially affect their students' (and their progenies) life chances and wellbeing. Instead, the findings suggests that beyond deeper engagements with manifestations of settler colonialism's stratifying structures (e.g., systemic racism in relation to school funding and property taxes) via the sub-construct *CCR*, that *Reform Based Mathematics* itself needs to be wholly re-imagined. Through this anti-colonial re-imaging, one could account for students' prior experiences with *RBM* and colonial ideology, but would also have an eye towards otherwise futurities for mathematics and our collective wellbeing.

## **Integration of Findings**

This study has established several novel findings. First, in answering question one there was compelling evidence that mathematics and mathematics education, as related disciplines, are deeply implicated in the genealogical development of Imperialism and settler colonialism in the United States and beyond. Second, the findings presented in this study demonstrate that mathematics curriculum, including those emerging from the Common Core State Standards, propagate colonialist consciousness in substantive and particular ways. Further, this study provided evidence that mathematics, potentially more so than any other discipline, contributes the bulk of colonialist consciousness' metaphysical and epistemological substance. Although the same may be said about science, mathematics and its symbolic logic is rarely, not since O'Halloran's (2005) maverick systemic functional linguistic analysis of mathematical texts, critiqued as problematic. As such, this study's engagement of Grande's (2015) conceptualization of colonialist consciousness has contributed to Grande's (2015) and O'Halloran's (2005) works by providing particular curricular examples that illuminate the fallacy of mathematics' claim to universal, objective, and immutable truths.

Furthermore, this study contributed an empirically based, relational schema for the specification of Grande's (2015) conceptualization of colonialist consciousness in relation to Western mathematics (See Figure 4.1.). In particular, each sub-construct of colonialist consciousness is connected to both i) a branch of philosophy and ii) a positive feedback loop. Further, within Figure 4.1, this positive feedback loop visualized both the process by which colonialist consciousness' non-empirical metaphysics is naturalized (Deloria, 2012) and how a mathematics curriculum may fulfill Euro-American's cultural

needs for power and control (Ani, 1994). Although it may be the case that this empirically-based, relational schema may manifest differently for other disciplines, this study evidenced that Grande's (2015) conceptualization of colonialist consciousness could be generatively specified to a specific content area.

The findings presented in relation to question two provided increased trustworthiness of question one's anti-colonial curriculum evaluation framework, as a generative tool for illuminating colonialist consciousness' manifestations within Western mathematics curriculum. In addition to illuminating particular manifestations of colonial consciousness, the framework illuminated the ways in which these manifestations were instantiated within different curricular components. Further, this study added to the literature base for qualitative absolute criterial curriculum evaluations of mathematics curricula, as it was not only able to analyze application-based word problems, but also conceptually and procedurally oriented pedagogy as well.

Although it was implied in question three that the criticalmathematics and anti-colonial mathematics curriculum frameworks may be mutually illuminating, the illumination was largely uni-directional with the anti-colonial mathematics curriculum evaluation framework being the more generative of the pair. Nonetheless, it must be noted that criticalmathematics, for its part, has a coherent approach to curricula development and curricular critique. Specifically, their laudable approach to conceptualizing curricula integrates mathematical content-based pedagogy (sub-construct *RB*), classroom contexts (sub-construct *SC*), and topics and approaches to inquiry (sub-construct *CCR*) in a highly coherent manner. However, as evidenced, all of criticalmathematics' sub-constructs and sub-categories need to be fundamentally

reconsidered from the perspective of colonialist consciousness. In particular Criticalmathematics' aforementioned subservience to the stratifying structures of *Reform Based Mathematics* must end, while its sociocultural approach to learning must be reconsidered to address settler colonialism.

### **Conclusions and Implications**

The title of Howard Zinn's (2002) autobiography advanced the now often quoted claim that *You Cannot be Neutral on a Moving Train*. This study, in intentionally building from the scholarship of Critical Indigenous scholars and scholars of Color, evidences the desirability to elaborate on Howard Zinn's titular claim, especially in relation to mathematics. To do this it may be helpful to start before the construction of the train. For mathematics built and navigated the settlers' ships, engineered the weaponry necessary for the settlers' to steal Indigenous lands, surveyed the stolen lands into rectangular grids, maximized settler profits from enslavement on reconstituted lands, reinvested settler profits into manufacturing, *engineered the tracks and trains for manufactured goods*, and *mined the coal to power the settlers' train*.

This study, in specifying Grande's (2015) conceptualization of colonialist consciousness constructed a qualitative, absolute criterial, anti-colonial curriculum evaluation framework that can illuminate the specific ways in which mathematics is not neutral with respect to the construction of *settler trains*. Rather, *settler training* starts with the propagation of colonial logics, which as this study evidences are identifiable within mathematics curriculum as specific, describable manifestations that can be organized into function-based clusters. In this section, specific recommendations about how *settler training* may be generatively disrupted, unlearned, and replaced, in relation to

mathematics, is presented for three audiences: textbook developers and policy makers, teachers and teacher educators, and theory-driven evaluators and researchers.

### **Textbook Developers and Policy Makers**

Questions one and two evidence that mathematics curriculum, including those emerging from the Common Core State Standards, propagate colonialist consciousness as a coherent hierarchical, positive feedback loop. As such, textbook developers wishing to work from an anti-colonial stance could potentially provide an important service to a justice-oriented teaching profession. For textbooks offer teachers a potential scope and sequence for a course, pedagogical examples to draw from, and an assessment bank for teachers to inquire about the state of student learning. Of course, one drawback of textbooks, especially mass-produced ones, is their lack of attention to both the specifics of place and the particular goals, social-cultural practices, concerns, and/or perspectives of local communities. However, rather than positioning textbooks as everything, that is, the whole of the curriculum, or as nothing, or as innately oppositional to local and personal concerns, textbooks may be used more generatively. Instead, textbooks, especially ones written from an explicitly anti-colonial stance, could be examined as a potential source of ideas about how one may go about relating to students, from an anti-colonial stance, in a pedagogically and ontologically sound way.

With this spirit in mind, anti-colonial and critical textbook developers and policy makers are encouraged to use the anti-colonial curriculum evaluation framework as a tool for illuminating the ways in which they may need to shift their framing of mathematics, pedagogical approaches and examples, assessments, and application of mathematics. Thus, curriculum developers may find it useful to develop a unit with an anti-colonial

topic and/or pedagogical approach in mind, and to then engage the anti-colonial curriculum evaluation framework as a generative resource. In doing so, they can iteratively try to improve, edit, delete, stop, start, re-imagine, open-up, particularize, and/or pause on a unit or specific aspects of a unit. In many ways, it is not an end, but an ongoing process of being in relation to people, places, and philosophical principles. Policy makers can support this process, materially and institutionally, by making it a requirement for their district's, state's, or nation's adoption of texts in schools.

### **Teachers and Teacher Educators**

While questions one and two evidenced that Common Core mathematics text(book)s propagate colonialist consciousness as a coherent, hierarchical, positive feedback loop, question three evidenced that even critical mathematics propagates the deep, overlapping, and bi-directional aspects of colonialist consciousness' metaphysical, epistemological, and cosmological orientations. Thus, given the critical, philosophical, and mathematical knowledge necessary and the time constraints of K-12 teaching, university-based teacher educators are well positioned to take the lead in anti-colonial shifts in mathematics education research, evaluation, and teaching. Although this anti-colonial work is undoubtedly already occurring amongst teachers and/or community members, teacher educators have an opportunity through their electives and methods courses to begin teaching and learning with future educators about what it means to teach mathematics from an anti-colonial stance. However, even with their relative expertise, this endeavor will necessitate teacher educators to position themselves as co-learners within their own classrooms. This is especially true for White settler teacher educators,



for whom the structures of settler colonialism remain materially beneficial and invisible within their day-to-day experiences.

Thus, teacher educators who wish to advance teaching mathematics from an anti-colonial stance may first want to start by evaluating their own methods course using the anti-colonial mathematics evaluation framework. This may help, as it has for the study's author, to give mathematics teacher educators a lived texture to the manifestations of coloniality within mathematics curriculum. From there, teacher educators may wish to take example lessons from a variety of mathematics curriculums and to evaluate them individually or in collaboration with their preservice and in-service teachers. One may choose to focus on a set of lessons and evaluate it with respect to one sub-construct of colonialist consciousness at a time. Alternatively, and pedagogically more manageable, they may want to collect a smorgasbord of lessons from a variety of sources that seem to best highlight specific manifestations of colonialist consciousness. Of course, all of these are pedagogical decisions that must be decided in relation to the particularities of a course, one's students, and one's own level of understanding.

In addition, teacher educators in their research in schools and communities may want to pilot anti-colonial units that have been vetted collaboratively via this study's evaluation framework. In doing so students, teachers, and community members should be engaged in conversations about student learning, teacher discourse and word problems, classroom environment, and the constraints of K-12 teaching within the settler state. Of course, unease with discussing anti-colonialism and its relationship to, for example, racism and climate change, given the perceived time limitations within the curriculum is often voiced. Rather, than merely minimizing these concerns, they should be elevated as

opportunities to discuss the lived palpability and power of white supremacist, anthropocentric settler colonialism. Thus, when manifestations of colonial power cause material barriers to curricular instantiations of anti-colonial praxis, these barriers must be discussed for mutual illumination, resistance, refusal, and for the potential re-imaging of pedagogical spaces.

### **Theory-driven Researchers and Evaluators**

Questions two's findings evidenced that a trustworthy model for tying seemingly esoteric conceptualizations to concrete, everyday manifestations in existing curricular materials was possible. Thus for theory-driven evaluators and researchers this model is particularly informative, as a reciprocal model of theory production and practice-oriented application. However, while this offers a model for applying complex theories within a qualitative absolute criterial evaluation, it does not sanction its use unequivocally, but rather suggest the need for pausing or stopping some forms of theory-driven research. For example, this study's identification of the purposes of colonialist consciousness' mutually amplifying metaphysical and axiological orientations, that is, material wealth accumulation, indicates the need to pause on the utility of creating theory-driven evaluations and research in relation to such constructs as *problem solving*. Specifically, for what purposes are we solving problems? As this study evidences colonialist consciousness resolves problems related to removing impediments to the accumulation of material wealth, rather than preparing us for a future where our youth can grapple with our intertwined ecological and human calamities. As such, theory-driven evaluators may need to re-examine the metaphysical and axiological assumptions behind their

theorizations and begin re-constructing their theory-driven evaluations using their own specifications of Grande's (2015) conceptualization of colonialist consciousness.

### **Limitations of the Study**

This study's findings aimed to be generative rather than definitive. As noted in the positionality statement, this study was carried out from a particular place, from a socially located person's experiences, and, as evidenced by the author's use of the third person to discuss himself, from within Western cultural onto-epistemology. As such, other anti-colonial scholars may experience the same mathematical curriculum texts differently, and thus, they may interpret, illuminate, and generate different understandings from their experience with the texts. Such thoughtful differences, rather than causing a crisis in relation to inter-rater reliability, are welcomed as generative opportunities for critical, cross-cultural discourse (de Sousa Santos, 2008).

Two considerations may be helpful for those who are considering applying this study's findings beyond English-language, Common-Core-based mathematics curricula within the United States. First, as theorized by Tuck and Yang (2012) even if colonialism's logics are consistent, the manifestations of its structures may vary in relation to the specificity of a place, its flora and fauna, and its people(s). This means that the specific manifestations of colonial logics within mathematics curricula presented herein may vary if a mathematics curriculum is situated outside of an Anglo-settler colony in North America. As such, care should be taken in interpreting the manifestations outside of this context.

Second, *Eureka Math* has a decidedly teacher-centered curriculum, which although is common in Western mathematics, it is not representative of all mathematics

curricula. As noted in this study, care must be taken in not overpraising the rebuffing of *Detachment from Sources of Local and Personal Knowledge*, *Detachment from Nature*, or *Independence* implicit in project based (PBL), critical place-based, and/or more student-centered curriculums, respectively. However, given that these kinds of curricula were not analyzed for this study, the evaluation framework may be missing manifestations that relate, in particular, to these kinds of curriculums.

Finally, out-of-school time, non-profit educational organizations that often have the curricular flexibility ideal for piloting anti-colonial mathematics curricula must also take caution. Specifically, non-profits, especially religious and educational non-profits, have been critical to the expansion of the settler state, the cultural and racial reconstitution of European nationals as White Americans, and the attempted, genocidal erasure of Indigenous peoples and cultures (Saler, 2019). As such, manifestations of coloniality related to non-profits' religious and/or explicitly moralistic, cultural goals might be uniquely necessary. However, the time and independence of non-profits have an appeal worth pursuing, albeit with warranted caution (Samimi, 2010).

### **Recommendations for Future Research**

Based on the findings from this study, there are four proposed avenues for future research. First, the anti-colonial mathematics evaluation framework, which guided the analysis of the curriculum may be used as a blueprint for researching how colonialist consciousness manifests differently within elementary and high school textbooks and even in relationship to other comparable standards based mathematics curriculum. In doing so, trends, such as the hypothesis that *DFN* may manifest strongest in lower grade levels (to aide in the development of a hierarchical schema of being), could help aid in

the construction of empirically-based theorizations of how colonialist consciousness' shape shifts within K-12 curricula. Further, such investigations may help illuminate other manifestations of colonialist logics that do not manifest in relation to the content and content-based pedagogy of middle school mathematics curricula.

Second, the anti-colonial mathematics evaluation framework could be taught to pre-service and in-service teachers whose experiences with learning to teach from an anti-colonial stance could be studied relationally over their professional lifespans. This might help develop a community of learners composed of community members, elders, educators, teacher educators, curriculum developers, and educational leaders who want to promote anti-colonial learning spaces for our youth and communities. Further, in studying our experiences, overtime this community could develop learning protocols, structures, and systems that help anti-colonial educational practitioners not only adapt to the hydra-like shape shifting of coloniality (Patel, 2015), but also actively create otherwise, radical possibilities.

Third, this study could help to construct theoretical and empirical reconsiderations of critical mathematics. In doing so, these reconsiderations could generatively engage critical, social-justice-oriented scholars and educators in mathematics to re-align their energies towards an anti-colonial stance. Although discordance arising from the incommensurability of different sociopolitical projects is to be expected, clarity about the root cause of our existentially threatening circumstances is important and relatively obtainable.

Finally, this anti-colonial evaluation framework could be used as a blueprint for how to research the way colonialist consciousness instantiates itself within other

disciplines' text(book)s, in particular, science. Given that one of the emblematic features of modern Western science is its engagement of mathematics' semiotic systems (O'Halloran, 2005), this study is primed for modification by critical science educators who wish to work from an anti-colonial stance. As mathematics and, to a lesser extent, sciences are both purportedly universal and immutable, such an analysis would also help specify the ways in which science curriculums manifest the sub-constructs of Grande's (2015) colonialist consciousness. In addition, the results of the engagement of both an anti-colonial science and anti-colonial mathematics curriculum evaluation frameworks could be cross illuminating in relation to the different ways that colonial logics manifest in different disciplines.

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