Disability Studies, Multiculturalism and Urban Science Education: A Mixed-Methods Phenomenography of Graduate Student Learning

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ABSTRACT

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Urban and multicultural science teacher education research seeks to educate new science teachers to more fully understand ‘Science-for-all’ and prepare them to effectively navigate urban classrooms. Therefore, to successfully enhance ‘Science-for-all,’ there is a need to address what the labeling (i.e., categorical labeling and/or mislabeling) of students with disabilities means for science teacher education, its research and practice. Consequently, we need more research in this nascent field to ground this claim in evidence rather than speculation, especially as the disproportionality of students of color being placed in special education becomes more prevalent for all disciplines.

This dissertation used a phenomenographic design to study a cohort of graduate students’ conceptualizations of disability and difference as they progressed through the only required diversity course in a science education program at a large, urban university in the American northeast. Twenty-two students within this ‘Science-for-all’ course participated in the study, with a subset of ten that opted into a more in-depth data collection. Data collection included in-depth interviews, a modified Pedagogy of Science Teaching Test (POSTT-DIS), and a Classroom Learning Environment Questionnaire, as well as bi-weekly course reflections and bi-weekly lessons created by the participants. Mixed-methods data analyses addressed to what extent these graduate students embraced a Disability Studies in Education perspective relative to disability and also whether the students developed a critical lens toward difference (i.e., expressed, imagined, and/or imposed variations in human behavior and potential). Further analyses explored
to what extent these theoretical elements transferred into pragmatic applications by the participants, for example in their lesson planning, that addressed disability and difference to provide evidence of their capabilities to bridge theory to practice.

Findings suggest that the course maintained the relatively static conceptualizations about disability held by the participants – the likely contributing factors are explored in more depth, including recommendations for improvement. The data also suggest that while students in this course were able to theorize critically about multicultural issues in urban science education, their capacities to reflect on their pedagogical decisions and plan comprehensive ‘Science-for-all’ classroom learning environments remained disciplinary focused. Thus, rather than emphasizing critical pedagogies that are pertinent for effective and transformative change in science education for diverse populations, the participants remained focused on narrowly defined, content-specific ways of teaching and learning science. Implications for this research include focusing on both the goals and implementations of courses such as this one, attending to the unique case of disability as outside the realm of conceptualizing difference, and attending to graduate students’ needs to help them bridge the divide between theory to practice.
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I start my acknowledgements off with this short excerpt from an adaptation of one of June Jordan’s keynotes that took place at Barnard College in November 2001 to focus others, and myself, on the notion that to acknowledge those that have helped us in the past we must also actively work in the present, to embrace the lives we have now because of such support.

It is with this excerpt in mind that I start in the past and work forward – to work toward the now.

To My Ancestors:
An Ivy League is so far from my roots and I carry you with me, always;

To My Father:
Thank you for teaching me what consistent pride in Self feels like, and my work ethic;

To My Mother:
Thank you for teaching me resilience, and the notion of self-preservation;

To My Brothers:
Thank you for teaching me to find my way, by any means necessary;

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Thank you for teaching me to love myself, and what it means to truly love your students;

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I dedicate this dissertation to you all, as well as to those who are also working toward the mutually constituted goals of changing those realities in the world that deny address-ability and response-ability, to borrow Kelly Oliver’s words. It is because we have hope that we fight.
Chapter I
INTRODUCTION

As Michael Cole has pointed out, education historically (and currently) was used to (1) divide societies across needed labor positions, (2) distribute particular content based on the political economy of that society driven by its ideological/cultural values, (3) instill a hierarchy that sought to mirror society more broadly by emphasizing different cognitive expectations for populations in each level of that hierarchy, and (4) inculcate populations into the cultural expectations of society (2005). As this history of education has exhibited, the ways that the indoctrination process of citizens comes to fruition is dependent on institutional factors that include or exclude, as well as how these factors regulate access to resources and teachers that are by design focused on fostering more critical and equitable education for all students, if that is the larger sociological goal of the nation state. As it were, this was, and remains, the goal of ‘Science-for-all’ in science education research and practice.

While the push for ‘education for all’ as a human right has had significant representation on a global scale (Hodgson, 1998), the enactment of that ideology has had different implications for populations across the world. Some authors have argued that it is misguided by its intentions, which exhibited a lack of care for the capability of all students to engage productively with education and its systems that have developed over time to support inclusion and exclusion (Robeyns, 2006; Tikly & Barrett, 2011). In science education, the inquiry movement had sought to mediate education-for-all beyond merely a human right and, instead, emphasized the need to engage students with the nature and practice of science (NOS) to become scientifically literate at both local and global levels (see, e.g., Abd-El-Khalick et al., 2004). However, this burgeoning ‘Science-for-all’ mantra has been questioned henceforth due to its lack of critical interrogation of
the elements of education that have been historically used to mark difference (and therein social position), limiting access to appropriate and efficacious science education for diverse contexts and students (Basile & Lopez, 2015; Mutegi, 2011; Rodriguez, 2015). In these critiques of ‘Science-for-all’ and ‘education-for-all’ is where we find the crux of this dissertation’s purpose.

The intention of inquiry in science education was to facilitate learning for all students, as seen in its reform documents over the past 50 years in the United States (cf. American Association for the Advancement of Science (AAAS), 1967; 1989; 1993; National Research Council (NRC), 1996; 2011; NGSS Lead States, 2013). Through this push for inquiry learning, science education presented itself as both a means and an end to civic goals (Rudolph, 2014), which could be seen more broadly in human rights initiatives focused on ‘inclusion’ of all citizens in civil society and its projects (Goodley & Runswick-Cole, 2015).

Through their framing of inclusion as a civic goal for all citizens including those with disabilities, Goodley and Runswick-Cole (2015), as well as others (cf. Armstrong & Barton, 1999; Rieser, 2012a), projected a vision for the inclusion of people with disabilities in all educational disciplines as fundamentally a human rights issue. This ideology can be paralleled with John Rudolph’s (2014) request to revisit science education as a means and end for civic goals, one that placed one prominent goal for science teaching and learning as having similar moves in rhetoric toward more critical and equitable education with the aforementioned disability studies theorists. Thus, these two disciplines concurrently articulated the same goal of human rights for all through ‘(Science) education for all.’

Indeed, as this dissertation highlights, this goal is far from its climax and deserves a more thorough research base to enhance science teacher education toward realizing the long-sought goal of a comprehensive and socially just ‘Science-for-all.’ In embarking on a path to analyze the
inadequacies of the ‘Science-for-all’ mantra for inclusion of students labeled or perceived as having disabilities, this dissertation breaks new ground on research not yet done in the field of science education, as well as multicultural teacher education more broadly.

**Rationale for Study**

Historically, disability has been framed within a deficit lens stemming from conceptual perspectives adopted in science and medicine, which then have led to ideologies imposed onto society that remain preoccupied with the perfection of the human body (Herndon, 2011), as well as the efficiency of the human mind (Armstrong, 2013). However, as Linton (1998) argued, the need to flush out the nuances between *impairment* and *disability*, i.e. physiological/psychological challenges and the socially constructed interpretations that support these limitations through lack of critical interrogation, respectively, has yet to fully permeate the social institutions where those labeled with disability are more likely to be discriminated against (e.g., the workplace, schools, social service agencies, etc.). This conception of disability beyond the medical deficiency perspective that has been historically used to denigrate the lived realities of people with disability is crucial for understanding disability (and difference) beyond deficit (Rieser, 2012a), which is fundamental for any truly inclusive educational agenda.

Alternatively, framing disability from more progressive and productive perspectives, such as questions of planning physical space (Titchkosky, 2011), metaphors of difference (Broderick, 2010), and forms of neurodiversity (Armstrong, 2013), consider disability as a form of ‘diversity’ in the aforementioned conceptualizations – enacting a ‘social perspective’ of disability that has transnational support for its pragmatic and philosophical impact in education and the lives of youth as they experience inclusion and exclusion (cf. Danforth & Naraian, 2015; Erevelles, 2011; Shakespeare, 2013). These newer perspectives politicize the access and efficacy
of human rights, as well as what these rights mean for the social institutions that produce citizens of a particular nation state, such as schools. Indeed, coordinating these perspectives with the ‘Science-for-all’ inclusive science education agenda moves beyond the traditional multicultural science education movement that (intentionally or not) has excluded disability as a form of diversity relevant to science teachers and their practice (see, e.g., Atwater, Russell, & Butler, 2013). This then becomes a nascent field of study that needs further inquiry.

This reformation of disability as a valid form of diversity places certain requirements on teacher education. For example, for teachers to meet the goal of a comprehensive form of ‘inclusion’ they must question normalcy in education and the derived practices that have been used to exclude students (cf. Connor, 2011; Davis, 2010). These propositions challenge what we see as a ‘normal’ student and depart from traditionally implemented scientific dichotomies used to justify inclusion and exclusion based on ability/disability (Reiser, 2006b). Scientific and medical perspectives generated from seemingly objective research have been historically based on dichotomies such as subjective/objective, able/disabled, and civilized/primitive, which have led to a Westernized and Anglicized colonization of the body through an unquestioned and normalized perspective (Haraway, 2013). These dichotomatic perspectives have also led to evaluations based on an ‘either/or labeling’ critiqued as detrimental to any educational system focused on building civil societies that challenge lived oppression (Harding, 2010).

In more critical approaches, science, education, medicine, and deficit perspectives of impairment are seen as inter-dependent of each other in terms of the ways people conceptualize their meaning and uses within society. Therefore, the study of disability in science teacher education becomes inherently tied to the inquiry movement for inclusion of all students within the civic ends of scientific literacy (DeBoer, 2000). Moreover, this embodies a reflection of
current studies in critical multicultural science education that emphasize a move toward looking at science and culture through an interdisciplinary lens (e.g., Meyer & Crawford, 2011).

Indeed, this problematization further engages with the discussion of how different certification tracks are used when educating general education teachers (such as science teachers) to separate them from their special education (SPED) counterparts, and the impact that this lack of consideration for students with disabilities can have on the evaluation of these students’ capabilities (Feng & Sass, 2013). This shift toward learning about disability as diversity, and beyond disability as deficit, places one goal of science teacher education research to be focused on how do our teacher-candidates learn about diversity (and therein also disability) within the courses that are asked to serve them in their tenure to become science teachers.

**Purpose of Study**

The purpose of this study was two fold. First, the primary intention was to investigate the extent to which a ‘Science-for-all’ graduate course helped foster more progressive perspectives of disability beyond the curative and deficit lenses used by medicine and special education, respectively. And secondly, this study also investigated the extent to which this same course met its own goals for its students to think more critically about multicultural issues in urban science contexts, as well as to what extent they may be able to bridge these theoretical underpinnings of the course to more pragmatic choices, such as lesson planning, and utilize more critical reflections on their pedagogical choices.

As a recent analysis of the segregation of students of color exhibits, the re-segregation of schools leads to lower achievement for these students and less preparatory courses than their white counterparts (Michelson, 2015). Tying this with the historical and present-day reality of minority students labeled with disabilities being more likely to be placed in self-contained
(segregated) spaces without access to the general education classroom because of their disability labeling (Brock & Schaefer, 2015; Reid & Knight, 2006), emphasizes the need to help teachers grow in their conceptual understanding of these realities.

The racial disproportionality in special education has raised many deep and concerned conversations about its prevalence in the past 20 years (Kincaid & Sullivan, 2016; Patton, 1998; Skiba, Poloni-Staudinger, Simmons, Renae Feggins-Azziz, & Chung, 2005). However, there are counter-arguments that claim no difference in racial disproportionality (e.g., Morgan et al., 2015; 2016). These latter claims of ‘non-disproportionality’ though, through their seemingly objective statistical analyses, lack a thorough representation of both the bias-laden process of disability labeling (Ahram, Fergus, & Noguera, 2011; Dever, Raines, Dowdy, & Hostutler, 2016; Roberts, 2016) and the consequence of this labeling of students in their exclusion from the general education classroom (Cosier, Causton-Theoharis, & Theoharis, 2013; Kurth, Morningstar, & Kozleski, 2014). Indeed, to say the realities of students labeled with disabilities start and end with the labeling process, and can be appropriately defined through a numerical representation of prevalence, is to completely disregard the nature of schools as microcosms of larger social assumptions. This, additionally, denies the history of disability as it has played out in the United States as part of larger eugenic plans, forms of exclusion from citizenry, and acts of blatant exploitation vis-à-vis assumptions on economic dependency (Nielsen, 2012).

More concertedly, as recent reports have shown that at least 25% of teachers hired outright from their certification paths come from graduate education programs (Ingersoll, Merrill, & May, 2014; Strategic Data Project, 2014), the need to study this population and the ways they are learning about disability is pertinent, now more than ever, if this exclusion from general education due to special education labeling (disproportionate or not) is to be mediated by
action rather than speculation. This becomes an additional component of science teacher education as well, if ‘Science-for-all’ and the civic ends of scientific literacy is truly what the goal of science education is working toward, emphasizing the claim that science education has long sought to move beyond training ‘soon-to-be indoctrinated’ scientists (Duschl, 1988).

If science teacher education continues to educate graduate students in ways that disregard disability as a critical component for conceptualizing diversity, then the exclusion of students that are labeled with disabilities (especially, minority students of color) will continue without question. Additionally, if the goals of educating all students toward attaining and being able to use scientific literacy within the ‘Science-for-all’ agenda are placed at the forefront of where science education should progress to, this will never meet its civic ends if there is not a consideration of how students labeled with disabilities are conceptualized as diverse learners that can be leveraged in science classrooms as capable science students. One area of inquiry, then, is the need for more research on how graduate learners grow within their capacities to attend to disability beyond the medical perspectives, how they critically conceptualize difference more broadly to attend to the needs of urban contexts as sites of multicultural realities, and how effective these required diversity courses in science education are at helping these students meet these goals of implementing the theories emphasized in their courses pragmatically for all students. Following suit to this call, the research proposed here investigates this very problem.

**Goals of Study**

This dissertation studied how graduate students’ conceptualized disability, and other forms of difference, within a ‘Science for all’-driven *Urban and Multicultural Science Education* course. In particular, if the goals of multicultural science education (MSE) are focused on inclusion of all students, then the practices graduate students envision adopting to incorporate
science inquiry into their pedagogies should be studied more thoroughly to showcase how such a course influences their conceptualizations and attention to all forms of diversity, including disability. This goal more fully addresses the body of research on needs for science teacher education, and the lack of engagement by multicultural science education researchers to address disability in their articulations of equity and social justice (discussed more thoroughly in the literature review). Moreover, it focuses on a more nuanced understanding of diversity beyond the traditional labels of differences among categories of race, class, gender, and linguistic fluency, and explores a broader perspective of science education reform than primarily couched in the enactment of inquiry pedagogy as a transformative educational agenda.

Utilizing a phenomenographic research design, this dissertation sought to provide an evidence-based account of how the curriculum and pedagogy emphasized in the course influenced these graduate students’ conceptualizations of disability and difference through their capacity to attend to issues that they might face in real life. Phenomenography is “a research method for mapping the qualitatively different ways in which people experience, conceptualize, perceive, and understand various aspects of, and phenomena in, the world around them” (Marton, 1988, p.143). Phenomenography was used to achieve the goal of this study because of its use in higher education to investigate the goals of courses and the actual outcomes found within students’ capacities to attend to particular phenomena. Put more simply, instead of just asking students what they thought about multicultural issues in urban science education, phenomenography in this study instead asked students to pick out elements in a provided scenario that was representative of contexts these students would be required to analyze in their future profession. In doing so, the analysis this methodology took on was highly interpretative and focuses on a second-order type of investigation; in other words, what students pay attention
to is not taken as face-value but rather juxtaposed to what they *did not* pay attention to when analyzing the scenario provided to them. Through this methodology, critical research traditions can also be valued and imported to analyze the avoidances that participants enact by not addressing issues in these scenarios, which then provide evidence of lacking attendance to areas of interest that are pertinent for understanding how participants might make decisions where such issues play out in real life. Given such an interpretative and critical research inquiry, claims were then made about what concepts (and what attributes of those concepts) did and did not get paid attention to, providing evidence for students’ learning based on their capacities to attend to particular phenomena in ways that were aligned with the goals of the course, and those emphasized above in this dissertation’s purpose.
Chapter II

LITERATURE REVIEW

This chapter first introduces the history of educational inclusion and engages the reader with the implications of the inclusion movement for reform in science education. Extending the idea of inclusion further, it then presents the case of disability through the competing perspectives used for research, in particular it focuses on the differences between the material realist and social perspectives of disability to describe the diverse array of conceptualizations of disability within the larger literature base. It then presents the current state of urban and multicultural science teacher education and the place of inclusion for students with disabilities in that literature, the current research for students with disabilities in science education, and the limitations to that research to move the ‘Science-for-all’ agenda forward. Finally, the author presents the conceptual framework used to challenge the barriers that have prevented the engagement with disability studies in science teacher education.

History of Educational Inclusion and Exclusion

The well-known Brown v. Board of Education case that succeeded in desegregating schools has been applauded as the first piece of legislature to start the work of including all students in the American educational system (Kluger, 2011), even while it has been critiqued as an insufficient marker of progress (Ladson-Billings, 2004a). In this landmark step toward inclusion across racial lines, the United States educational system set the stage for future study of how that type of integration would influence the nature of instruction (e.g., Gutierrez, Rymes, & Larson, 1995) and how new identities would be formed through these new and diverse array of interactions (e.g., Akkerman & Bakker, 2011). As a subsequent shift in public education, the multicultural movement sought to “reform the school and other educational institutions so that
students from diverse racial, ethnic, and social-class groups will experience educational equality” (Banks, 1993, p.3). While the changing landscape of the multicultural movement has seemingly led to reforms to be more inclusive of individuals using labels such as difference such as race, gender, religion, sexuality, and disability (Ladson-Billings, 2004b), analyses done at the time for research genres in multicultural education neglected disability and regarded it as a discipline in its own right, justified but outside the purposeful use in an analysis of multicultural education (e.g., Bennett, 2001) – calling for a proverbial ‘separate but equal’ status for disability.

Interestingly, the disability studies in education movement stemmed from legislation riding off the Brown v. Board of Education statute (Lipsky & Gartner, 1997). Disability studies has also been advocated as intimately tied with the implementation of ‘inclusion’ in the United States (Connor, Gabel, Gallagher, & Morton, 2008), directly connected to the analysis of the re-segregation of students of color in American classrooms (Reid & Knight, 2006), and the subsequent categorization of students of color as unable to assume the role of ‘smart’ student because of the disability labeling process and racial prejudice (Leonardo & Broderick, 2011). Indeed, disability and its influence on the inclusion of all students in the United States warrants more than a ‘separate but equal’ role, as well as a greater interrogation than previously studied.

The World Health Organization (2011) provides a concise and poignant remark on ‘inclusive’ education, henceforth referred to as inclusion, and its importance:

Children with disabilities are less likely than children without disabilities to start school and have lower rates of staying and being promoted in school. Children with disabilities should have equal access to quality education, because this is key to human capital formation and their participation in social and economic life. While children with disabilities have historically been educated in separate special schools, inclusive mainstream schools in both urban and rural areas provide a cost-effective way forward. Inclusive education is better able to reach the majority and avoids isolating children with disabilities from their families and communities. (p. 225-226)
Inclusion in this proposition refers to “a child’s right to belong to her/his local mainstream school, to be valued for who s/he is and to be provided with all support s/he needs to thrive” (Rieser, 2012b, p.201). This ideology of inclusion stems from earlier articulations within the multicultural movement that challenge the justifications used for excluding students from learning in mainstream schools across racial and cultural lines (Ferri & Connor, 2005), but as this dissertation shall show, the ideology of inclusion within science education remains stringently aligned with more traditional notions of diversity-to-be-included along lines of racial, gendered, and classist analyses, and less along intersectional analyses that include disability.

Riding on the coattails of the multicultural movement of the 1960’s, disability studies provided a new way to envision disability within existent frameworks of difference. Further analyses done reframed inclusion from a disability studies perspective as an integral part of conceptualizing the purpose of education beyond a material realist perspective solely valuing physical attributes and resources as the largest limitation to inclusion (Allan, 2010). These analyses then further highlighted the intentional disconnection made between traditional labels of social difference (race, class, gender, etc…) and disability. These new analyses, instead, incorporated how disability as a label was insufficient to conceptualize the support needed for actual inclusion of students, paralleling claims that also suggest this ‘naming’ of racial, gendered, and classist labels is insufficient for diversity work in science education (Rivera Maulucci & Mensah, 2015). These rearticulating discourses elaborated on the reality facing disability studies and its place in the multicultural movement, which provides a thorough base for the reader to conceptualize for them self the need for including disability in the multicultural pot, as it were.

Out of a fear of being associated with biological markers that were used by eugenicist paradigms traditionally enacted to justify exclusion for students from diverse backgrounds,
multiculturalists, instead of banding with their disability rights counterparts, completely declared their praxis as separate from, and more relevant than, disability (Erevelles, 2006). This exclusion of disability does not, however, address the realities that teachers face in the classroom and the literature that elaborates on how racial prejudice is intimately connected to the re-segregation of schools for youth of color. Indeed, this literature also neglects the reality of the school-to-prison phenomenon that is prevalent, especially for young Black men (Archer, 2009) and young women of color with disabilities (Annamma, 2013; 2014), while also totally disregarding the relationship that has been recently developed between disability and this pipeline for students of color (see Ben-Moshe, Chapman, & Carey (2014) for an extensive treatment). With the importance of disability studies grounded in the larger multicultural reform movement through the increasingly diverse student population within the United States (see Frey (2011) for a demographic analysis), educating graduate students for the task of meeting the needs of all students is crucial within the larger educational context but also in specific disciplines such as science.

**Inclusion and Educational Reform**

As Broderick, Reid, and Valle (2006) pointed out, the concerns of teachers that value constructivist and democratic teaching and learning in their classrooms vary widely in their conceptualizations of disability studies as a framework to improve inclusion. Their survey responses showcased how the internal concept development of disability beyond deficiency and the medical perspective is a struggle to conceive even for those self-identified as disability scholars. Their findings additionally showcased how some teachers stressed that it is imperative for students to ‘fit into’ the traditional classroom and gain ‘entrance’ to inclusive settings through traditional measures of success, as well as the systemic bureaucracies inhibiting these teachers’
perceived capability to fully include students with disabilities. Through these accounts the narrative of disability as a complex framework and socialized concept is highlighted.

The aforementioned authors describe disability as both conceptually based and then practiced within the classroom as a form of assimilation rather than responsiveness. This complex nature of the conceptualization and implementation of a socially just and civically responsible approach to disability inclusion persisted within the disability studies in education field and challenged the notion of the social perspective of disability versus the material realist perspective advocated within traditional special education (SPED). In particular, integration of a critical race studies and disability studies framework for analyzing personal and institutional prejudice had taken hold to incorporate disability in the larger frame of multiculturalism more thoroughly than previously theorized (Anamma, Connor, & Ferri, 2013). Through these discourses, disability is seen beyond a myopic view and grounds the extant arguments of disability studies and SPED in a broader perspective that address the notion of systemic racism that has plagued equitable public education, as well as the mere nature of inclusion for any marked diversity. Thus, a need for background into why this argument is important more broadly is needed to seed the importance of disability as diversity more thoroughly within other labels of difference.

Anastasiou and Kauffman (2011) advocated for a revisit to the ‘war’ being held on special education at the time by providing support for the pragmatic realities of learning for students with disabilities and the demanding cognitive expectations from inclusive classrooms that the authors considered lacking in the fundamental promise for education to be a social institution that first and foremost ‘did no harm.’ However a point poignantly made by many disability studies in education scholars challenged this claim by focusing on the nature of
categorization and segregation for students labeled with disabilities that were disproportionately in favor of these labeling practices for students of color since the onset of integration in the 1960’s (cf. Artiles, Kozleski, Trent, Osher, & Ortiz, 2010; Ford, 2012). And while this disproportionate representation of minorities in SPED has been challenged based on recent analyses of longitudinal data for the labeling of students (e.g., Morgan et al., 2015; 2016), this research does not address the implications of students being perceived as having disabilities and disciplined based on the deviation from ‘normal’ behavior expectations (Collins, 2011; Watts & Erevelles, 2004) or the ways that students with disabilities from minority backgrounds are disproportionately placed in more restrictive (segregated) environments than their white peers (Sullivan, 2011). At this point, the chapter turns to an expansion on what perspectives influence these practices for general education and SPED teachers.

Disability Perspectives

The material realist perspective focuses on impairment as a deficit in need of resources to be on par with able-bodied people while the social perspective suggests that disability is an identity and form of diversity within both the physical and neurological senses mainly in need of an institutional paradigm change for reform. Tom Shakespeare (2013) provides an alternative and more synthetic view coming from a critical realist tradition where both individual and group dynamics are called into question. Shakespeare advocates for a departure from both the ‘strong’ material realist tradition stemming from medicine and special education, as well as a departure from the ‘strong’ social perspectives nested in more philosophical traditions.

Shakespeare instead focuses on how both personal and institutional barriers are considered important (2013). Indeed, and even more importantly, he responds to that the ways that empirical studies of disability and their influence within social institutions (such as
education) can be used to better the lives of those whose bodies are visibly marked with impairment and those who are labeled with invisible forms of disability such as those disabilities dealing with the mind (Coded as: ADD, Autism, Development Delays, Emotional Disturbances, etc.). This background provides evidence for the claim that integration of students with disability into the mainstream education system is not the same as inclusion for students with disabilities to ‘thrive’ in their quest for learning and self-actualization (Rieser, 2012b), and thus couches the argument being had here to focus on the notion of disability beyond ‘in need of saving’ (Baglieri & Shapiro, 2012) – a call emphasized in a recently acclaimed volume on urban and multicultural education for all when thinking about race, class, and Indigeneity (i.e., Emdin, 2016).

This argument of practical versus philosophical compounds and complements an analysis done by Lous Heshusius in 1989 where she suggested a move beyond the ‘Newtonian mechanistic paradigms’ of special education in the reductionist sense that were, at the time, being replaced for a more holistic view derived from the scientific discoveries in quantum physics where a paradigm of relation was a more descriptive and supported view of reality. In her analysis, Heshusius advocated learning as “understanding relations rather than pieces of knowledge” (1989, p. 425, emphasis in original), which challenged views of education for students labeled with disabilities as well as the ways that they should be educated. This lineage of change in the ways scientific discovery can, and should, influence changes in the way disability can be conceptualized more broadly in special education provided a grounds for studying how this change occurs and what means could be used to produce this end.

Interestingly, Heshusius’s remark on knowledge was later echoed within cognitive science and science education to move beyond the traditional paradigm of conceptual change for learning to integrate more phenomenological (diSessa, 2008), affective (Sinatra & Pintrich,
2003), epistemic (Sinatra, Kienhues, & Hofer, 2014), and socio-cultural (Zembylas, 2005) components. This analysis also emerged parallel to challenges in science education to educate science teachers about inquiry-based and student-centered instruction crucial for educating all students to be scientifically literate (DeBoer, 2000) and emphasizing the civic purpose of science education (Rudolph, 2014). This focus on conceptual change posits that science teacher education, an area of teaching and learning, be changed from learning NOS content to also emphasizing contextual factors of learning – a claim with evidentiary support from the multicultural movement’s influence on research and practice in education.

**Science Teacher Education: Disability, Multiculturalism and Urban Realities**

Science teacher education has had a prominent shift toward inclusive education of all students since the onset of integration in the 1960’s (see above literature referenced in the previous sections). Most recently this includes community-based science teacher education that focuses on how the experience of teaching science education beyond the classroom could influence understandings of science teaching and learning (Calabrese Barton, 2000; Cone, 2012), the generation of multicultural curricula that showcases the nature of heterogeneity in scientific accomplishments throughout the ages (Pringle & McLaughlin, 2014; Suriel & Atwater, 2012), work geared toward emphasizing socio-scientific issues in science education where students’ place in the world is valued (Lee, Chang, Choi, Kim, & Zeidler, 2012; Levinson, 2006; Zeidler, Sadler, Simmons, & Howes, 2005), social-justice frameworks in science education that complement an anti-racist science education which responds to injustices within students’ local communities (Hodson, 2003; Mensah, 2011; Rivera Maulucci, 2013; Rodriguez, 1998), and a culture-based approach to pedagogy within urban settings where the lived realities of the students are brought into the classroom to teach science content (Emdin, 2010; Seiler, 2013).
The discipline however still significantly abides by the tradition of behaviorism that focuses on teacher responses and their physical moves (i.e., Druva & Anderson, 1983; Greene, Lubin, Slater, & Walden, 2013), as well as the preoccupation with cognitive constructivism that emphasizes independent change of teachers’ representations as the primary mechanism for science teacher reform (i.e., Guzzetti, Snyder, Glass, & Gamas, 1993; Yin, Tomita, & Shavelson, 2014). Within this tradition there remains neglect in the consideration of what capacities of attendance are developed, the types of reflective attitudes developed, and the critical nature of socio-cultural phenomena. This is seen most in the study of science teachers and the NOS.

Prominent science teacher education researchers focus on developing sophisticated understandings of the nature of science (NOS) in science teachers (Abd-El-Khalick & Lederman, 2000; Faikhamta, 2013; Hanuscin, Lee, & Akerson, 2011) and inquiry-based pedagogies that have been shown to produce significant effects on student learning when increasing teacher guidance (Furtak, Seidel, Iverson, & Briggs, 2012; Keys & Bryan, 2001; Kirschner, Sweller, & Clark, 2006). This focused reform of science teacher education within a student-centered, inquiry-based scientific literacy, however, has lost the civic values emphasized as crucial in understanding how to use science as a citizen within a nation state (Rudolph, 2014) – it has lost its goal of criticality and therein also its power to influence diverse contexts and students. It is within this reform-based paradigm that we find the limitations of an inclusive ‘Science-for-all.’

This research, moreover, neglects the nature of scientific competency being nested more broadly within episteme, motivation, and affects that influence how the general population interprets and believes science (Sinatra, Kienhues, & Hofer, 2014). Additionally, the vast majority of reform for science teacher education dealing with disability focuses on educating science teachers through the material realist perspective of disability and, rather poignantly,
seeks to mediate the experiences of students with disabilities in science classes through professional development that emphasizes this paradigm. This reform-based agenda for disability through a material realist paradigm is emphasized prominently even while SPED training within this professional development model has been shown insufficient in its efficacy for SPED student achievement (e.g., Feng & Sass, 2013). The question remains: Why maintain this materialist preoccupation in the face of evidence questioning its expected outcomes?

The focus on the pragmatic needs of students to learn science content is grounded in the realities that science teachers face when trying to teach students with disabilities. Through the material realist paradigm for science teacher education, this research advocates for a practice-based approach toward learning ways to engage students with disabilities rather than explicitly challenging the conceptual knowledge that these teachers hold about disability, schooling, and society (therein also disability, multiculturalism and urban science education). Because there has been too little interrogation of the ways disability contributes to exclusion (those often occurring within conversations about race) there are consequently limited ways that teachers think about disability. This includes limited understandings of disability as a social construct and its influence on students’ access and participation in science classrooms resulting from the teacher’s conceptualizations about disability (Boda, In press a). These limiting perspectives are insufficient for a truly inclusive ‘Science-for-all’ goal. This is especially the case if the goal of ‘Science-for-all’ including students with disabilities is limited to recommending how SPED sectors can improve science instruction for these students, without multicultural science education also interrogating this topic.

The most recent studies focused on inclusive ‘Science-for-all’ include professional development to ‘raise awareness’ and adopt ‘inclusive practices’ through multidisciplinary
collaboration (Brusca-Vega, Alexander, & Kamin, 2014; Kirch, Bargerhuff, Cowan, & Wheatly, 2007), adopting more technologically-assistive pedagogies into the science classroom (Bargerhuff, Cowan, & Kirch, 2010; Gomes & Mensah, 2015; Marino, 2010), viewing the impact of inquiry-based activities on achievement for students with disabilities and their attitudes toward science (Mastropieri et al., 2006; Therrien, Taylor, Hosp, Kaldenberg, & Gorsh, 2011), and attending to a more practitioner-based research agenda for meeting the needs of students with disabilities in the science class (McGinnis, 2013). All of this research on science for students with disabilities neglects any explicit goal to challenge and change science teachers’ conceptions about disability before they go into their classrooms, as well as re-conceptualizing courses to more fully realize this goal within teacher educating institutions.

Therefore, it should not be surprising that when surveyed in 2014, science teachers (N = 1,088) felt they had received little to no formal training and felt unprepared to meet the needs of students with disabilities in the K-12 science classroom (Kahn & Lewis, 2014). Compounding on the attitudes and perceptions science teachers come into their classrooms with, even when co-taught with a special education teacher students with disabilities in science classrooms continue to not receive a form of science pedagogy that meet the needs of these students (Moin, Magiera, & Zigmond, 2009). This also corroborates with more recent findings that center the general education teacher as the main disseminator of science knowledge (King-Sears, Brawand, Jenkins, & Preston-Smith, 2014), and the difference in perspectives toward science instruction that occurs between students with and without disabilities (Preston-Smith, 2015). Indeed, science instruction is by design and implementation not meeting these students’ needs.

These accounts of research intervention, and calls for increased science teacher preparation geared toward meeting the needs of all students, echoes past research in urban and
multicultural science teacher education (UMSTE). This inquiry then requires further empirical research on how this re-conceptualization of disability in science teacher education can move beyond a practice-based approach toward an integrative approach for ‘Science-for-all’ that truly emphasizes that all students will be able to learn because of the teacher education provided by the science teacher education research community. In this way, the charge for science education more broadly becomes for us as researchers to start the inquiry process into the courses that we design to meet the needs of our students to fulfill an inclusive ‘Science-for-all.’

Through this paradigm, knowledge production and utility for new science teachers can then be reframed as “conceptualization as a process” (Mortimer, Scott, & El-Hani, 2012, p.231). And thus, this view of learning for teachers is beyond Westernized notions of reason traditionally advocated in the study of changing concepts within science learning (i.e., Posner, Strike, Hewson, & Gertzog, 1982). It is here where disability studies can provide a productive paradigm to study this broad notion of knowledge in the context of research geared toward disability, differences, and conceptual change (CC).

**Conceptual Framework: Medicalization, Culture and Disability**

Disability studies as a field deconstructs the creation of normalcy in the educational perspectives currently lived and used to justify exclusion (Davis, 2010). It also presents medicalization, science, culture, and social institutions as influential to the ways people conceptualize the body and the mind (Davis, 2014), as well as how disability disrupts these conceptualizations to move beyond identity politics (Davis, 2013). Science teacher education research through this re-conceptualization provides a novel paradigm to view conceptual change in UMSTE. Through this paradigm, subjective/objective dualism is challenged and brought to the forefront for discussion. Learning about relations becomes part of the analysis wherein
knowledge and practice become dependent on one another while additionally being interdependent within their construction in society more broadly, thus influencing decisions made in classrooms by teachers, as well as researchers in their own work dealing with multiculturalism and urban science education. This perspective values factors in conceptual change research such as episteme, motivation, and affect that have yet to be systemically analyzed in the field (Sinatra, Kienhues, & Hofer, 2014), or in UMSTE. Using this conceptual framework both complements previous studies emphasizing the nature and practice of science, as well as fill holes in current UMSTE that neglects disability as a diverse construct of exclusion.

The past twenty-five years of more inquiry-based initiatives in science education have presented a research base from which one main conclusion can be made: inquiry is complex and efficacious implementation is not easy (cf. Abd-El-Khalick, Bell, & Lederman, 1998; Anderson, 2002; Brickhouse, 1990; Capps & Crawford, 2013; Crawford, 2007; Lederman, 1999; Welsh, Klopfer, Aikenhead, & Robinson, 1981). Increasingly there has been an inquiry into how this initiative can be fostered through non-conceptual aspects such as ‘culture’, ‘motivation’, ‘worldview’, and ‘values’ with some sort of relationship existing between these seemingly non-conceptual constructs and sophisticated understandings of the nature of science (NOS) (Abd-El-Khalick & Akerson, 2004; Akerson, Buzzelli, & Eastwood, 2012). Indeed, the obsession with the nature of science can be prominently seen in the continued generation of discourse around how to reframe the NOS to fit into student learning and teacher training (cf. Abd-El-Khalick, 2013; Duschl & Grandy, 2013). While an important field for science teacher education, this type of research neglects the work done in multicultural science education, as well as overlooks consideration for students with disabilities in terms of their access to quality science teachers and inclusive contexts designed so they can participate in this type of pedagogy.
As seen from twenty-five years of research and practice, challenging the ‘diversity as deficit’ paradigm has been a complex and inter-disciplinary research endeavor on all fronts (cf. Banks, 1993; Banks & Banks, 2007; Ladson-Billings, 2006; McDowell, 1990; Sleeter & Grant, 1988; 2009). Moreover, the persistence of the metaphor of ‘difference’ in the labeling of deficiency for students from diverse backgrounds remains imperative for future intervention for science teaching, especially in urban settings where racialized forms of culture play a pivotal role (Emdin, 2012; Gil & Levidow, 1987). With this ideology at the forefront for inquiry within traditional labels of difference (i.e., race, class, gender, etc…), what then does this mean for the consistent lack of inquiry into disability as such a label of difference – it is almost as if this field has relinquished (just like the disciplinary fields) the accountability of students labeled with a disability to their special education counterparts: The old adage ‘Out of sight, Out of Mind.’

Whatever the case, the reality remains that when diversity is labeled as deficiency, it done so through means of identifying and diagnosing ‘the Others’ that exist in juxtaposition to the standard white norm (Ladson-Billings & Tate, 1995; Miller, 2016, See also the recent volume in the American Education Research Journal for a trans-disciplinary and trans-national explication of this juxtaposition, AERJ, Volume 53, 2016). Thus, there is a need to conceptualize disability and the perceived capabilities of students that fall into the ranges of categories within that label through a similar juxtaposition that has bred the realities of exclusion for these students (Annamma, Connor, & Ferri, 2013; Broderick & Ne’emen, 2008; Leonardo & Broderick, 2011). This poses an additional research agenda not yet fully implemented in UMSTE and, moreover, this call for such a research inquiry is further supported most prominently when a recent study done with university teacher educators where the majority of participants automatically referred to disability as merely a code for ‘SPED’ and ‘rehabilitation,’ as well as that these teacher
educators attest that disability is often only included in one course, if at all (Cosier & Pearson, 2016). Thus, the need of a place for disability at the proverbial multicultural education and urban science education table is needed, now more than ever, with a rally call being incited against disability’s ‘separate but equal’ status within the research in these fields.

The Place for Disability

Disability, as used henceforth, is used to describe both visible and non-visible cues with consideration across medical, material realist (SPED), and social (Disability studies) perspectives (Davis, 2014), all of which contribute to teachers’ perceptions of students labeled with disabilities (Broderick, Reid, & Valle, 2006). Medical perspectives focus on a curative mentality that sees any type of disability as one that can, and should, be eradicated from human experience as to alleviate social, personal, and economic strain (Rieser, 2012a). This perspective is the most traditional of the three and is pervasive in all forms of media representation of disability. Material realists focus on the immediate resources and limitations that face people with disabilities in their personal, private, and professional lives. They seek to mitigate the limitations set up in the realities that face people with disabilities so as to have them be productive members of the already existent status quo of society (Rieser, 2012a), and assimilate into the ‘normal’ student subject position that is docile, obedient, and valued vis-à-vis their ability to contribute to the economic ends of civil society (Farnen & Sunker, 2016; Nielsen, 2012).

Social perspectives of disability, however, envision disability as diversity – both in the tangible material realist sense and cognitive approaches toward neurologically-based disabilities that emphasize a neurodiversity/neuro-divergent mentality (Armstrong, 2013; see also the upcoming volume by Baker & Leonard, 2017 for a greater elaboration through a NeuroEthical perspective). This paradigm also critiques societal contexts and its institutions that are designed
to exclude rather than include (Titchkosky, 2011). Indeed, when paraphrasing Len Barton, Roger Slee (2010) elaborates on the importance of disability studies in education: “Special Educational Needs was [is] a euphemism for the failure of schools to educate all children” (p.68). While there has been extensive research in the multicultural science teacher education community in terms of traditional labels of difference (i.e., race, gender, economic background, and the like), the inquiry into disability as a marker of difference is not just lacking, it is invisible, and thus indiscernible for graduate students given the non-existent research on this area of inquiry.

Given the substantial inquiry into science teachers’ belief systems concerned with ‘multiculturalism’ over the past twenty years (cf. Akerson, Buzzelli, & Donnelly, 2008; Bianchini & Soloman, 2003; Calabrese Barton, 2000; Cone, 2012; McDaniel, Devi, Crockett, & Atwater, 1995), there remains no substantial model of conceptual development integrating disability as a discernable construct of difference, let alone an inquiry attempting to describe how a lack of critical interrogation of disability may influence pedagogical decisions and lesson planning of science teachers to meet the needs of this population. Through this lack, the ways that we educate graduate students to confront these realities in their future classrooms is relegated to those in special education, which the previous literature showcases that such accountability merely ‘passes the buck’ rather than actually making systemic change that is actionable by these new teachers in their classrooms. And with the current over-representation of students with disability being from diverse racial backgrounds, the call for such a description of learning that occurs within the singular courses used to educate graduate students about multiculturalism and urban science education is more imperative than it has been ever before.

In creating the argument for disability’s place at the multicultural table, this dissertation moves beyond non-conceptual mediators vis-à-vis perceptions of students, toward explanations
and conceptualizations used by teachers for student learning in diverse contexts. This is a relatively nascent field in education, especially involving culture, and let alone disability, as conceptual constructs rather than psychologically defined beliefs. The idea of culture is currently treated outside of the boundaries of cognitive study and relegated to an individualized nature of culture as inter-dependent (Artiles, 2015), neglecting culture as a factor that influences the evolutionary study of learning (Heyes, 2012). Hence, there is a need for more research on graduate student learning, and analysis to inquire about how this learning is fostered, or plainly neglected, within urban and multicultural science education courses. This, then, provides a view into the influence of how disability in attended to with respect to other forms of diversity.

**The Place for Conceptual Change (CC)**

Teacher educators have been calling for more cognitive studies in teacher education for over twenty-five years (cf. Clark, 1986; Floden & Klinzing, 1990; Korthagen & Kessels, 1999) with little attention from the conceptual change in science teacher education field (Schwartz, Shapiro, & Gregory, 2013). What studies have been done involve the efficacy of teachers to implement conceptual change methodologies of learning in the classroom for student conceptual growth (Chen, Brown, Hattie, & Millward, 2012; Rivero, Azcárate, Porlán, Martín del Pozo, & Harres, 2011) or to evaluate ‘effective’ teaching (Aguirre & Haggerty, 1995; Gustafson & Rowell, 1995; Morine-Dershimer, 1993). The current landscape of teacher education in CC research also deals with particular strategies that foster content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), and the type of interventions needed to sustain such practices (Saalbach et al., 2014).

The extant literature of diversity in science teacher education advocates a largely cognitive CC model to study teachers’ development of the concept of ‘diversity’ (cf. Larkin,
2012; Thorley & Stofflett, 1996), or how culture as a performed and produced element plays a role in the teaching and learning of science (Cobern, 1993; 1996). This provides a base from which other CC research on disability can be grounded. This line of inquiry, however, does not sufficiently measure the conceptualizations teachers draw upon in their capacities to discern practice-based scenarios involving disability, how these teachers grow longitudinally in these capacities beyond the medical/material realist perspectives of disability, and what type of teacher education can be used to more efficaciously induce changes in pedagogical decisions and lesson planning for inclusive science education, particularly those designed to include students with disabilities. Indeed, this study of ‘diversity’ as a de-contextualized construct from the realities and theoretical implications that are nuanced in culture as it is practiced in classrooms lacks applicability when studied as a general conceptual construct, as well as falls short when disability is not considered as a discernable construct paid attention to by teachers for their practice in the future, or when thinking about inquiry-based pedagogy in science education.

The study of how graduate students grow in their ability to conceptualize disability beyond deficiency is in need to more holistically analyze how to educate science teachers to meet the needs of diverse populations of students with equitable teaching and learning methods. This remains pertinent to science educators in particular as the nature and practice of science has greatly influenced, and continues to influence, the way that disability is conceptualized in larger society that then becomes performed and produced by science teachers in their classrooms. Science teachers, and school communities more broadly, continue to position students as ‘unable’ to learn science because of their disability marker and their culturally situated behaviors that justify their exclusion (Boda, In press a; Collins, 2003; 2011) and little science education research regards disability as a purposeful site to interrogate difference and exclusion in science
teaching and learning (Jimenez, Browder, Spooner, & Dibiase, 2012). This occurs while ‘disability as a disease to be cured’ is highly pervasive in the ways people conceptualize disability within singular deficit narratives (Broderick & Ne'eman, 2008), and the medicalization argument of disability currently being had along the science-sociological binary in neuroscience (e.g., Kapp, Gillespie-Lynch, Sherman, & Hutman, 2013).

To continue to disregard the influence that society has played on the ways that graduate students conceptualize disability, and then how they professionally practice and perpetuate exclusion because of this (defined or imposed) labeling, limits the scope of understandings that science teacher educators can draw on to educate science teachers efficaciously toward equitable and ethical approaches to science teaching and learning for diverse populations that they may face. This disability studies based conceptual approach to science education emphasizes that in the study of culture through racialized, classist, gendered, etc. lenses, there is a lack of integration for disability as a social marker of both visible and invisible exclusion that has yet to be considered – it relegates disability to those in the medical profession or those ‘specialized’ teachers that are trained to teach those special education students. This is insufficient for a truly inclusive ‘Science for all’ agenda that seeks to address equity issues in science education, as well as the research bases that have not considered disability as a construct that influences the ways teachers perform exclusion in the classroom. To this end, this dissertation fills this gap by inquiring into one such Urban and Multicultural Science Education course, and in doing so provide evidence of the course’s attendance to disability as a construct of diversity.

**Research Questions**

The following research questions were addressed in this dissertation. Specifically, the sub questions labeled a, b, c, etc., will be the focus used in addressing each research question:
1. To what extent does a ‘Science for All’-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?
   a. Do these students showcase significant changes in their choices to enact inquiry-based pedagogy within inclusive science classroom scenarios?
   b. What conceptual understandings of disability do these students exhibit?

2. To what extent did this course help the entire cohort of students embrace a critical lens, and bridge theory to practice?
   a. How did the cohort feel about the course?
   b. What themes emerged from these students' longitudinal reflections of the course?
   c. What discernment patterns emerged from their pedagogical justifications and 'Science-for-all' lesson plans?
Chapter III

METHODOLOGY

Conceptual change (CC) has been advocated as a substantial theory of learning from which science education should be drawing methodological and pragmatic implications (Taber, 2009). Within CC, phenomenographical methodologies are utilized when inquiring about how humans conceptualize experience beyond dualism (Marton & Pang, 2008), while “focussing [sic] on conceptions of specific aspects of reality, i.e. on apprehended (perceived, conceptualized or ‘lived’) contents of thought or experience” (Marton, 1981, p. 189). Therein, the methodology of phenomenography is used to study how peoples’ experiences influence and change their responses to phenomena, and how such discernable responses can be systematically showcased as an outcome space. Phenomenography envisions learning as a relationship between variation across specific dimensions and as a reflection of the structure and organization of awareness (Marton & Pang, 2008). Additionally, as Tight (2015) elaborates in his review of the phenomenographies published since the 1980’s, “phenomenographers operate with the underlying assumption that, for any given phenomenon of interest, there are only a limited number of ways of perceiving, understanding or experiencing it” (p.2). Indeed, as Åkerlind, McKenzie, and Lupton (2014) elaborate:

…understandings and misunderstandings of a disciplinary concept may be understood in terms of which aspects or features of the concept are discerned, or not discerned, in students’ awareness … Awareness of an aspect is indicated by the perception of the potential for variation in that aspect; lack of awareness is indicated by an implicit, taken-for-granted assumption of uniformity in that feature. (p. 231, emphasis in original)

In other words, phenomenographers study the change that happens when concepts are learned. However, not in terms of an individual learning experience, but rather how the perspectives of groups of participants can be used collectively to derive sets of interpretations
that people use based on experiencing a phenomenon. Additionally it leads to an interpretation of how their discernments become representative of the ways the concept can be understood as it manifests in the social contexts where it was experienced. In doing so, the goal of such research is not to affirm ‘right’ answers; but, rather, to measure the learning that occurs as a function of the experiences that students have within instructional environments that are geared toward changing how these students discern elements of the world around them pertaining to a specific area of interest.

In this process, the goal of phenomenography is to outline an ‘outcome space’ that focuses on both categories of description (i.e., what conceptualizations are most attended to) and descriptions of thinking (i.e., how are the participants making sense of this awareness through justification or rationalization) (Marton & Pang, 2008). Thus, phenomenography is effectively used to research how courses are designed to be responsive to concepts that provide a problematization or challenge to participants’ conceptual understandings, because of their experiences with the concept both from their prior experience, as well as those that occur as a function of the course of study itself.

Åkerlind, McKenzie, and Lupton (2014) describe the use of this methodology in three stages: (1) Identification of concepts that are worthy of intensive curriculum design to challenge participants’ conceptual understandings; (2) Using phenomenography to study changes in these participants conceptual understandings of the concepts as a function of the courses that exist to address such learning; (3) Designing pedagogies to address the misunderstandings that are found within step 2 based on the concept of inquiry identified in step 1. This dissertation focuses on step 1 and 2 of this process, and provides a model for step 3 within its implications section. To this end, these findings answer the call by Åkerlind (2012) that claims of the importance of
certain concepts of study are made from empirical evidence, in addition to hypothetical promise.

Phenomenography has been used for the qualitative portions of mixed-methods studies involving an intervention for science teacher educators (Kern, 2013) and pre-service teachers’ conceptions of NOS (Wan, Wong, & Zhan, 2013). However, science teacher educators have not implemented the use of Åkerlind, McKenzie, and Lupton’s (2014) approach to studying course goals for multiculturalism and urban science education in post-secondary contexts, as of yet. This dissertation utilized phenomenographical research to study the concept of disability in a multicultural science education course to observe and describe to what extent the enrolled graduate students developed capacities to critically attend to disability and other forms of difference. For concision, see Appendix A for research question and data alignment.

**Research Design**

Using phenomenography to study how an *Urban and Multicultural Science Education* course meets its goals of fostering criticality, and the extent that students develop attentiveness to think about disability beyond the medical and SPED perspective of disability is described in some detail, because it has not been done previously. Within this research, identification of what Åkerlind, McKenzie, and Lupton (2014) call ‘threshold concepts’ is analyzed through the lens of a problematic concept that involves four attributes: (1) *Troublesome*, (2) *Transformative*, (3) *Integrative*, and (4) *Irreversible*. In other words, there is an assumption that threshold concepts can be used educationally to stimulate conceptual change, and result in new understandings. Such a threshold concept should be one that is difficult to understand by novices (troublesome), can result in a qualitative shift in how the participant perceives the subject in which the concept is nested (transformative), involves the exposing of relationships that were previously unknown by the participant of the subject (integrative), and not likely to be forgotten or disconnected from
a participant’s awareness of the subject and its relationship with the world (irreversible). To attend to the threshold concepts of inquiry within this research, disability was chosen as the focal construct for an in-depth analysis of evidence for research question 1. Furthermore for Question 2, a concurrent analysis focused on other forms of difference in terms of the students’ capacities to think critically; and then pragmatically implement their intention for an inclusive ‘Science-for-all’ agenda in their teaching. This latter research focus is the primary goal for the multicultural course examined in this study; namely, to showcase the extent to which the whole cohort of students was meeting the course’s goals of ‘Science-for-all (summarized in Chapter 2).

Additionally, as shown in the literature review of this dissertation, the idea of ‘disability’ as informed by a disability studies in education (DSE) perspective fulfills the requirements as a threshold concept. Given the ‘science for all’ civic and literacy goals of science education, disability provides a novel perspective from which to build new understandings of how and why some students are excluded from access to inquiry-based pedagogies in the science classroom. Therefore, these students may lack adequate opportunities to build their scientific literacies based on the civic goals proposed by science education.

**General design of the phenomenography.** The in-depth level for the phenomenographic analysis for research question 1 required an interview protocol centered on a trigger scenario, one in which participants are presented with a disciplinary-relevant scenario where they need to apply the threshold concept (disability). In this course, disability was taught along with other concepts such as culture, science, and urbanity. Thus, to assure that participants attended to disability as a marker of difference, and measure their conceptualizations as they changed as a function of the course, the interviews were purposefully designed to elicit a response of how disability was discerned, as discussed below.
A descriptive protocol of incidents in a classroom was presented to each interviewee with individual scenarios of student behavior; and then in a subsequent different scenario a student labeling was presented to provide a context to elicit the interviewee’s interpretations. These scenarios were adapted from two multiple-choice excerpts from a New York State (NYS) teacher certification exam (Students with Disabilities CST; NYS Education Department, 2006), which constituted the first part of the interview protocol for the ten volunteer graduate students (See example in Appendix B). Thereafter, each interviewee was presented with examples of an actual teacher’s response to each scenario where the teacher elaborated on what they would do in the stated context. These teacher responses come from a previous project done for a disability studies in education course. This provided the evidence base for the in-depth analysis used to address research question 1. Continued questioning (probing) was used during the interview to inquire more deeply about the interviewee’s thought process (i.e., why she/he thinks the way they do, and why they said what they said). This was followed with further questions about their personal experiences, as well as any additional ideas from their academic degree program that may have been ‘at-play’ in the scenario and teacher response but were not explicitly addressed.

The interview structure that was used is as follows: one scenario was presented; thereafter, a sample teacher’s response was presented, and finally three questions were asked. These questions pertained to: (1) which of the four concepts (science, culture, disability, urbanity) that were focused on in the course best exemplified the teacher’s response, (2) if the interviewee had any personal experiences that they drew from to make sense of the interaction in the scenario, and (3) what ideas from their degree program that may be appropriate had not been addressed within their discernment of the scenario-response context. The population for both the entire course cohort and the subset of participants for the interview protocol were sixty percent
within science education and forty percent outside of science education, therefore providing a wide range of degree ideas that would be useful for this analysis. This iterative process happened with four scenarios, all involving the same teacher and their different responses to each scenario. Additionally, two different teachers’ responses were used – one for the pre- and another for the post-course interview.

These interview transcripts were then analyzed for categories of description to determine an outcome space and descriptions of thinking that justify the conceptual understandings participants had provided. Figure 3.1 depicts the structure of discernment for the interviewees in order to measure the phenomenographic data, while Figure 3.2 provides the step-wise scenarios that were presented to each interviewee at the beginning and the end of the course (see Appendix B for exact teacher wordings provided to the interviewees). Figure 3.2 scenarios were purposefully sequenced to showcase a ‘disorganized’ student (Mary) then a student’s ‘abnormal behavior ‘Gus.’ Mary is then labeled with a disability and Gus is ‘bullied’ to probe further.

Figure 3.1. Phenomenographic Interview Structure. Participant presented with student behavior and example of teacher’s response, participant discerns the exemplary concept for context (circle 1), asked to reflect on personal experience (circle 2) in reference to the context (circle a), and asked to reflect on their degree program (circle 3) in reference to the context (circle a).

For research question 2, the more general population analysis of the whole cohort was conducted through the collection of the participants’ course-required assignments, which
provided multiple levels of analysis from which both research questions drew. These assignments were also analyzed using the phenomenographic method. These multiple data sources, while straying from the traditional notion of phenomenographic analysis as constituted through interview alone (Åkerlind, 2012), were used to ‘map-out’ a larger-grain analysis of the cohort’s categories of description involving ‘difference’ (broadly defined) and then displaying the cohort’s ways of thinking about these categories for further analysis, as shown to be useful in other phenomenographic educational research (e.g., Boda, In press b).

Figure 3.2. Sequence of Student Behavior Scenarios. Participant is presented each scenario, then the Phenomenographic Interview Structure in Figure 3.1 was implemented, followed by the next scenario and subsequent reiteration of the interview structure.

Setting. The study site was a graduate course in a science education program designed to engage pre-service teachers and education researchers in multicultural issues that affect urban science education, its theory and practice. The professor on record taught this course as he had in the past with only an inclusion of the research measures designed to ‘catch’ the phenomenography of the course, and these measures were only implemented with those students that volunteered to participate in this study. There was no change in the nature of the course
curriculum and pedagogy by the researcher other than the collection of data from the participants. This study took place at a large, urban university in Northeastern U.S.A., and is the sole ‘diversity’ requirement for graduate students in the science education program.

**Participants.** As suggested by Trigwell (2000), phenomenographies require a minimum of ten interview participants and a maximum of twenty-five, with an average number of between fifteen and twenty interviewed participants. This dissertation enlisted 22 out of the 24 students enrolled in the course who supplied their course materials. From among that pool of students, 10 volunteered to participate in the in-depth pre-/post-course phenomenographic interviews. Sixty percent of the entire cohort was from the science education program, while the other 40% were from outside the program – the same proportion was represented within the 10 interviewees.

Students were given a one-page summary of the research design, its requirements beyond the course assignments, and the option to participate in the research. Demographic data were also collected at the time of this petition. For the results of this demographic data collected from the 22 participants see Table 3.1 below. The collection of required course assignments and a post-course classroom learning environment questionnaire were done with all 22 participants of the cohort. The pre-/post-interview took up about 1.5 hours in its entirety outside of class at the beginning and end of the course (about 45 minutes for each interview).

In order to retain the maximum agency of the participants in the self-disclosure process when using identifying preferences, Figures 3.3 and 3.4 represent word clouds, which correspond to the prevalence of the participants’ preferred gender pronoun that they reported and their reported prevalence of self-identified communal groups, respectively. Self-reports were maintained in their exact statements from participants to ensure their agency and ability to respond to their positionality, as suggested by researchers (Rivera Maulucci & Mensah, 2015).
Table 3.1

Demographic Data of All 22 Course Participants in this Research Study

<table>
<thead>
<tr>
<th></th>
<th>Percentage</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Degree Attained</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bachelor’s</td>
<td>77.3%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Master’s</td>
<td>22.7%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Professional Experiences</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In Number of Years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Science Research</td>
<td></td>
<td>.73</td>
<td>1.03</td>
<td>0 – 3</td>
</tr>
<tr>
<td>Education Research</td>
<td></td>
<td>.77</td>
<td>1.47</td>
<td>0 – 5</td>
</tr>
<tr>
<td>Lead K-12 Teacher</td>
<td></td>
<td>1.25</td>
<td>2.00</td>
<td>0 – 3</td>
</tr>
<tr>
<td>K-12 Instructional Aid</td>
<td></td>
<td>.76</td>
<td>.88</td>
<td>0 – 2</td>
</tr>
<tr>
<td>K-12 Class Observation</td>
<td></td>
<td>1.69</td>
<td>2.42</td>
<td>0 – 10</td>
</tr>
<tr>
<td>Educational Background</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(In Number of Courses)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPED\textsuperscript{a} Courses</td>
<td></td>
<td>.91</td>
<td>1.38</td>
<td>0 – 6</td>
</tr>
<tr>
<td>UME\textsuperscript{b} Courses</td>
<td></td>
<td>.36</td>
<td>.88</td>
<td>0 – 4</td>
</tr>
</tbody>
</table>

\textsuperscript{a}SPED refers to special education courses; \textsuperscript{b}UME refers to urban and multicultural education courses.

Figure 3.3. Word Cloud of Participants’ Self-Reported Preferred Gender Pronouns; the size of the font in the figure corresponds with the number of self-reports of this word, N = 22.

Data Collection Methods

The data collection involved a mixed-methods design (Creswell, 2014). A mixed methods approach is a consistent and measurable research method that has been used in other phenomenographic studies of graduate students in education (e.g., Blummer, Watulak, &
Kenton, 2012). See also the discussion in Micari, Light, Calkins, and Streitwieser (2007) for a more in-depth explanation of the importance of mixed methods design in phenomenographic research. All data collected were primarily qualitative as per the tradition and purpose of phenomenographic methods (Tight, 2015).

![Word Cloud](image)

*Figure 3.4. Word Cloud of Participants’ Self-Reported, Self-Identification Communal Group; the size of the font in the figure corresponds with the number of self-reports of this word, N = 22.*

To ensure confidentiality, and to not cause speculation of individual gendered or ethnic interpretations of the findings reported in this dissertation, all participants in this research that are quoted directly are not referenced by a gendered name, instead by a number (Participant 1, 2, 3 …). Moreover, to be as concise as possible, the data collection and analysis are organized under each research question having a specific section describing the data collection and another describing the analysis of this data. In this way, the above section ‘General Design of the Phenomenography’ is then parsed out to describe where each data set was used so that the reader
may have a better grasp of each research question, and the evidence for the sub-questions.

**Research question 1.** To what extent does a ‘Science for All’-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?

The data collected for this research question were two-fold, namely a pre-/post-course multiple-choice questionnaire and a pre-/post-course semi-structured interview that followed a phenomenographic format. To address the in-depth phenomenographic outcome space, an interview protocol was implemented in the first beginning weeks of class and within the last two weeks of class at an outside-of-class location determined by the researcher and participant (research question 1b). This protocol is addressed more thoroughly in the section above titled ‘General Design of the Phenomenography.’ This interview protocol provided the evidence for the phenomenographic outcome space (research question 1b).

Evidence of any changes that occurred in the 10 participants’ inquiry-based pedagogical choices for inclusive science contexts (research question 1a), was obtained by a pedagogy of science teaching test (POSTT; Coburn et al., 2014). It was modified from its original structure to define the context in each of the scenarios provided in the 16 multiple-choice questionnaire centered in the city where the participants were studying (an urban center). It also included a demographic survey of the students portrayed in each scenario. It was purposefully designed to contain a population of students where 33% were labeled with disabilities, indicating an inclusive classroom population.

A short-answer reflection intended to elicit why the participant chose the response they did was also added after every multiple-choice scenario – 16 scenarios and 16 responses for each participant in the pre-course implementation. This second portion of the POSTT measure was used for research question 2c. A different version of the POSTT was modified in the same way
as for question 1a, and was used as a post-course measure with the same number of scenarios and
responses, but with a majority of different disciplinary questions. These measures were
distributed electronically via Qualtrics to all of the 22 participants in the course within the first
two and last two weeks in the course. There were only 10% unanswered scenario reflections
within the pre-course questionnaire and 5% unanswered scenario reflection with the post-course
questionnaire, which is comparatively a high response rate compared to studies in other areas
such as psychology (Baruch, 1999) and health (Morton, Bandara, Robinson, & Carr, 2012).

Moreover, the science content that was used in the original POSTT was designed for
elementary teachers. This was not changed, thus assuring all participants could feasibly interpret
the scenarios without being preoccupied by lacking content knowledge. These modified versions
were aptly named POSTT-DIS, for the incorporation of students with disability labels in their
contexts (see Appendix C for the POSTT-DIS 1). Only the multiple-choice answers, which were
given a numerical coding scheme based on their level of inquiry (Coburn, 2015), were used for
research question 1a.

Three course-required assignments were also collected as evidence of any changes in the
ways these 10 participants conceptualized disability as a form of diversity (in the interviews) and
the cohort more broadly. These were auto-biographical and theoretically-grounded assignments
designed to elicit students’ capacities to critically reflect on their past experiences, the course’s
curriculum, and the ways that they would adopt a multicultural perspective in their future urban
science classrooms. These data sources served as corroborating measures to provide insight into
if, and to what extent, the cohort more broadly was engaging with an interrogation of disability
amongst the other forms of difference being discussed within the course (See the entire syllabus
of this course in Appendix D for a description of these assignments titled ‘Read and Reflect

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Papers’ and ‘Science-for-All Essay’). These additional measures served to support claims made by the author for research question 1b.

**Research question 2.** To what extent did this course help the entire cohort embrace a critical lens, and bridge theory to practice?

The data collected for this research question were three-fold. To address research question 2a, a previously constructed and empirically validated measure was used to gauge how the cohort felt about the learning environment of the course, the Classroom Learning Environment Questionnaire (CLE; McGhee, Lowell, & Lemire, 2007). This measure was collected without any identifiers from the participants during the last day of class, 20 out of the 22 participants completed the measure, representing a 9% non-response rate that is within the acceptable range of missing data. See Appendix E for this measure in its entirety.

To address research question 2b, course-required materials were collected electronically after every other class meeting. These ‘Reading Reactions’ constituted the main data source for this research question. The students were required to respond to question prompts included within the syllabus for each week, while also drawing on the discussions in class and their interpretations of the readings required for that week (see the course syllabus in Appendix D for a more elaborate explanation of the requirements, the readings assigned, and the question prompts). These reflections were collected electronically on Moodle (electronic course platform) and were used to detect any phenomenographic changes throughout the course. These changes were based on the categories of ‘difference’ that were utilized by the cohort as they intersected with their ways of thinking about markers of difference more broadly defined. In essence, this was used to measure the effect of the course on the cohort’s various understandings of ‘difference’ beyond just disability, that were addressed in research question 1.
To address research question 2c, data were collected from three different sources. First, the POSTT-DIS (explained in research question 1 above) was used to address if the entire cohort would change the way they thought about using inquiry-based pedagogical methods within inclusive science contexts. This data collection occurred during the very same time as research question 1a’s data collection. Additionally, the responses from this measure, focusing on the cohort’s justification for these pedagogical decisions, were used to determine to what extent a critical lens was used by the cohorts in making their decisions for scenarios where disability was present. Finally, data were collected every other week, opposite weeks to those for ‘Reading Reactions’ discussed above, wherein students were asked to design ‘Science-for-all’ learning environments within an open-ended questioning lesson-plan structure (see Appendix F for this structure). All of these three measures combined constituted the data set for research question 2c.

**Positionality of the Researcher**

Positionality in this research refers to two different, but complimentary, roles in educational research and society more broadly: (1) Positionality of the researcher when proposing, conducting, analyzing, and reflecting on research; (2) Positionality as a broader socio-cultural construct that is adopted when thinking about the interactions between peoples in a specific community and context that is influenced by cognition and culture, and mediated by multiple levels of societal indoctrination. The first is discussed here, the latter discussed at the beginning of the findings section, where it is needed.

Positionality of the researcher, as Milner (2007) eloquently states, involves four differing levels of engagement with the self, with the Other, and with the system in which both operate upon one another. In terms of ‘researching the self’, I am someone from a mixed ethnic and cultural background that affiliates with an intersectional way of knowing about the world (May,
Moreover, I adopt a queer Mestiza conscientization (Anzaldúa, 2015) for understanding my Self. In other words, I focus on how *between* markers of difference (i.e., between labels of Black and White, in terms of race, for example) exhibit nuanced ways to experience the world, and power dynamics therein. Moreover, because no single label directly constitutes my ‘in-between’ identity, the way I have experienced the world is affected by this position, and therefore I bring this lens to my work. Thus, this positionality influences how I view the data being collected in this research, as well as how I analyze that data to draw out themes in the data sets as interacting patterns of discernment. Indeed, while this does not deny the privilege I can exert from this position, it does complicate it; this is, moreover, especially important to my approach to this work and the analysis of disability that I take for the data.

As all researchers do, I use particular perspectives in the analysis of the data I collect. For the purposes of this research, suffice it to say that I draw on all the perspectives proposed within Chapter 1 on disproportionality as it intersects with race, class, gender, and disability; I also draw on the nature of disability studies perspectives provided in my Conceptual Framework stated in Chapter 2. Put simply, as I read my data I am making sense of it by using multiple frameworks of disability within and outside of education that can be at times competing against one another. Disability, in my reading, is *both* an individual attribute ascribed onto someone as well as an individual attribute one can own as an identity. These perspectives do no imply one is more relevant than the other, but rather that the *realities* of how disability manifests for the individual is a complicated relationship between the Self and the Other, which becomes more complex when placed in context. Disability in this way can be read as something that is imposed and/or owned, these being views that either take an assumptive lean or an inquisitive lean toward the concept of disability. The assumptive lean – the imposition – does not ask how the individual
thinks about them self when thinking about disability, while the inquisitive lean – the owned – makes explicit that when thinking about disability within your Self and Others, we cannot disconnect the personal from the political nature of how disability is constructed and then imposed. Therefore, if participants in this study adopted an assumptive lean about disability without explicitly inquiring about the nature of how concepts such as ‘need’ for the individual may be constituted in collaboration with the individual labeled with a disability, the participant is seen as adopting a negative perspective toward disability because they fundamentally neglect the nature of disability as being constituted and imposed on the individual, denying them agency.

In another explication of my perspectives toward disability, it is both a group marker that can be imposed to talk about a particular demographic as well as a group marker than can be analyzed for its positioning power. In other words, group dynamics that occur in context are influenced by the labels we place on those that we ‘Other’ in relation to our own Self – our own identity and familiarity with the labels we own for our own consciousness. Moreover, as group dynamics play out in context they then produce specific bodies of knowledge about the group labeled as the ‘Other’ – i.e., Whiteness as a group attribute is constructed through a set of ways of knowing about the world in particular systems of logic and then acted on in particular ways that people in a social context are familiar with because of their affiliation with Whiteness as a socially accepted norm. This perspective taken toward disability, like that of racial analyses, focuses on disability as something that is co-constructed through understanding how we have created particular bodies of knowledge about what disability means as an individual and group marker, as well as the assumptions that people use to justify decisions about disability, and those who are marked and/or choose to own this label. Therefore, if participants in this study adopted a generalized perspective for what students may or may not ‘need’ with respect to disability and/or
abnormal behavior, they then lacked explication of the nuances that are produced between
demographic labels such as disability and race, while also holding onto these generalized
assumptions because they avoided to look more intersectionally at the nature of how general
statements of ‘need’ may fail to meet individual ‘need,’ or how these assumptions produce
exclusion in ways that are created by their view of disability as deficit, as in need of saving.

From these standpoints, I find the purpose of my research within a critical theory
tradition that intersects with a constructivist assumption of knowledge production influenced,
and dependent on, a historical materialist ontology of Self, Other, and systems constituting the
world. In other words, I conceive of the world as an on-going (and by design, unequal)
production of value driven by capitalist intentions (historical materialism) that leads to
experiences influencing how we perceive the world as it exists in particular schemas
(constructivism). This reality, thus, mediates how we think and conceive of the world as products
of these matrices of power wherein we make sense of our place in history, our place in present
day, and how we project that positionality into society more broadly creating/upholding power
and privilege (criticality). The way in which this positionality influenced my interpretations of
the data based on the overall themes of this dissertation connected to the literature are elaborated
in the Discussion chapter.

For brevity and concision, the other three components Milner (2007) maps out for
approaching positionality as a researcher (‘researching the self in relation to others,’ ‘engaged
reflection and representation,’ and ‘shifting from self to system’) can be combined in a few short
statements that I adopt as a researcher, which are elaborated on thereafter in practical form:

• I understand, and attend to, the nature of formal academic knowledge production with the
  intent to improve the lives of others (and those who are Othered) through my work;
• I approach research as a fundamentally theory-driven practice that can be utilized to disrupt traditional narratives that denigrate lived realities and deny agency;

• I focus on unspoken assumptions within larger societal structures, which seek to enforce the negative aspects of the previous two points.

Thus, I am a researcher who speaks about ‘unspeakable offenses’ (Erevelles & Minear, 2010) – those ‘indiscernible,’ ‘undesirable,’ and blatantly ‘invisible’ and ‘uncomfortable’ challenges to the status quo that are driven by the conceptual, social, and epistemic modalities of learning through which lived experience and representation is interpreted.

As I have had extensive exposure and interaction with the context of this study before this dissertation, the nature of this research was purposefully chosen as both critical and constructivist so as to inquire about what catalysts for action would be needed to fill the neglect in urban and multicultural science education in terms of disability. In this way, a bricolage method (Kincheloe, 2001) was utilized to exhibit the variations between the ways the researcher analyzed the data and that of others who contributed to his understandings and interpretations of the data collected. In other words, to not solely value a singular perspective as the only way of understanding the data, and to maintain that critical work such as this sits between disciplines, I strive as researcher to both envision multiplicity from the data and obtain multiple viewpoints of my interpretations. This was pragmatically done through the formation of a ‘Perspective Panel.’ Moreover, as an informal teaching assistant within this course, I was asked to lead four of the 15 sessions when the professor was not able to attend. During these sessions, I adopted a pedagogical model similar to the professor’s to maintain a consistent approach, but did engage the participants with thinking more pragmatically about the content of the course.

Discussed below in the Data Analysis section, a panel was formed to provide their
perspective on the data that was collected and contribute to the multiple ways that the data could be connected to the claims made by the researcher of this project. For this reason, it was not useful to try and separate myself (the researcher) from the context of the research. Indeed, seen in the phenomenographic tradition as well as that of critical research, the goal was to emphasize a particular view on the analysis of the data collected, but doing so in such a way so as to also allow for multiple interpretations to be present within the report. In doing so, I adopted a bricolage when I phenomenographically interpreted the main data collection sources for each research question: Interviews in research question 1 and course reflections in research question 2.

Through this lens of *bricolage*, my work makes explicit the need to address issues of power and social construction as elements that constitute meaning in the individual and the culture where s/he is situated – to make evident the need to move beyond a superficial reliance on data as merely ‘as is’ toward data as representing something ‘as it has been constructed.’ Moreover, by adopting this goal, my role as a researcher is not to ‘uncover’ in the positivist sense, nor is it to define a new type of ‘empirical rigor’; rather, my role is to problematize the assumptions laden in normative practices and the ideologies that produce exclusion for those not represented within the larger societal narratives (Rogers, 2012).

Indeed, the act of knowing and positioning one’s self as observer of truth was not the purpose of this analytic process. Rather, as a critical researcher and someone who self-identifies as a bricoleur, the intent of this type of research was to make visible the multiplicities of perspective, but doing so in such as way so as to address power, language, culture, and history as they have played out and contributed to the present socio-cultural contexts of our institutions (Giroux & McLaren, 1986). This was done particularly with an eye toward how disability as a conceptual construct was being interrogated by the students of this course. Thus, in this analytic
step toward emphasizing a multiplicity of perspective and reaching beyond a positivist sense of
objectivism that is advocated in critical qualitative research (Cannella & Steinberg, 2011), the
research of bricoleurs, and I argue also that of phenomenographers,

maintain[s] that this object of inquiry is ontologically complex in that it cannot be
described as an encapsulated entity. In this more open view, the object of inquiry is
always a part of many contexts and processes; it is culturally inscribed and historically
situated. The complex view of the object of inquiry accounts for the historical efforts to
interpret its meaning in the world and how such efforts continue to define its social,
cultural, political, psychological, and educational effects. (Kincheloe, McLaren, &
Steinberg, 2012, p.170)

Given that the nature of this research is on the fringes of new ways of conceptualizing
disability in science education, this option of a ‘Perspective Panel’ was adopted to emphasize
and enact this bricolage. Indeed, following Lincoln, Lynham, and Guba’s (2011) descriptions of
perspectives taken toward qualitative research, as a critical theorist and primary analyst of this
data that was phenomenographically seen through a constructivist lens, the ‘quality’ and rigor of
this process is emphasized through a paradigm of “historical situatedness; erosion of ignorance
and misapprehension ... [and] Trustworthiness and authenticity” (p. 99). In this way, ‘internal
and external validity’ through ‘reliability and objectivity’ are rejected and, instead, the data is
purposefully analyzed through lenses that provide insight beyond these traditional forms of
criteria for ‘goodness’ to emphasize a call to action from this theory-driven process of
interpretation, description, and presentation (Lincoln, Lynham, & Guba, 2011).

Through this process of bricolage, and the adoption of the identity as a bricoleur, this
dissertation emphasized the fundamental nature of phenomenography as an inquiry into
conceptualization as discernment – what is and what is not discerned as pertinent to a particular
narrative being constructed by those participating within the inquiry process. In doing so, it also
embodied the nature of critical praxis in teacher education to look at ideology, practice, and
reflection within the context of such conceptualizations (Arnold, Edwards, Hooley, & Williams, 2012). With these paradigms of research in mind, I present the data analysis process and then subsequently reporting on the findings from this dissertation.

**Data Analysis**

The methods used for data analysis are presented sequentially for each research question.

**Research question 1.** To what extent does a ‘Science for All’-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?

Research question 1a, as stated in Data Collection section above, drew from the POSTT-DIS measure wherein the multiple-choice answers were previously coded along a continuum of four different levels of instruction: (1) Didactic direct; (2) Active direct; (3) Guided inquiry; (4) Open inquiry (Cobern et al., 2014). These numerical metrics were provided by the author of this research (Cobern, 2015) and then applied to the choices made by the ten interviewees (see POSTT Keys 1 and 3 that were used in this research in Appendix G). Given that the data sets from both the entire cohort and the interviewees for the POSTT-DIS pre-/post-course measures were not normally distributed (Shapiro-Wilks test, p < .05), the Wilcoxon-signed-rank test (a non-parametric, repeated measures test; Rey & Neuhäuser, 2011) was used to measure if there was a statistically significant difference in the changes between the interviewees (research question 1a) and the cohort’s (research question 2c) inquiry-based pedagogical decisions. A repeated-measures test was used as some questions were present both in the pre- and post-course POSTT-DIS and therefore, to be conservative, a non-parametric unpaired t-test was not used.

For research question 1b, Wan, Wong, and Zhan’s (2013) phenomenographic method of interview data analysis and Charmaz’s (2014) application of grounded theory were used to analyze the interview data collected. Given that phenomenography is couched in using an
interpretative lens toward data analysis, the interview data were analyzed both grounded in a constant comparative method toward data analysis using an interpretative lens (Fram, 2013) and the open-coding process emphasized in grounded theory (Birks & Mills, 2015). Using both focused and inquisitive approaches during data analysis provided the base from which the categories of description for the threshold concept (disability) could emerge. This was also the method used to analyze the descriptions of thought that the interviewees were using to justify their conceptualizations. This use of multiple theoretical lenses to analyze data, and providing a thick description emphasized by qualitative research as a process that should be implemented throughout the analytic procedure (Freeman, 2014), allowed for insight beyond the singular employment of a data analysis method (such as grounded theory alone). This process has also been highlighted as a fruitful data analytic process to observe multiplicity of interpretation that would not be achievable within a highly specific structuring of data analysis (Berge & Ingerman, 2016). A more detailed description of this process is described below.

First the researcher read all of the interviews for the pre-course interviews multiple times to gain fluency with the data set as a whole. Data set here represents one time-series set of interview data (i.e., only the pre-interviews from the course were coded, then the post-interviews from the course were coded thereafter). Constant comparison of these data sources was then conducted, as suggested within the analysis of qualitative interviews wherein the focus is to generate within and between interview comparisons (Boeije, 2002). Each data set (pre/post) was coded separately so as not to bias the other before final analysis that compares the data sets to one another. As the purpose of this research was to observe any differences in the outcome spaces from pre- to post-course, this method was purposefully employed.

The interviews were openly coded, with a focus coding process of those open codes done
to “compare codes with codes and think about the ones that may be promising tentative categories” (Charmaz, 2014, p.140). An axial coding process was then done to parse out the variations among the interviewees’ focused codes to describe what sub-categories exist within the larger category of the focused code and describe how they were related (Strauss & Corbin, 1998). Finally, following phenomenographic analysis, thematic codes were then generated from the focused codes and the subsequent axial coding process that were used to ‘map-out’ the outcome space for research question 1b.

These final codes represented the themes (categories of description) participants’ used to conceive the threshold concept in question (disability) and how these conceptions vary based on the thought process used to justify these dimensions of knowing (i.e., the variations in the dimensions of thinking participants employed when elaborating on their discernments). This final coding process constituted the ‘outcome space’ for the participant pool and was generated from the pre- and post-course outcomes spaces individually that were essential for the subsequent analysis of the differences between pre-/post-course comparisons. The outcome spaces from each time-series data collection (pre/post) were compared to one another to refine final categories of description and descriptions of thinking within the outcome space that was to be reported. Following the phenomenographic tradition of variation theory as a premise to understanding changes in learning as defined by qualitatively different discernments that can be described through the differences in conceptualization (Tight, 2016), variations between the categories of description for the threshold concept (disability) were also identified.

After this final coding process was done, examples from this outcome space were provided to a panel of stakeholders in education interested in teacher education in two iterations. Both iterations showcased three examples of how the researcher connected the data with his
interpretation, wherein the panelists’ perspectives were recorded to provide multiple perspectives toward the interpretations that the researcher identified and to refine the focal argument.

**Research question 2.** To what extent did this course help the entire cohort embrace a critical lens, and bridge theory to practice?

For research question 2a, the classroom learning environment questionnaire was implemented. The data analysis of this measure follows the sub-scale grouping of questions that was reported by its authors (McGhee, Lowell, & Lemire, 2007), which were produced by principal component factor analysis: Classroom positive (CP), personal negative (PN), diversity values (DV), and persistence in major (PIM). The analysis of this measure took the form of a descriptive quantitative analysis showcasing means and standard errors of all four subscales. This measure was used to elucidate the nature of the learning environment so as to report on the classroom as a context where the other research sub-questions were couched, therein providing a measured description of the setting from the participants’ point of view.

Research question 2b involved a similar data analysis procedure emphasized for the phenomenographic interview analysis as the one in research question 1b. One difference for research question 2b was that eight examples were provided within each iteration of the ‘Perspective Panel’ – constituting at least one analysis of each phenomenographic code. Moreover, due to the sheer amount of data to code (>500 double-spaced pages of text), the coding process of this data set was done using the coding software NVIVO to utilize a constant comparative analysis of the two dimensions of phenomenographic analysis: Categories of Description and Descriptions of Thinking. See Leech and Onwuegbuzie (2011) for an in-depth and step-by-step explanation of this process.

Essentially, as within grounded theory, all text was read multiple times to get a grasp of
the relative nature of the data set and, in following phenomenographic traditions, the specific concept of inquiry (in this case ‘Difference’) was then applied as an interpretative lens through which axial codes could be developed, then collapsing into thematic codes. After these codes were collapsed in their respective nodes (a term used in NVIVO to indicate a theme), the data set was coded all over again to identify patterns in the ways that the participants were thinking. This second round of coding in NVIVO was done without any pre-determined thematic codes as is an option within the NVIVO program. Thus, this reduces a bias toward any particular themes when coding the ways the participants were thinking. These were then collapsed into cases (a term used in NVIVO to indicate a type of pattern). Finally, a matrix query was done (a term used to see the overlapping between nodes and cases, in this process), which identified when a node (a Category of Description) overlapped with a case (a Description of Thinking). This matrix query was used for analyzing the large set of data collected from the participants’ course reflections.

The frequency of each way of thinking within each category of description was counted and entered into an Excel sheet where any relative change in thinking types could be observed. As there were seven total data collection times within the course, the first three were condensed and constitute the ‘1st half of the course,’ while the last three were condensed and constitute the ‘2nd half of the course.’ The fourth, the median point in the course, is presented merely as reference to the other two condensed data sets – as a proverbial temperature check of progression. From this condensation of multiple data collection points, shifts in each category of description in terms of the descriptions of thinking that the respondent used can be described in a time-series description where the 1st half represented a ‘pre-course collection time’ and the 2nd half represented a ‘post-course collection time,’ which are compared based on the frequency of each description of thinking used by the participants within each category of description.
Research question 2c involved the POSTT-DIS analysis that was reported above in research question 1a for the multiple-choice responses. For the short-answer reflective responses in the POSTT-DIS and the lesson plans designed by the participants, a modified scale from Ward and McCotter’s (2004) teacher reflection rubric (the Focus scale) was used to code each reflection (see Appendix H for this scale’s content from the original rubric).

A total of 704 responses could be obtained from the 22 participants who took the 16-scenario measure pre- and post-course POSTT-DIS measure (352 responses for each time of collection). Within the pre-course measure, 335 responses were collected giving a 4.8% missing rate of data. Within the post-course measure, 285 responses were collected giving a 19% missing rate of data. Both levels of missing data are within an acceptable rate for such instruments. Within the lesson plans designed at seven times-series bi-weekly intervals throughout course, 154 lessons were possible to collect. Of those 154, 139 lessons were collected from the 22 participants – a 9.7% missing rate of data, also within an acceptable level of missing data for such an instrument. Both sources were coded with the same rubric; a procedure is listed below.

Two separate raters were given samples of this data to code independently and then three inter-rater reliability values was calculated: Percent agreement, Cohen’s Kappa (Cohen, 1960), and Krippendorff’s Alpha (Hayes & Krippendorff, 2007). Initial values for agreement and reliability estimates were ‘fair’ (Gwet, 2014). However, after a more detailed inquiry into the most prominent categories of disagreement (Technical and Dialogic), and following Krippendorff’s acceptable methods of improving inter-rater reliability estimates after they were calculated (Krippendorff, 2004), these two categories were then collapsed into one category.

These new inter-rater reliability estimates were within a ‘good’ reliability range (Gwet, 2014) from the 175 cases coded by the two raters. They are listed as follows: Percent agreement
= 94.85%; Cohen’s Kappa = .795; Krippendorff’s Alpha = .795. An online calculator was used to calculate these values (Freelon, 2011) in both iterations of this inter-rater reliability procedure. Below in Table 3.2 represents the relationship between the new codes and a familiar coding schema that science educators can relate to; namely, the levels of inquiry (Cobern, 2000). Traditional/routine codes were like structured inquiry: students might be doing ‘hands-on’ investigations but the structure of those investigations and the teacher determined the purpose of them. Reformative codes included students’ input in the design of the structure of the investigation, but the purpose was still entirely determined by the teacher. Finally, representing the goal of the course, critical codes aligned with open inquiry where student input was incorporated both within the structure and purpose of the investigations.

**Table 3.2**

<table>
<thead>
<tr>
<th>Levels of Inquiry-Based Pedagogy</th>
<th>Who determines the … of the classroom</th>
<th>Levels of Reflection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Structure</td>
<td>Purpose</td>
</tr>
<tr>
<td>Structured</td>
<td>Teacher</td>
<td>Teacher</td>
</tr>
<tr>
<td>Guided</td>
<td>Teacher and Students</td>
<td>Teacher</td>
</tr>
<tr>
<td>Open</td>
<td>Teacher and Students</td>
<td>Teacher and Students</td>
</tr>
</tbody>
</table>

**Ethical Considerations**

The ethical concerns for the study involved slight uneasiness for participants during the interview portions but as all the other data collected is required for the course, the vast majority of this study has little ethical concerns for participants. Indeed, as Seidman (2013) points out, the qualitative research interview in social science research is not devoid of ethical concerns for participants and therefore a clear and concise informed consent was used with an additional explanation of the rights of the participants. Also, as this type of research involves extended time...
for the researcher within the setting where the research is taking place, the researcher developed relationships with the participants so as to put the participants at ease and remind them that the goal of the research is not to evaluate them as individuals but rather the cohort as a whole (Åkerlind, McKenzie, & Lupton, 2014).

As the purpose of this research is focused on how to attend to disability, there were expected uncomfortable engagements when participants were faced with this concept. However, as with all work dealing with ‘unspeakable offenses’ (Erevelles & Minear, 2010) and uncomfortable research purposes that focus on the nature of exploitation in society more broadly (Milner, 2007), as a critical researcher I do not shy away from these considerations and rather utilize my relationships that have developed with the participants to leverage a great deal of comfort within the course contexts (and interview process) to provide a safe space for opinion and conceptualization beyond ridicule. Indeed, the purpose of this research was, time and time again, emphasized not on ‘right’ answers but on the participants’ answers, whatever they may be.

Limitations

As in any small population study, the generalizability of the findings is minimal. However, as referenced in the methodology, as this was a critical research project, this was not the purpose and therefore only minimally becomes a limitation in that it does not aim to meet the standards of all research projects in all areas of education. The purpose of this study was not to provide a fully developed experimental design but rather provide a baseline body of research not yet fully considered in science education, teacher education, conceptual change, and the cultural politics of education. In doing so, this study contributes greatly to the literature in these fields.
Chapter IV

FINDINGS

Some definitions and explanations of terminology used throughout this findings chapter are presented first to clarify their use. This is then followed by a short description of ‘positionality’ as used in this research that is used to describe the nature of some of the participant’s responses while discerning certain concepts encountered in the study. Thereafter, the findings are presented for each question sequentially.

On Vocabulary

As described more thoroughly in the Methodology chapter, this was a phenomenographic research study. As such, the focus of this research was on what participants discerned – what they paid attention to and what they did not. Phenomenography values discernment, where the participants’ attendance to particular concepts (without specifically guiding them through their discernment of concepts) was the focus. The nature of the analysis, thus, was not solely on the ‘essence’ of the ways people experience the phenomenon as similar across experiences to define one common theme, and instead focused on differences in conceptualizations (Marton, 1988). Phenomenographers, indeed, actively search for variation among experiences and describe them while also applying a theoretical lens to make sense of the data. In this way, as described in the Methodology chapter, particular vocabulary was used in reporting the findings.

First, the terms ‘discern,’ ‘discernment,’ ‘discerning,’ as explained within the foregoing rationale in the prior paragraph, were all used to describe the differences among the findings (i.e., what did the participants discern and how did they discern the concept under inquiry). Thus, ‘perceptions’ was not used as a word to describe the data reported due to its implication with beliefs in the epistemological sense. Moreover, these participants’ discernments were described
in terms of how a concept being addressed by the participant was ‘constituted’, ‘manifested’, and ‘consecrated.’ These are all vocabulary, again, that focused on the participant’s attendance to how the concept exists based on the participants attendance to the concept during discernment.

For example, a participant might have discerned that disability played the most important role in a scenario presented to them, and therefore envisioned disability to be constituted in a particular way based on their deciphering of what attributes of the concept ‘disability’ were playing out in the scenario and the rationale they provided that justified their attendance to those attributes (i.e., the participant’s category of description and description of thinking for the concept of disability in that scenario, respectively). These two dimensions of analysis in phenomenography were used widely across all the findings: Categories of Description and Description of Thinking. Moreover, they were used as intersections (i.e., when a category of description was justified by a particular way of thinking expressed by the participant). It is through this vernacular that the findings are presented, and with a purpose to attend to the traditions of reporting phenomenography as discernments that describe how concepts are constituted and the justifications used within the thoughts processes of the participants.

Moreover, as this research was not focused on gender differences among participant responses, and did not seek to parse out individualized conceptualizations related to any identity label that was not self-disclosed in the participants’ utterances, the singular ‘they’ was used throughout the findings in recognition of a non-binary form of a singular pronoun beyond the option of she/he as recommended in other research genres (Bodine, 1975; LaScotte, 2016). This was done purposefully to make sure the readers do not provide their own biased lens toward gendered voices. Because ‘positionality’ is an important idea used in the Findings, particular attention is given to defining its meaning as used in this study.
Positionality

Mensah (2012) states “positionality is fundamental to understanding how particular social variables intersect with teacher identity … [and that] positionality refers to how one is socially located (or positioned) in relation to others” (p.126). While located in the work of identity, this working conceptualization of positionality provides a unique pseudo-psychoanalytic perspective toward cognition and conceptual change, as well. In Mensah’s articulation of positionality as a function of how one interacts with the world – and, thus, as the world interacts onto them – with particular mind paid to how one constructs their notion of Self as a role to play within particular contexts, the notion of positionality becomes inherently tied to the cognitive processes that people use to justify their place in comparison to others. Moreover, this is performed within social contexts as a representation of this comparison based on particular expectations that are imposed onto that role from outside societal perspectives of Self in relation to one’s own Self.

Complimentary to this view, Oliver (2001) has written about the notion of subject position and subjectivity in the context of understanding address-ability and response-ability from a similar psychoanalytic framework where socially located subjects are produced through their interactions with cultural representations of various markers of differences. Oliver has also later gone on to talk about the nature of these social locations as constitutions of particular ideological assumptions of value placed by historical design to differentiate and denigrate particular cultures deemed ‘inferior’ within various moments in history (2004). This, therein, affects the social positions through which people conceive them self (their Self) and others (those that are Othered) through the juxtaposition of Self and Other as defined, and separate, entities.

Combining these two perspectives of social location toward teacher identity and subject position, respectively, we find a useful lens to interpret the ways people may justify their
conceptualizations of Others that carry markers of difference beyond their own specific social location. Moreover, as Collins (2003; 2011) and Hatt (2012) empirically find, this social positioning (i.e., the performances that derive from the conceptualizations of one’s Self positionality with respect to an Other’s positionality) influences the cultures that are created in classrooms as a function of some race, class, and (dis)ability positions being valued, and others devalued. Herein, we find that to name positionality is both a description provided by people as a form of self-reflection and self-analysis to know one’s role (and Self), as well as an analytic description of social constructions that marks difference in various and nuanced ways that can be determined beyond the self-reported, self-reflective process emphasized in identity work.

As this research was focused on cognition and conceptual change, the latter definition which provides an analytic description of positionality as it is used by people to make sense of markers of difference is adopted in order to provide a critical lens toward these phenomenographic findings, and make claims about how the participants’ conceptualizations intersect with the ways they are thinking about disability and difference. Thus, this dissertation utilizes this working conceptualization of positionality as a way to make visible the nuanced nature of thinking that the participants use to differentiate between the categories of description that constitute ‘disability’ (research question 1), as well as the categories of description that constitute ‘difference’ more broadly (research question 2).

**Research Question 1**

To what extent does a ‘Science for All’-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?

**Research question 1a.** As a baseline measure, the POSTT-DIS was used to observe if the course affected the participants’ understandings of inclusive contexts as possibly requiring
some fundamentally different pedagogies compared to a general education classroom where guided inquiry would be the penultimate goal for science teachers. A Wilcoxon test indicated no significant difference between the pre- and post-course pedagogical choices for both the ten interviewees as a subset of the cohort and the cohort as a whole (Table 4.3).

Table 4.3

<table>
<thead>
<tr>
<th>Sample</th>
<th>Collection Period</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviewees (N = 10)</td>
<td>Pre-course</td>
<td>3.1</td>
<td>.23</td>
</tr>
<tr>
<td></td>
<td>Post-course</td>
<td>3.2</td>
<td>.36</td>
</tr>
<tr>
<td>Cohort (N = 22)</td>
<td>Pre-course</td>
<td>3.0</td>
<td>.37</td>
</tr>
<tr>
<td></td>
<td>Post-course</td>
<td>3.1</td>
<td>.28</td>
</tr>
</tbody>
</table>

This lack of statistical significance in the differences from pre- to post-course is not surprising because the value of ‘3,’ on the scale for the POSTT-DIS, equates to guided inquiry – one of the professional goals for science instruction within the program where this study took place.

**Research question 1b.** In terms of the phenomenographic outcome space, three categories of description were identified intersecting with four descriptions of thinking, as per the phenomenographic method. Below in Table 4.4, are representative examples from the phenomenographic interview data set of each category of description for the concept of disability so that the reader can concisely interpret the thematic descriptions presented thereafter. Through presenting these examples, the reader should be able to analyze the findings with a greater understanding of what the categories mean within this chapter, and be able to discern the nature of the more finite analysis across the dimensions of thinking used by the participants.

The outcome space for this phenomenographic analysis is also provided in Table 4.5 below, with subsequent explanations of both the categories of description and their intersecting
Within the qualitative analysis of differences between the categories of difference, two variations in conceptualizing disability were identified and are also elaborated below. As almost all of the intersections (except that of ‘Disability as Perception’ and ‘Critical’ justification, shaded in gray in Table 4.5 below) between the categories of description and the descriptions of thinking were present within both the pre- and post-interviews, only the post-interview data are presented in the findings of this research question.

Table 4.4
Representative Samples of Each Category of Description for the Concept ‘Disability’ Collected from the Phenomenographic Interviews with the 10 Subset of Participants in the Course Cohort

<table>
<thead>
<tr>
<th>Categories of Description</th>
<th>Examples of Each Category of Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability as Label</td>
<td>Participant 3 stated: “I say it because it seems like those are some pretty good examples of a kid who has some social/emotional learning deficiencies.” This represented disability as a label, as something the student ‘has’ (i.e., social/emotional deficiencies).</td>
</tr>
<tr>
<td>Disability as Integration</td>
<td>Participant 4 reflected: “There was a student, a couple of students there, that would occasionally display behaviors similar to this but teachers worked together and also created a classroom environment where [pause] like the lessons would still progress even though the students were making noises.” This represented disability as something to assimilate, something to normalize, and to tolerate.</td>
</tr>
<tr>
<td>Disability as Perception</td>
<td>Participant 5 contemplated: “I think that’s a default kind of way of thinking oftentimes when you’re in these urban environment when you’re positioned to internalize all these different ideas about students … is it a matter of context, culture, so I think that teachers should have some way to reframe their ideas about students, particularly in urban schools.” This identified disability as a perception based on bias teachers’ hold, something to problematize.</td>
</tr>
</tbody>
</table>

Among these three categories of description, there were distinct ways in which the participants conceptualized disability. Within the ‘Disability as Label’ category (henceforth referred to as Labeling), a medicalized perspective of disability was employed to justify the notion of impairment as being merely a part of a labeling process that leads to a naming of
impairment as disability. This conceptualization became situated almost entirely in the student, and therefore students labeled with disabilities in this category are conceived of as ‘in need’ of help to cure this impaired state (intra-personal), or this label of disability is determined by the nature of comparison of the individual to others without a labeled disability (inter-personal).

Table 4.5

<table>
<thead>
<tr>
<th>Categories of Description (Disability)</th>
<th>Intra-personal</th>
<th>Inter-personal</th>
<th>Contextual</th>
<th>Critical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disability as Label</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disability as Integration</td>
<td>*</td>
<td>*</td>
<td>Variation 1</td>
<td></td>
</tr>
<tr>
<td>Disability as Perception</td>
<td>*</td>
<td>*</td>
<td>Variation 2</td>
<td></td>
</tr>
</tbody>
</table>

* All intersections (blank spaces) emerged from the data and are elaborated below in their own section

However, within the ‘Disability as Integration’ category (henceforth referred to as Integrating), a more special education perspective was employed to justify the notion that while students have impairments, the nature of disability is such that these impairments can be normalized toward becoming like a non-disabled student in the general education classroom through interaction (inter-personal). It also focused on the attendance to (or lack thereof) places and spaces where disability is constituted (contextual) in hope to achieve ‘normality’ for the student labeled with a disability by assimilating their impairment into a set of tolerated
behaviors/accommodations and having their needs met in spite of their disability (similar to how a non-labeled general education student would need scaffolds).

The two first categories remained fixated with disability within the student (i.e., Labeling) or having students labeled with disabilities become just like their normal and more-able, non-disabled counterparts (i.e., Integrating). However, the third category ‘Disability as Perception’ (henceforth referred to as Perceiving) focused on how the context of where disability is learned and employed can influence the biases that teachers hold about students because of their labels of disability (contextual). This category also focused on the ways that society more broadly constructs disability as a deficit (as the two other categories embody) with consideration for the ways these socio-cultural constructions of disability manifest in assumptive biases of capability, denigration of Self, and outright exclusion (critical). This third category of difference employs *one of many* perspectives of disability coined within Disability Studies.

**Labeling.** In terms of the category of description Labeling, two distinct ways of thinking were identified. The first, intra-personal thinking, placed the focus on disability as a conceptual construct attributed and derived within the individual. The second, inter-personal thinking, placed the focus on disability as an exchange or dialogic process between two or more individuals which led to a constitution of disability through comparison to the ‘normal’ student. As seen below by discernment from Participant 1 when trying to make sense of Mary’s disability label imposed on her in Scenario 3, we find that this Labeling of disability as impairment maintained that there was something wrong with the student, and in attributing this label as fundamental couched in the individual, the goal was to get help for this ‘lacking’ positionality. Even as the claim wavered between a definitive need ‘or not,’ the justification remained solely within the individual student as the producer of disability:
I think again, like this, she’s been labeled emotional unstable and learning disabled so again I would just question that because now I’m starting to see that kind of label possibly just like a mask for someone who is disruptive or you know has something else going on that maybe she does need a co-teacher and an IEP but maybe she doesn’t. (Participant 1)

This is also seen as discerned by Participant 3 when they noted this intra-personal notion of disability as Labeling again in the nature of how disability operates in schools based on the participant’s personal experiences. Through the attribution of disability as labeling (not to be misinterpreted as a comparative contextual analysis) we see that the participant justified disability as individualized, centered in positionalities derived from negative behavior, and as typical of ‘disability’ in that it was abnormal and in need to reform the individual:

I mean I’ve definitely seen teachers you know do their very best to evaluate the whole student. You know there were several examples that you gave this teacher of these specific behaviors that you know to me it sounded like just things that I’ve seen before but I’ve typically seen those things in a special education class. (Participant 3, emphasis in utterance)

Moreover, this notion of disability as intra-personal description became nuanced in that even though disability goes through a Labeling categorization, and was conceptualized as dependent on an individual’s attributes, the nature of whether it was deficit remained within the medicalized notion of whether the impairment was seen as ‘curable’ (i.e., eradicable), as Participant 10 discerns from their personal experiences after discussing Gus’s bullying incident in Scenario 4:

[Have I experienced this?] Not really. Not where they have uncontrollable behaviors. Like I mean we had one kid who had like, who would make movements but it wasn’t really disruptive and people didn’t really mock him so it was different. (Participant 10)

Indeed, this individual attribution of disability as Labeling also manifested within notion of ‘protection’ wherein because of the disability label, and its inherent connection to the individual as unable or proverbial broken, the individual was in need of safety, an attribute that the student
was incapable of reaching alone. Participant 9 discerned this from their experiences in classrooms after discussing Mary’s label of disability in Scenario 3:

I’ve worked in a special education school this semester. I just remembered there was a girl – they were all special ed – but there was a girl that was so sweet and so nice and so respectful and so deferential and everything about her just made me want to take care of her. (Participant 9)

Participant 5 also discerned this protective need in an intra-personal way as a function of Labeling when attending to the teacher’s response to Gus’s bullying scenario:

To me, it almost seemed like she was protecting or trying to also protect him from [pause] like if he has a disability and has troubles, she wanted to protect him from potential negative interactions with students, I think that’s how disability plays a role ‘I have to try to protect this student’ … she could’ve also took that situation in a different way with the student and maybe use it as a teachable moment and try to really address some of the deeper issues with the student but instead she’s just trying to protect the student and put him with the well-behaved student so they [Gus’s bullies] don’t say anything to that student and they don’t hurt that student’s feelings. (Participant 5)

Through these examples we see a consistent attention paid to disability as a Labeling process that spoke to the individual student’s inability, to their deficit, and to their need. This intra-personal thought process was also considered further through the lens of the medical perspective based on the disabled student’s individual ability to hide impairment and therein not exhibit a disability label. This Labeling categorization was also found within another way of thinking exhibited by the participants in the study: “Inter-personal.”

As this Labeling categorization played out in the conceptualizations of the participants, an inter-personal thought process was adopted to justify the construction of disability as in need of cure due to its deficient attribution through comparison with a ‘normal’ student positionality. Within these inter-personal ways of thinking, the participants shifted their relevance to conceptualizing disability as an interactional constitution that occurred between two or more individuals, and thus required something ‘beyond’ the capacities of the individual student to
ameliorate the deficit embodied in a disability label. Participant 3 exemplified this inter-personal thought process when responding to Gus’s “abnormal” behaviors in Scenario 2 as they reflect on their personal experiences, as well as how the role of the teacher is limited by time and skill. Through the justification of need as comparison to other aspects (and students) the teacher must be attentive of, Participant 3 couched disability through a labeling of ‘unteachable’:

I’ve had kids that were similar to this and I don’t know that most teachers have the skill set that’s necessary to manage their class and manage this uncontrollable behavior. There’s just not enough time in the day, you have a finite amount of time as a teacher to get the lesson across and it’s [pause] you have to have interventions and I think that’s what she’s saying. (Participant 3)

More prominently seen throughout the participants as they conceptualized disability as a label that was constituted between people was the notion of disability being part and parcel to diagnostic procedures – as being constituted and defined by an outside expert comparing those being labeled with a disability with those that are not in need of such help. Participant 4 showcased this conceptualization process as they explicitly identified disability as an inter-personal placement of label from outside of the individual student through comparison to those that do not need a label: “disability does get mentioned in there as the official process of diagnosing a student with a disability.” Indeed, Participant 4 further constituted this interactive placement of label when elaborating on their experiences with teachers and the labels of disability that should be applied if and only if the process of diagnostic labeling was done to identify these deficits:

Well I guess [pause] this isn’t reminding me of the teacher’s response but is kind of a counter to this, the opposite I’ve seen is that there’s this group of set students in the high school I was observing and whenever I would [pause] quite a few of the other teachers when I would talk to them would say ‘oh, most of those students need to be on IEPs’ and I was like ‘but, you know there’s not’ [and they would reply] ‘well they’re not officially diagnosed with that but that’s what they need’ just that in contrast to this more thoughtful approach, reminds me again of this just because of its contrast. (Participant 4)
Participant 4 then moved on to identifying, like that of Participant 10 above, disability labeling through the notion of controllable and uncontrollable attributes that were specific to the student. However, Participant 4 included a different justification within their response when Gus is being bullied in Scenario 4 that without the diagnostic process – an inter-personal constitution – required for this conceptualization of disability as a deficiency, disability was not identified:

and disability, I don’t know I might change my mind about that [pause] It doesn’t talk about trying to get him diagnosed but I feel like there is an assumption made that the student can control [pause] their behavior. (Participant 4)

This labeling of disability through comparison to the ‘normal’ child as a procedural constitution of the concept was, finally, considered as an expected process that teachers are required to do, and thus followed the medical perspective of diagnostics to ‘find’ disability, identify it, and cure the impairments that might ‘plague’ the student. Participant 10 exemplified this in recalling their personal experiences after making claims about Mary in Scenario 1:

My own experience as a teacher like when this is happening, where this is what we are supposed to do. Like I’m taught to do this as an employee of the [city’s] public schools. You talk to the guidance counselor, you call home, you have a meeting, you think about if they need to be evaluated for special education. Definitely, this is what we are taught to do as teachers. (Participant 10)

In these readings of disability as label, and therein from a medicalization perspective of impairment, the ways of thinking adopted by the participants (intra- and inter-personal) embodied the curative perspective toward disability. These ways of thinking reinforced the notion that disability was a labeling process, defined either by the impairment constituted within the individual (intra-personal) or constituted by comparison (inter-personal). It was through these discernments that 90% of the participants envisioned disability by the end of the course. However, as we shall see within the ‘Integrating’ category of description, another perspective
toward the special education notion of assimilating impairment to attain ‘normal’ student positionality was concurrently used.

**Integrating.** As stated above, the categorical description of ‘Integrating’ focused on the special education (SPED) perspective of disability where the identification of impairment leads to a label of disability. This category was different from that of the category of Labeling where the purpose was to identify deficiency for intervention as a *curative* solution. Within this Integrating category, the purpose of this categorization of disability was to provide accommodations so that the deficit that was identified as impairment can be *normalized*, rather than (explicitly) cured. Within this Integrating categorization, the student labeled with a disability could (hopefully) embody the positionality of student that was on par with that of the normal student position, and that the impairment (coded as a disability) would be *assimilated* into the general education classroom by the teacher providing accommodations and the students tolerating these modifications to the general education curriculum, pedagogy, and assessment.

Rather than medicalized aid that required eradication of the impairment, the notion defined by the Integrating categorization, then, could (implicitly) consider disability as a *possible* form of difference. This alternative conceptualization of disability entailed a qualitatively different level of discernment illustrative of Variation 1. For instance, within a Labeling categorization the purpose was always to ‘cure,’ but that was not the case (at least in the explicit sense) within the Integrating category of disability. Moving from Labeling to Integrating, for these participants, meant to think about disability beyond explicit notions of cure and, instead, think about disability as something that could be seen as more ‘normal’ in terms of a tolerable form of difference that could occur through accommodation of impairment to participate in the general education classroom. And while this notion of ‘normalizing’ has salient tones of cure
within it, the nuance was that Labeling was not implicit, rather that when disability was labeled it was an explicit and visible semantic component of their conceptualizations as ‘cure.’ This was qualitatively different when participants used integrating to discern disability.

As with the categorization of disability as Labeling, the categorization of Integrating exhibited two distinct ways of thinking: Inter-personal and contextual. Within their inter-personal thinking, like that of the Labeling categorization, disability was considered by the participants as a constitution between two or more people. However, the nature of that constitution within the Integrating category was upheld by the purpose to assimilate students labeled with disabilities into the classroom in ways which would require others to tolerate their disability as a function of the interaction between people – not just the individual being cured of their own impairment by medicine. Participant 1 embodied this conceptualizing of disability when discerning the concept being constituted within Gus’s abnormal behavior in Scenario 2:

I mean I guess screaming episodes in the middle of class would be disruptive. So now after taking this class I feel like disrupting your class a little is fine so, I don’t know, maybe that’s okay. But again, I feel like we’re going to disability because she’s thinking like [pause] I mean it sounds like something is [pause] you know, he’s got a lot of noises going on, so maybe that is some sort of disability or Tourette’s or I don’t know what. So I would go with disability - and then she talks again about getting the parents and guidance counselor involved, did she say parents here? (Participant 1, emphasis in utterance)

This participant’s conceptualization remained grounded in the purpose to integrate the student into the general classroom structure in ways that would normalize this particular student’s perceived impairment (‘disruption’ and ‘noises’) with attention paid to outside sources (i.e., parents and guidance). Participant 1 further highlighted this conceptualization of disability as an interaction between people with the purpose of integrating after their description of Gus’s abnormal behavior in Scenario 2. While referencing their personal experiences, and ideas from their degree that pertained to the scenario, Participant 1 stated:
Well I think I told you last time that I have a brother who sounds like this and as a sister it’s really [pause] he’s a hard brother to have because everywhere we went he was disrupting things and he ended up going to a boarding school for his specific learning needs and then he integrated into a local school when he was in 5th grade and you know I think he really was not in regular classes, I think he had a integrated homeroom and then went off to segregated classrooms and then he still had lunch in the main cafeteria and integrated [again] then. So I really think about him when I think about this to sort of say you know some things people do to be disruptive are kind of fun and some are ‘oh, I wish I didn’t have to do that but I’m doing that’ … I am trying to think more in terms of like if someone is like that, if it could possibly work, if the class could possibly absorb that distraction and move on, you know is it possible to keep him engaged in that classroom, I think that would be the goal. (Participant 1)

With lingering notions of contextual factors that would influence the nature of how disability was conceptualized as Integrating, Participant 1’s response represented the fringe between inter-personal and contextual ways of thinking. It is through this conceptualization where disability was focused on in terms of the purpose to assimilate the ‘disabled’ student into the ‘normal’ classroom positionality, with ‘normal’ student interactions emphasized as the exemplar. The participant remained focused on the tolerating factor that would involve other students and the goal to ‘keep him engaged’ in similar ways as the other ‘normal’ students.

Indeed, this Integrating conceptualization of disability was further complicated by the notion that, through inter-personal interactions, impairment (and therein a departure from an expectation of ‘normal’) was defined and identified through the comparison to that ‘normal’ student positionality. Thus, there was an emphasis on the purpose of this conceptualization to assimilate the ‘disabled’ positionality into a ‘normal’ positionality. Participant 8 discerned this Integrating conceptualization within a special education perspective, and its inter-personal reliance, when relating Scenario 4 of Gus being bullied by his classmates with their own personal experiences, focusing on the purpose of assimilation:

I mean I really feel like she has to talk to those other students about it because Gus is part of the school culture and part of the class so yeah again I don’t have any real personal experiences with a student [pause] because Gus has [pause] Does Gus have an IEP?
Researcher: No, nothing like that was said. Ok, so then he’s just part of the class and the students are just being distracted by whatever Gus is doing and need to be talked to. But kids [pause] yeah I don’t really know what Gus’s situation is. (Participant 8)

Highlighted in this conceptualization was the notion of assimilating the impairment exhibited by Gus, thus constituting disability only when students bring attention to this deficit. Subsequently, this utterance exemplified a strong reliance on special education, first and foremost to make sense of the “abnormal” behavior that Gus exhibited. This conceptualization then transitioned to trying to conceptualize the impairment beyond Gus to emphasize the integration of Gus into the ‘normal’ positionalities within the class. However, the participant then retreated to locating disability as still constituted through Gus’s interactions. This, then, constituted disability through the original interpersonal justification that Gus does or does not have an impairment to normalize through SPED accommodations provided by an outside source – the individual education plan (IEP).

Participant 4 shared these same interpersonal constitutions of disability as a way to emphasize Integrating students labeled with disabilities into a ‘normal’ student positionality. This arose when Participant 4 was speaking about an “inclusive” classroom that they had experienced first-hand, subsequent to reading Scenario 2 with Gus’s abnormal behavior:

Sometimes a couple students would start tantrums in the class and [pause] and even in those scenarios they had a system worked out with the student so they could say you know ‘hey I feel like your behavior is approaching this and I would really like it if you could bring it down to here’. So they had quick personal communications that had already been worked out in like longer talking processes and then they also [pause] so they also address it but then get back to the general classroom. And the way that the [general education] students, seeing the way that their teachers also included these students, they did not seem to be disrupted by it. (Participant 4)

Here we still find that Integrating was the foremost purpose of describing disability. In particular, this conceptualization did not depart from an inter-personal constitution. This utterance stills
emphasized how the interactions between parties contributed to the constitution of disability as an Integrating purpose – the students were seen as contributing parties to assimilating and normalizing disability into the general education ‘way of doing things.’ Departing from this inter-personal justification for the integrating constitution of disability, contextual descriptions of thinking were also prominent in the evidence gained from the participants.

Within their contextual thinking, participants exhibited the notion that place and space were important components when thinking about how disability was constituted. Participant 8, below, after Mary had received a SPED label in Scenario 3, discerned that disability would be applied no matter the context. Moreover, through the special education perspective the participant focused on that the impairment related to disability plays out through the integration, or lack thereof, of those students labeled with the disability. In this utterance, Participant 3 exemplified how Integrating disability was fundamental to understanding disability, but also that contextual factors of exclusion (in their experience) were the ‘norm,’ emphasizing that no matter the context, disability existed and therefore could be understood in this way:

This scenario is sounds like she’s talking about disability. ‘If she has an IEP this student’ [pause] the teacher is putting a lot of responsibility on the special education teacher. So whether it’s a self-contained or inclusive class she’s saying that the special education teacher should be getting her the work, the student the work, and maybe helping trying to figure out how to control her and calm her down and to transition properly. So it seems the teacher is putting this in the disability category because of how much emphasis and responsibility she’s putting on the special education teacher … I mean [pause] again growing up in my school we were, students who did not have IEPs were very very much separated from students that did have IEPs so there was not a lot of mingling in between. So if a student had an IEP they would rarely be in classes with students that didn’t have IEPs so they rarely rarely ever saw each other, it was very segregated in our school, the way that we were taught. And so this reminds me of that because it just seems like the content teacher don’t really know or aren’t trained or aren’t really sure what to do with students who aren’t ‘normal’ students. (Participant 3)

Along similar lines of contextual thinking emphasized above by Participant 3, Participant 7 discerned from their personal experiences that emerged after Scenario 3 when Mary was labeled
with a disability that disability, indeed, exists devoid of context. As shown below, Participant 7 elaborated on the notion that disability can be accommodated to ‘normalize’ the impairments that exist within the student. However, they are dependent on a separate context and set of skills that could only be provided through a special education perspective of disability.

Again that student teaching placement, that was an ICT class and we did have a special education teacher but they weren’t really [pause] it was kind of weird because they didn’t really plan together. She [the special education teacher] would just be in the class and offer support but not necessarily be super involved and for a lot of things. They would pull the students out – like if they were doing labs – they would pull the students that needed that extra support out of the class so it reminds me of that.

Researcher: When they pulled them out of the class, did they still do the labs?
Yeah they did [pause] so it was kind of weird because they would make it sound like ‘oh we’re choosing different groups’ but they were pulling the students that had IEP’s out of the class and then they’ll bring them into another setting and then they’ll work with the special education teacher for those labs. But I don’t think that was beneficial because sometimes she just didn’t know, like the content, so she would run to the classroom and ask questions so I feel like the students were missing out on that a bit.

Researcher: So, the only students that were pulled were students with IEP’s?
Yeah, that needed that extra support.
Researcher: Did the general education students ever say anything about that?
No, they were kind of accustomed to it because they always knew and they had a list and they would call them out and they knew that they were going to separate the class so they were [pause] it was normal to them to just be separated like that. It was interesting.

(Participant 7)

Interestingly, through this utterance, Participant 7 exemplified the notion that exclusion was not ‘beneficial’ because of the lack of students interacting with the general education teacher who is fluent in science. However, Participant 7 remained confident that these students ‘needed that extra support.’ In this way, disability as Integrating represented the special education perspective in that sometimes, and for some students, exclusion from participation in the general education classroom was not only necessary, but common practice in the nature of schooling – an inevitability for these students. This justification provided outright support for exclusion, even as it categorized disability as normalize-able – accommodation took precedence over participation.
Indeed, this notion of inclusion or exclusion (‘of context’) constituting disability as a conceptual construct, particularly one that was used for Integrating students labeled with disabilities into a general education curriculum, was also apparent when Participant 5 was discerning Scenario 3 after Mary receives a formal disability label. Consequently, as Participant 5 reflected on their personal experiences, context remained a prominent influencing factor for conceptualizing disability:

She immediately thought about a self-contained classroom or an inclusive classroom, which oftentimes is the setting in which special education students with disabilities are instructed. She also talked about trying to formulate a plan, which I don’t think is bad to have individual plans for your students but I think a lot of that stems from the idea of her having this disability, they decided that she was incapable of receiving what other students were receiving because of the disability the student was diagnosed with … Like sometimes I would remember my own teaching practice where I would have to be careful about comparing a student with a disability to another student who I felt was more normal and so like a lot of times that happened in my first year like ‘fresh experience’, not really an expert in the field and so the language around how I would talk about different students would be very tricky because even though a student may have a disability it doesn’t mean they’re not a normal student and so you have to careful about the words you use and I think similar situations have helped me think about that. (Participant 5)

Through Participant 5’s elaboration of how disability was constituted through context as an Integrating process, they also attended to how experiences within these contexts influenced this conceptualization of students beyond the ‘norm,’ and the students’ positionalities because of that comparison. It was here where the line between the categories of Integrating and Perceiving were less finite, and from this utterance we found a bridge to present the difference between Integrating as a special education perspective of disability and Perceiving as a step toward one of many perspectives that are used in ‘Disability Studies’ toward the concept of disability.

**Perceiving.** Just as with the other two categories of description for disability, Perceiving also had two district ways of thinking that justified its conceptualizations; i.e., contextual and critical. Like that of the Integrating category, Perceiving utilized a contextual frame from which
to view disability as a conceptual construct. Here, however, disability as Perceiving in the contextual sense moved beyond conceiving of disability as impairment to ‘normalize’ and, instead, emphasized the need to interrogate context through the ways that experiences within particular spaces may dictate perceptions of students who are labeled with disabilities. This became the fundamental difference in the way that these participants conceptualized disability.

This second Variation moving from Integrating to Perceiving was qualitatively different in that the focus was no longer on the positionality of the student in comparison to the ‘norm’ (Integrating and Inter-personal), nor was the focus on how to tolerate and accommodate the plight of an impairment through a ‘separate but equal’ instructional model for students with disabilities (Integrating and Contextual). Rather, in Perceiving, participants conceived of disability as a conceptual construct constituted through bias that stemmed from the assumed positionalities of students (and teachers) in particular contexts (Perceiving and Contextual). Moreover, the participants also viewed disability as a conceptual construct that can elicit particular ways of viewing hierarchies of value within classrooms, and the assumptions of appropriate positionalities therein (Perceiving and Critical).

An emphasis of context was focused on in conceptualizing disability as a perceptual quality that fostered assumed positionalities of students and teachers. Participant 6 elaborated on their personal experience after Scenario 1 where Mary was presented as a disorganized student, which represented the intersection of contextual thinking and the perceptual quality of disability:

I would have to say that for student teaching, like now that I’ve been a student teacher and this is the first time I’ve ever been with another teacher in the same room. I remember that most of the ways that she reacted to students who behaved this way was just assuming that something was wrong and, I mean she assumed something was wrong as if there was something wrong with at home or the student had something or just [pause] or just trying to involve people who are higher up as basically as quickly as possible. Where for me it was ‘ok, maybe just the student was like just that day he just had a bad day’. The teacher did mention this but I think what I’m trying to say is
sometimes we [pause] at least my cooperating teacher was really quick to make assumptions … Well, at least from my degree program, for me [pause] I don’t know, for me it’s really hard thinking about what my degree program has made me think about other things here because to be honest when I was in class and when they were talking about classroom management and just, or disability, or any point, I wouldn’t really agree with what the degree program said. For example, if a student is acting out you have to immediately control it and control the student and I really don’t agree with that. I don’t know, I just don’t see [pause] I think I’m a little bit more [pause] Like I think I let things slide more which is in contrast to my program where they teach ‘oh, no, you have to have a set of structures in place otherwise the students are never going to listen to you or you’re never going to have them on task or whatever’. So, for me, I don’t know. (Participant 6)

In their explication of the contextual factors that have influenced their conceptualizations of disability as a form of Perceiving, Participant 6 used context as a way to make sense of how different places have constituted disability – compounded onto inter-personal interactions.

Particular emphasis was also placed on ways of describing disability that did not interrogate how assumptions were being produced and disseminated because of how these spaces constituted disability as inherently tied to deficit in comparison to the ‘norm.’ This differed from an Integrating conceptualization. The focus, instead, was not on assimilating disability to reach the norm, but rather the purpose was to think about how disability was constructed due to these contextual factors – to perceive disability as dependent on the contexts that produce its nature.

Participant 6 went on to elaborate further on disability in this category after Scenario 3 when Mary received a disability label. This categorization constituted how people should perceive the concept of disability vis-à-vis ‘abnormal’/’normal’ positionalities imposed onto students. This conceptualization of disability was then adopted by Participant 6 based on their experiences in particular contexts where the Perceiving of disability was impactful:

Well since I’m seeing IEP in here, I’m just going to say disability because IEP like at least for what I [pause] at least from my student teaching experience and just working in schools previously whenever I hear IEP normally everyone just thinks about disabled or like the student is just deficient in some way. They’re not [pause] it’s not even different it’s maybe just the schools. (Participant 6)
Indeed, following this utterance, Participant 6 elaborated on some personal experiences and the nature of their academic degree where the participant discerned the nature of the context where the concept of disability was learned as influential to more practical moves that would be performed by teachers due to this conceptualization:

Whenever I hear differentiation I always think when teachers say differentiation, and even my own peers when they made us do our lesson plans and they said how are you going to differentiate. Basically what we did was try to find some source that says ‘well, this is what differentiation is and for these students these are the categories of things you could do’ but a lot of the times we didn’t understand what does this even mean, is it that this, let’s say for example for a student that has [pause] what would they say on an IEP [pause] problems with skills acquisition, they would say that the differentiation could be that you have to start with the student modeling what you’re going to do, the activity for that day, but then it just says that. And it does seem pretty specific but when you do it in practice you see the differentiation really isn’t there because a lot of times the student is just like ‘okay? I saw it and I did it, but I’m not understanding what’s going on’ and even if we did the differentiation, and even sometimes we think ok we see it, but are we actually learning how to do it well or are we actually [pause] or is this just some generic thing that someone says that really doesn’t seem to be something that can work in real life or just some type of disconnect between what differentiation is as learned in our program and what actually happens in the classroom. (Participant 6)

While a superficial analysis might relegate the above utterance as an Integrating conceptualization, the Participant was attempting to make sense of the concept of disability through the perceptions that had developed in context. The purpose, then, was not such that the student labeled with a disability was to be cured, or required to be accommodated because of their impairment. Rather, the nuance of this conceptualization was that disability was constituted through perceptions that are derived from the contexts, which enforce particular ways of interpreting disability. In this way, Integrating was not the focus; Perceiving was the focus in these utterances. Through these distinctions of context and its influence on perception, participants conceptualized disability as something that constitutes both a cognitive component, as well as performative component. Only two participants out of the ten adopted this
conceptualization of disability, though. Perceiving category, however, had also showcased a more Critical ways of thinking about disability, which constituted the final disability construct.

As stated in the beginning of this research question, all intersections between the categories of description and descriptions of thinking that were present within the pre-course interview were also present in the post-course interview, with the exception of one. This new intersection between Perceiving and Critical, while not adopted by 90% of the interviewees, did emerge in one post-course phenomenographic interview. It should be evident that the Perceiving category is less prevalent than the other two categories of description (namely, Labeling and Integrating) based on the use of exemplars for each category expressed by individual participants. Nine out of ten participants in the post-course interview discerned disability under the categorization of Labeling; while, seven out of the ten participants in the post-course interview discerned disability to be within the Integrating category. Only three out of 10 participants discerned disability to be “Perceiving,” and only one did Critically.

Below in Participant 2’s conceptualization of Perceiving disability as constituted through a Critical lens, and therein through an nuance intersectional nature wherein systems and interactions are put under inquiry to conceptualize this concept, disability was being constituted as a construct related to Perceiving. This participant saw disability as a conceptual construct that became constituted through systems that (re)enforce labeling as paramount for thinking about disability and difference (i.e., edTPA) and interaction within the teaching community that constituted disability as deficiency to be under surveillance (i.e., from cooperating teachers). This moved beyond a mere contextual analysis. This one critical discernment is presented below, coming from personal experience in Scenario 3 after Mary was labeled formally:

I certainly recall times where my cooperating teachers have said to me ‘oh, you know, watch out for so and so because he’s got an attention disorder’ or ‘watch out for her
because she’s persistently disruptive’ and before I even meet the student I’ve got this label on them, this like picture of them, and so I guess in that sense it reminds me but I’ve never [pause] You know the other thing I’ll add is that in my last student teaching placement when I was doing my edTPA, I had to write the kind of ‘context for learning’ thing and one of the things you have to do is complete a table about all the particular modifications to learning your students need – or whatever the right terminology is for edTPA. And it’s basically ‘ask your cooperating teacher for a list of all the IEPs and ELLs’ and so again before I even started my teaching I had my students listed out with their IEP numbers and their ELA scores attached to them. Which I think about it, as much as I tried for that not to influence my approach to the students, I think that does affect my relations with the students. I’m not saying that that information shouldn’t be given to teachers because plainly the more information you have on any student the better but I think that I had to make a conscious effort not to let labels like this kind of put the blinkers on me in terms of getting to know the student beyond that label. (Participant 2)

This participant conceptualized Perceiving disability as a constitution of intersections that influenced bias on who students labeled with disabilities are in terms of their identity. They then went on to elaborate on how this could then lead to teachers’ actions representing those assumptions in classrooms onto these non-normal student positionalities – in effect, denying these youth agency and being seen as ‘capable students.’

This participant delved into this reality of systemic and interactional factors that have influenced their Perceiving of disability as a conceptual construct. They then move into a critical constitution in that they recognized the limitations in them self to devoid their cognition of that label, with subsequent reflection on what that could then mean to student identity formation through the eyes of the teacher. Finally, and most critically, they also considered how through the actions of the teacher particular positionalities were imposed and enforced onto the students that have been labeled with a disability, also connecting it to another form of difference (English fluency). Indeed, the categorization of disability as a Perceiving act, of something that is to be discerned beyond a medical impairment or special education label, did not remain isolated from the categorization as Labeling or as Integrating – as this participant also adopted the Labeling and Integrating categorizations within their post-course interview discernments, as well.
These interviews can also be compared to the course assignments, which required more internal motivation to discuss disability. Of the twenty-two students who submitted three separate essays thinking about forms of difference and their effect on urban science teaching and learning (particularly as it deals with multicultural issues), only two out of that twenty-two opted to discuss disability explicitly – both of those two also being interviewees, serendipitously. Of their conceptualizations, both utilized a Perceiving categorization of disability as a way of critically thinking about how disability is constituted. However, their categorizations were completely dependent on a separate explanation that derived from the readings themselves, rather than a description from their conceptualizations and sense-making skills. Utilizing the course readings as grounds for their claims about disability, Participant 4 and Participant 10 inclusions of disability as a form of difference are presented below, one after the other:

An additional example of the negative effects of how teacher perceptions of students based on a mismatch of what counts as showing engagement and knowledge is found in Martinez-Álvarez’s (2014) description of the way that a bilingual first grader, Esteban (pseudonym used) is classified as having a specific learning disability (SLD) and ‘semilingual’ by his teachers, meaning he is limited in his home language and English, because his language is not “at grade level” based on schoolwide rubrics of oral and written proficiency. (Participant 4)

Emdin (2016) explains that teachers should “recognize the biases they hold and how these biases impact the ways they see and teach students.” If a teacher believes that students classified as having a disability will do poorly, they likely will do poorly and it will become a self-fulfilling prophecy. (Participant 10)

Within both conceptualizations, the participants’ understandings of disability were focused on the aforementioned Perceiving category of description, and then viewed critically as negative biases that influenced students labeled with disabilities. In the interviews these two participants did not discern disability in this Perceiving and Critical way (only Participant 2 held this discernment pattern). Thus, this begs the question whether this critical lens taken toward disability in a Perceiving way would be the actual response adopted by these participants when
presented with a classroom scenario that they were required to discern and conceptualize in all its complexities, and in the moment.

Research Question 2

To what extent did this course help the entire cohort embrace a critical lens, and bridge theory to practice?

Research question 2a. The Classroom Learning Environment questionnaire was used to measure the participants’ feelings about the course’s pedagogical approach and content. Findings suggest that the participants perceived the course to be ‘good’ in the following areas:

- They felt comfortable in the course if they chose to engage in the discussions (Classroom, Positive),
- They did not feel that there were highly negative attributes that would prevent them for engaging in the course’s elements (Personal Negative),
- They agreed that diverse cultural views and values were appreciated in the course (Diversity Values),
- They somewhat agreed that they perceived that they would persist in this field of study after the course (Persistence in Major).

Below in Figure 4.5 is a mean and standard error bar graph representing the responses from 20 out of the 22 participants in the course taken on the last day of the course. In Figure 4.5, the y-axis represents a Likert scale (-3, “Strongly Disagree”; -1, “Somewhat Disagree”; +1, “Somewhat Agree”; +3, “Strongly Agree”), with the bar value being the mean with included errors bars. From this measure, it can be concluded that the participants generally enjoyed the course and viewed it as a space where productive discussions about multicultural issues in urban
science contexts could be had in a comfortable way that made the participants feel ‘at ease’ – i.e.,
the content of the course and its emphasized goal.

![Figure 4.5: Classroom Learning Environment Questionnaire Findings; Means provided with sub-scale categories with error bars included](image)

**Research question 2b.** As stated in the Methodology chapter, participants from the cohort were asked to reflect on their course readings and their discussions from class bi-weekly with the help of open-ended prompts provided within the course’s syllabus. Seven reflections were required by the course, with a total of 154 reflections possible submissions from the cohort. Of those 154 possible reflections, 149 reflections were collected for this analysis – less than 3% missing from the data set. Findings suggest that these participants grew in their ability to critically discern difference across multiple categories of description, as it had been discussed in the course. The discussions from the course involved many views of difference such as those emphasized based on language, (dis)ability, race, class, culture, gender, and the like.

Through phenomenographic and emergent data analysis, four distinct categories of description involving ‘difference’ were identified, with the same four descriptions of thinking that emerged within the analysis from research question 1b emerging in the data for this research
question, as well (i.e., Intra-personal, Inter-personal, Contextual, and Critical). Three of the
categories of description were the following: Difference as Label; Difference versus Enablement;
Difference being Transmitted. However, one category of description was identified as a unique
and separate sub-class of difference, which involved the concept of disability.

This other category, while inheriting some attributes from the previous set of three
categories that were used to describe difference more broadly, contained more unique attributes
not present in the other three categories of description for difference that were broadly
conceptualized. This other category (Disability as Limitation) is discussed separate from these
other three articulations of difference more broadly because of its special attendance to the
concept of disability that was unique to only disability. Indeed, the compartmentalization of
disability was a unique case of difference with its own limitations that were conceptualized as
indiscernible from the nature of difference within the broader articulations from the other three
categories. This is further exemplified as this category of description was only referenced within
the two sections where disability was included in the curriculum, while the other three categories
of difference were referenced throughout all of the course sessions, no matter the curriculum.

Among the total 149 reflections, 156 total utterances were coded. Figure 4.6 below shows
the relative prevalence of each category of description for difference with respect to the data set.
The phenomenographic ‘outcome space’ for ‘difference’ is provided after Figure 4.6 in Table 4.6
to showcase for the reader a general structure of Research Question 2b’s findings. Table 4.5 also
includes the two Variations between the categories of description to represent the qualitative
differences between the ways participants conceptualized ‘difference’ within the course.

For concision and clarity, each category of description is presented in their own sub-
section, as similarly done in research question 1b, with the inclusion of a Table within each
category’s section to foreground conclusions that emerged from the ways the participants were thinking about the category. For example, at the intersection between ‘Difference as Label’ and ‘Intra-personal’ thinking the conclusion states: Difference is *labeled* (the category of description) as an *individual attribute* (the description of thinking) defined within and/or ascribed onto a person or group of people. Among the categories of description, there also emerged three distinct Variations that describe the qualitatively different ways the cohort discerns ‘difference’.

![Percentage of Each Category of Description Type (156 Total Utterances)](chart.png)

*Figure 4.6: Prevalence of each Category of Description within 149 Cohort Reflections.*

After an explanation with supporting evidence from the data set is provided to support these conclusive themes, a Figure is presented that graphically represents the shifts in the cohort’s descriptions of thinking from the 1st half to the 2nd half of the course (see Data Analysis section in Chapter 3 for an explanation of this how these intervals were determined). At the end of this research question, the general trend among all categories of description in terms of the relative prevalence of the participants’ descriptions of thinking as a whole is provided graphically in a Figure, as well.
Henceforth, the categories of description are referred to as ‘Labeling’, ‘Enabling’, and ‘Transmitting’, with ‘Limiting’ describing the unique case, and therein the Variations are defined as the ‘Labeling vs. Enabling’, and ‘Enabling vs. Transmitting’. This is done just like how research question 1b was presented to maintain consistency in reporting the data.

Table 4.6

Phenomenographic Outcome Space of the Category of Description ‘Difference’ from the Classroom Reflection Utterances Collected from the 22 Participants within the Course

<table>
<thead>
<tr>
<th>Categories of Description (Difference)</th>
<th>Intra-personal Description</th>
<th>Inter-personal Influence from outside source emphasized in statement; a description of comparison to others</th>
<th>Contextual Multiple places and spaces are compared as factors that can change the interpretation of the concept</th>
<th>Critical Attentiveness to intersections of power, systems thinking, and identity are at the crux of the interpretation of the concept holistically</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference as Label</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>VARIATION 1: Labeling vs. Enabling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difference versus Enablement</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>VARIATION 2: Enabling vs. Transmitting</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Difference being Transmitted</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* All intersections (blank spaces) emerged from the data and are elaborated below in their own section

Below is a bulleted overview of the categories of description and their qualitative differences to help the readers read the presented findings. Through these initial explanations, the reader is provided with a general summary of the findings for this research question.

- Labeling category: Difference was constituted through a label such as ‘urban youth’ or ‘African American’. It was through the identification of a label that participants were able to then discern difference. This category represented the least complex
discernment of difference because the label served as sole necessary element for
describing difference and the capacity to identify the nature of difference.

- Enabling category: Difference was discerned by identifying a goal tied to a
description of difference, in many cases this involved the goal of student achievement
in school. Through considering that there is a goal to reach, and then sometimes
providing a means toward that goal through articulating the importance of difference,
participants discerned difference as an enabling action to improve learning.

Variation 1: The Enabling category represented a more complex discernment of
difference than Labeling in that there was another component to consider, a goal. Therefore,
difference was not seen as a concept lingering on its own but, rather, one that interacted with
other concepts that could change how difference was interpreted, and therefore discerned.

- Transmitting category: Difference was also constituted through an analysis of how it
was used, rather than its label, or a goal it was dependent on. It was through a
description of the use of difference that the participants discerned the constitution of
this concept – the participants saw difference as manifesting from uses that may or
may not have particular goals but did have particular effects through a process. In this
way, input and output were the focus of discerning difference within this category.

Variation 2: The Transmitting category represented a more complex discernment than
that of Labeling and Enabling in that it moved beyond identification as marker of difference
(Labeling), and it’s constitution did not depend on a specific goal (Enabling). Rather than
defining difference in relation to a singular end point, Transmitting difference (as discerned by
the participants) required an analysis of the cause and effect in and of itself as a process. In this
way, difference was not seen as constituted through the action toward a singular goal (Enabling), but discerned as part of any process where various inputs could constitute various outputs.

- Limiting category: Difference in this final category was constituted by the limits of conceptualization that the participants held about the overall concept of disability. Within the category, difference was discerned as a site of wonder, of previously unknown difference, and (at times) the limits of what constituted difference. More specifically, some attributes of the previous descriptions of difference were inherited within this sub-class of difference (disability), but when participants described disability it was conceptualized as a unique case that required fundamentally different conceptualizations from that of the other three categories. Moreover, disability presented the participants with limitations specific to only disability as a conceptual category of difference and therefore was constituted as a ‘separate but equal’ sub-class of difference, indiscernible at times. The category specifically attributed this ‘brink’ of conceptualizing difference with reference consistently made to disability as a marker of ‘unknowable’ and, therein, ‘indiscernible’ difference. This category was populated by responses of uneasy questions and lamenting statements of ‘impossible’ scenarios where difference manifests in terms of disability, while also attending to personal experiences that were previously not analyzable but now are seen by the participants to contain elements of disability as a concept.

This Limiting category represented the conceptual ‘edge’ of difference – of knowing and being able to discern difference as it manifested through disability. With lingering notions of disability as a label, Limiting was qualitatively different from Labeling in that the label of disability itself did not constitute a discernment of this form of difference. The participants,
while maybe focusing on the *name* of disability as a label, were often left to wonder about the unknown state of this difference as it manifested in their proximal social realities (e.g., within classrooms, their own pedagogies, and their personal lives).

Moreover, when thinking about this category, participants relinquished – even at the critical level – their ability to discern possible solutions (i.e., actions toward goals, as in Enabling) and their ability to define a process that constituted disability in the world as a form of difference (i.e., as in Transmitting). This last category, then, constituted the ‘threshold’ through which new conceptualizations of difference were sought by means of questioning, speculation, and auto-ethnographic analysis. It is through constituting disability as a sub-class of difference, and not as a comparable form of difference to that of the other ways of categorizing difference along lines of race, class, gender, and language, where disability was conceptualized as unique and beyond the conceptual attributes articulated by the participants of difference more broadly. It was for these reasons that disability becomes defined as a separate category of description, one that was beyond the conceptualizations for difference used by the participants and also one that described how disability limited the conceptualization of difference as a truly inclusive category.

*Labeling.* Labels of difference emerged as category of description when the cohort spoke about traditional markers of difference that have been emphasized in many multicultural science education courses (i.e., racial, gendered, and socio-economic backgrounds). Within this category, the participants conceptualized difference as existing because of these distinct labels of difference but did not interrogate how these labels were part of a larger goal or process (as the reader shall see in the Enabling and Transmitting categories, respectively). The four distinct conclusive themes among the ways of thinking for this category are provided below in Table 4.7.
Table 4.7

**Thematic Conclusions of each Description of Thinking for the Description of ‘Difference’ as found within the Category of Description ‘Difference as Label’**

<table>
<thead>
<tr>
<th>Descriptions of Thinking</th>
<th>Thematic Conclusions within the Category of Description ‘Difference as Label’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-personal</td>
<td>Difference is labeled as an individual attribute defined within and/or ascribed onto a person or set of persons</td>
</tr>
<tr>
<td>Inter-personal</td>
<td>Difference is labeled as a constitution between two or more people, or groups of people that are compared</td>
</tr>
<tr>
<td>Contextual</td>
<td>Difference is labeled through the spaces and places that determine the interpretation of the concept</td>
</tr>
<tr>
<td>Critical</td>
<td>Difference is constituted through labels that attend to notions of power</td>
</tr>
</tbody>
</table>

Like that of the analysis done in research question 1b, the data suggest that when participants used an intra-personal way of thinking, they were relating the constitution of difference to the individual, or a specific group of people as a whole. As one participant stated, "I have a hard time understanding why urban youth are disinterested in science,” therefore relating difference within the ‘urban youth’ label and attributing this difference to the group as a whole. Seen similarly in another participant when the spoke about their experiences, “I went to a high school that was very multicultural from my point of view. It did not have whites or East Asians but it did have Indians, Bengalis, Arabs, Guyanese, Africans, African Americans, and Latinos from many origins.” This utterance constituted difference as, again, dependent on the label and internal to a person or group of people with that label and thus defined difference within people.

This focus then shifted when participants thought inter-personally about this category. In this way of thinking, difference became related to an interaction between people. Difference in this way, in the following example, was based on the label in one participant’s response of Jay (a student in one of the books the participants read) as an “African American child whose culture doesn’t fit with the expectations of his teacher. As such, she marginalizes what he brings.” In this way, difference was dependent on the interaction between Jay’s label and his teacher’s response.
Moreover, as another participant noted about their experiences with difference, “maybe I was naïve, but I don’t feel that racism played much of a role in my town. I certainly didn’t find my black classmates to be less engaged in learning.” This maintained, like the previous utterance, that difference was inter-personally constituted through interactions between two or more parties that are categorized as ‘different’ due to the label of ‘black,’ and those that they are juxtaposed against, but are not explicitly listed by the participant.

As the participants moved into more contextual ways of thinking within this category, comparisons were then made between differing places and spaces to try to make sense of these labels of difference. Using ‘the hood’ as a label of difference – coding for disenfranchised populations in comparison to ‘First Nations people’ – a participant used this juxtaposition of context through labels to think about difference as a comparison. They stated: “I don’t believe we have as much of a racism problem as in the United States. That said, our First Nations people do suffer greatly from inferior infrastructure and access to programs.” This contextual analysis remained constituted by labels in contexts (i.e., ‘we’ and ‘the United States’). This was also seen in another participant when they stated, “not just the ‘inner city’ has poverty problems, but that sometimes rural areas are stricken by poverty and isolated.” Here, ‘inner-city’ and ‘rural’ constituted difference through this comparison of labels, which were related to two contexts.

And finally, as the participants moved into more critical ways of thinking about labels of difference they started to think systemically and intersectionally about how these labels produced bias and privilege. As one participant noted: "Although I am a Black woman, I was raised in a middle-class family with a good deal of privilege” – labeling ‘Black’ and ‘woman’ as different but including a critique of power (i.e., privilege) based on the label of ‘middle-class.’ Another
participant, when discussing the nature of scholarship that was read in the course, also exhibited this discernment of labeling difference more critically:

These scholars talk extensively about including students’ narratives more explicitly into the classroom and allowing students to utilize their voice in the classroom and guide teachers’ practices. However, these scholars do so from a privileged perspective. The only way we hear about the black, rural students’ stories are through the lens of White, privileged, college educators.

In the above utterance, the participant discerned difference through the labeling of ‘black’, ‘rural’, and ‘White’, while also attending to notions of power in how difference is constituted by that labeling process (i.e., in the form of narratives by ‘college educators’ that are fundamentally labeled as ‘privileged’). Below in Figure 4.7, this shifting of ways of thinking is showcased graphically, with the data suggesting that the participants grew more critical in their way they conceptualized this category, while lessening their intra- and inter-personal ways of thinking.

![Shifting Thinking in 'Labeling' Category](image)

*Figure 4.7:* Percentages, showing shifting prevalence in ways of thinking about the category of description ‘Labeling’ longitudinally across the course; Total number of utterances in this category = 47.

**Enabling.** Like that of the category of description ‘Labeling’, the categorization of difference as a focus on goals (often to aid learning) also emerged from the phenomenographic
analysis. In this category (Enabling), the participants viewed difference as constituted through the same descriptions of thinking as the latter category (namely, intra-personal, inter-personal, contextual, and critical), but they viewed this category of description as constituting difference through the enablement of people, places, and things being used as leverage to learn. Below in Table 4.8 are the thematic conclusions for each way of thinking in this Enabling category.

Table 4.8

<table>
<thead>
<tr>
<th>Descriptions of Thinking</th>
<th>Thematic Conclusions within the Category of Description ‘Difference versus Enablement’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-personal</td>
<td>Difference was described as an individual attribute that can enable learning, if leveraged</td>
</tr>
<tr>
<td>Inter-personal</td>
<td>Difference was constituted as an enabling interaction between parties toward a goal of learning</td>
</tr>
<tr>
<td>Contextual</td>
<td>Difference was defined by the spaces and places where enabling may occur and the impact these contexts may have on learning</td>
</tr>
<tr>
<td>Critical</td>
<td>Difference was enabled by attending to notions of power and its influence on learning</td>
</tr>
</tbody>
</table>

As the data support in the intra-personal interpretation of this categorization of difference, the participants’ ways of thinking about the Enabling of difference were focused within the individual when one stated, “students ultimately value and need … to trust their teachers in order to learn effectively from them.” Even if these abilities may play out between people, the fundamental nature of being capable to learn was constituted by the individual’s attributes and feelings. This utterance was devoid of a claim that these internal feelings are produced through inter-personal methods and therefore remained within an intra-personal way of thinking. This intra-personal Enabling of difference to learn was also seen when a participant noted that they should start by “reflecting on one's own bias, and aiming to understand the student's experience … [then they can] have more of an effect by supporting student learning.”
This utterance defined difference as something internal that can then Enable students to learn if first the participant could identify those differences that are constituted within their Self.

As this way of thinking shifted toward more inter-personal constitutions of difference, it was apparent that the conceptualization of difference focused on how to Enable learning to occur because of interactions. In this inter-personal way of thinking, the student was seen as ‘different’ not through individual attributes but through interactional positioning. One participant’s response exemplified this when they were reflecting on Jay’s lack of participation to learn (the child from the aforementioned book, again) and stated, “the disparity between how Jay works to position himself in the class and how the class positions him.” This utterance specifically located difference within an Enablement between parties – Jay and the class. Moreover, this interactional nature of difference was also enabled when one participant noted the following about how the nature of teaching emphasized the importance of difference:

Although an approach that prioritizes quantifiable teacher effectiveness is more easily implemented and benefits a certain style of administration, student feedback is crucial if one is to reform the system to maximize student learning.

Through identifying interaction between ‘student’ and ‘teacher’ as par excellence for changing the nature of learning in the classroom (and reforming all classrooms), difference remained constituted through inter-personal interaction that embodied the Enablement of learning.

This then shifted when the participants thought about the contextual nature of this category as being constituted through comparing and connecting places and spaces more familiar with the students to Enable their ability to learn. Difference, and its effect on student learning, were no longer due to the nature of inter-personal interaction alone, but also discerned through the notion that context could mediate the capability to learn. As noted by one participant:

[I plan on] handing out extra credit to students who perform science activities outside of class, ideally with someone close, like family, so that the content from the classroom is
being explored in the context of the home.

This was then corroborated when other participants talked about difference when viewing the Enablement of contextual attributes to enhance the learning process:

if students are engaged in the topic, debating and negotiating with one another for understanding and meaning then the class that appears too wild or excited may in actuality be learning and participating enthusiastically, much as they would with any other topic of interest outside the classroom.

Within both utterances, participants coded difference as functioning to Enable learning through paying attention to the contexts where difference would be made visible (i.e., ‘the classroom’, ‘the context of the home’, and ‘outside the classroom’).

Finally, as the participants shifted to more critical views of the categorization of difference as an Enablement to learn, we find a fundamental challenge to systems that have constituted perception. More simply, there was a recognition that more intersectional analyses influence the structure of the classroom, therein influencing the students’ ability to be seen as capable to learn. As one participant eloquently noted about this critical difference as Enabling:

The notions of what constitutes 'achievement' is far too limited, and often times manifests in less-inclusive lessons that fail to account for multicultural, critical, and feminist pedagogies. The degree to which cultural and societal constructs should be valued may well be argued until the end of time, however, as we move towards a more inclusive understanding of achievement, my belief is that we do our students (and, consequently, our society) a true disservice by failing to understand these constructs.

In their view, difference was tied to ‘achievement’ (and therein categorized as Enabling) but also couched in an understanding of power (i.e., ‘cultural and societal constructs’). Below in Figure 4.8, the data showcase an increasing focus on critical aspects of this categorization of difference, as well as relatively stable ways of thinking involving contextual and inter-personal constitutions. An observed fluctuation in intra-personal thinking is present, which does not show substantial change from the 1st to the 2nd half of course, even as it decreases along the midpoint
of the course and shows a lesser prevalence within the second half. Indeed, the ‘critical growth’ is seen mainly in the first half of the course (like Labeling), with second half relatively stability.

![Shifting Thinking in 'Enabling' Category](image)

*Figure 4.8:* Percentages, showing shifting Prevalence in Ways of Thinking about the Category of Description ‘Enabling’ Longitudinally across the course; Total number of utterances in this category = 53.

**Transmitting.** Within the category of description ‘Transmitting’, participants viewed difference in terms of how language played a role in constituting difference. Difference here, unlike the other categories, was focused specifically on language as not just a label or a mediator of learning but as transmitter of difference that was coded in various ways. In other words, difference within this category of description was conceptualized as being inherently connected to the language that disseminated this concept. Through thinking about difference in this category, the participants went beyond just viewing difference as being a label or being a part of a goal. Difference as Transmitted was focused on an analysis of the process that constituted difference as a function of how language use played a role in this process, and thinking about the ways that this process could be described. Below in Table 4.9 are the emergent thematic conclusions for this category of description ‘Transmitting.’
Table 4.9

Thematic Conclusions of each Description of Thinking for the Description of ‘Difference’ as found within the Category of Description ‘Difference being Transmitted’

<table>
<thead>
<tr>
<th>Descriptions of Thinking</th>
<th>Thematic Conclusions within the Category of Description ‘Difference being Transmitted’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-personal</td>
<td>Difference was described as an <em>individual attribute</em> that is <em>transmitted</em></td>
</tr>
<tr>
<td>Inter-personal</td>
<td>Difference was <em>transmitted</em> by virtue of interactions <em>between</em> parties</td>
</tr>
<tr>
<td>Contextual</td>
<td>Difference was defined by the <em>spaces and places</em> where the <em>transmission</em> of difference may occur due to the factors that are related to those contexts</td>
</tr>
<tr>
<td>Critical</td>
<td>Difference was <em>transmitted</em> by attending to notions of <em>power</em></td>
</tr>
</tbody>
</table>

As intra-personal played out in the other categories, so did the participants use it within this category when they focused on difference attributed to the individual. In one participant’s utterance we saw this constitution of difference coming from the notion of language located within the individual student after all other possibilities had proverbially ‘run out’:

Even when I have provided translate versions of assessments to ELL's and made other such modifications to support students. Perhaps the problem goes deeper than the wording of the assessment or the methods used to teach the content.

This comment made by the participant about their understanding of difference across language was specifically not a function of the modes of interaction (i.e., as with differing linguistic forms on the assessment) and not of the assessment itself (i.e., on the nature of language constituting forms of power through its practice of valuing one formal way of articulating questions and students responding). Instead, the problem was discerned as possibly ‘going deeper’ because, to paraphrase, ‘I’ve done so much already so it can’t be anything else.’ The only other deeper inquiry was to attribute this inability to the ‘ELL’s’ them self, therein emphasizing an intra-personal notion of difference transmitted through the language modifications that had been insufficient to mediate this lack of learning. Another intra-personal way of thinking within this Transmitting category was seen when a participant reflected on how “students should think about what they know and their own discourse to describe scientific concepts.” This utterance
emphasized that difference was constituted through the linguistic practices attributed to the individual student, and not the interaction or context that may have influence those differences.

This way of thinking about language then shifted when participants considered the inter-personal nature of interpretation. Within inter-personal thinking, the nature of difference among language was fundamentally constituted through dialogue, through comparison, and through (mis)interpretation that may occur due to the ways language was used socially among multiple parties. As noted by one participant: “People are usually not aware of how their word choice influences how what they say could be interpreted or misinterpreted.” Moreover, another participant noted a similar discernment of Transmitting difference through inter-personal interaction: “students and teachers should enter into a dialogue using their own vernaculars to arrive at a commonly understood wording of a scientific concept.” In these ways, difference in terms of Transmitting remained between parties and inter-personal, which shifted when participants moved into more contextual ways of thinking.

When participants utilized contextual thinking they described language and its use as a form of difference being directly related to other concepts, such as content knowledge. As one participant noted on their experiences:

When I first moved here, I knew English, but because I was not proficient, I was placed in ESL classes, and because I was placed in ESL classes, I was also put into basic math and sciences classes. I felt like they thought that because I did not know English, I did not know science or math at all.

Through the identification of language use as a form of difference, and then enacted within the purposeful delineation of contexts as coding for this difference, the participants discerned that language not just changed based on the parties that use them, but also determined access to particular spaces and places that were used to code for difference. This was supported by another participant when reflecting on how language Transmitted difference in different contexts:
“students of higher socioeconomic status can communicate more effectively in the classroom community than their counterparts in urban schools can.” In these ways, context, language, and difference at this intersection were always constituted together – differing from prior categories.

And finally, when the participants adopted a critical lens toward the Transmission of difference, they attended to more systemic notions of power and its pervasiveness in determining appropriate language, bodies of knowledge, and therein also the constitution of language as a form of difference in and of itself. This was showcased in an extended excerpt provided below:

There are certain constructs that just automatically get higher positions or privileges by virtue of it, such as the science discipline itself, or the Western Modern Science whereas the thick and wide inheritance of traditional ecological knowledge (TEK) is publicly shunned away and diminished to be unworthy of its official position in academia. Similar practice is done to the linguistic ability in that there are certain ways of speaking and writing that gain the privileged status than others, which are known to be the ones that belong to certain groups. All this can easily lead to both students and teachers not valuing their TEK or language of their ethnic and cultural groups, and thus shunning their identity in the public spaces.

Below, Figure 4.9 showcases the shifts made by the participants in terms of this category of description for the concept of difference related to Transmitting. The data showcase a relative stable use of critical and intra-personal thinking, with a decrease in contextual and increase in inter-personal thinking for this ‘Transmitting’ category of description for difference.

Limiting. Within this category, participants discerned the conceptual brink through which difference could be understood. In other words, the participants spent much more time in this category preoccupied with questions of wonder, statements of lament, and critiques of autoethnographic accounts that were previously indiscernible without a thorough conceptualization of the concept of disability. Below in Table 4.10 are the conclusions that came from analyzing the descriptions of thinking used in this Limiting category of description.
Figure 4.9: Percentages, showing shifting Prevalence in Ways of Thinking about the Category of Description ‘Transmission’ Longitudinally across the course; Total number of utterances = 35.

Table 4.10

**Thematic Conclusions of each Description of Thinking as found within the Category of Description ‘Disability as Limitation’**

<table>
<thead>
<tr>
<th>Descriptions of Thinking</th>
<th>Thematic Conclusions within ‘Disability as Limitation’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-personal</td>
<td>Difference is described as an <em>individual attribute</em> that manifests through the <em>limit</em> of disability to be conceptualized beyond deficit</td>
</tr>
<tr>
<td>Inter-personal</td>
<td>Difference is <em>limited</em> by virtue of interactions between parties that produce disability by comparison to ‘normal’ students</td>
</tr>
<tr>
<td>Contextual</td>
<td>Difference is defined by the <em>spaces and places</em> where the <em>limitation</em> of difference may occur due to the factors that are related to those contexts</td>
</tr>
<tr>
<td>Critical</td>
<td>Difference is <em>limited</em> (conceptually and practically) by attending to notions of <em>power</em> that produce disability</td>
</tr>
</tbody>
</table>

Just as in other intra-personal explications, the participants noted the nature of disability as a Limit that became attributed to the individual. As one participant noted about Jay (the previous character in the aforementioned book) and his disability: “In these passages depicting Jay’s ‘disability’, it is really difficult for me to see and understand why he is painted as different.” While this notion of difference was being attributed intra-personally, the participant
lacked the awareness to discern the production of this difference as a disability attributed to the individual student. Indeed, this lack of conceptualization – the Limiting nature of being aware of disability as a categorization of difference – was also exemplified by the naivety that another participant had about disability: “I do not think students with special education need special attention or special learning objectives or IEP. I believe that every student has different style of learning, different experiences, as well as background.” Through this notion of individual attribute ‘students with…’ as sole constitution of difference, the participant discerned disability through Limiting conceptualizations that confined difference (through disability) as internal, as intra-personal. Indeed, the following utterance from another participant showcased this Limiting and intra-personal ascription of difference through disability:

I certainly believe that students with disabilities should receive equitable education. Does that mean that they will learn science on the same level as a typical child? Will a student with disabilities learn science at all? I think it really depends on the nature and severity of the disability.

As the participants shifted into more inter-personal thinking about difference as a Limit, there emerged the notion that disability could be conceptualized as difference that manifested between parties, which was to be learned. This provided a glimpse into the participants’ awareness of disability as a form of difference, as well as the Limited conceptualizations participants could draw on to make sense of this category. As one participant noted in a very vague and non-descript way, “I will most certainly have students who have been labeled as disabled or impaired in some form and as a teacher I am going to have to learn how to help them learn.” This format of making vague statements concerning disability and its constitution through interaction was seen across participants. However, as one participant reflected on their personal experiences, they analyzed this category of difference as a concept that Limits, that requires something beyond the conceptualizations they hold, if interaction was not considered:
I had a teacher that used the ‘right’ tools to help me show others my math skills. In my case, I was fortunate enough to have someone who did not have a preconceived image of my abilities and disabilities, but the sad reality is that there are plenty of teachers who create preconceived images that certainly truncate students’ abilities.

By attributing difference through a Limiting conceptualization, the participants discerned disability as a category of difference important when thinking about it effects inter-personally. One final participant noted this Limitation of difference through an inter-personal constitution of disability that was ‘unknowable’ at the present time for them due to disciplinary constraints:

Scientific practices are predicated on and constituted by communication, as collaboration and argumentation are essential components of authentic science. How could nonverbal students engage in these practices using their own forms of communication? How could we assess the understandings science by nonverbal students as active producers and users of science?

Within more contextually-based thinking of difference as Limitation, participants emphasized the notion of how space and place played a role in how this category of difference could manifest. In particular, as one participant noted, this notion of context was one the most prominent way to discern difference as Limitation:

Jay’s experience in being excluded in schools and being identified as less competent than his white classmates is not a singular, exceptional experience or only relevant in non-diverse areas. In the New York City public school system, it is shockingly apparent that lower level, or special education classes are comprised of students of color while higher leveled classes have very few students of color.

Indeed, another participant also commented on the contextual nature of disability as a category of difference that Limits in their reflection of the impact of context on how disability manifests:

I was behind my peers when I moved from my low-income school to my new suburban middle school. However, my challenges with the content were not a matter of a disability, but rather a function of me not being exposed to certain concepts.

Through discerning disability as the limiting factor toward conceptualizing difference within a contextual analysis, these participants noted that difference, disability, and context were interconnected. And on a final note, as one participant stated about their personal experience with
‘IEP’ students, they “arranged their seats together in the corner of the classroom and did not challenge them intellectually.” This utterance further emphasized the connection between difference as a category of Limits and the contextual (explicitly physical in this utterance) changes that have been used to define this difference among students labeled with disabilities.

Finally, as participants approached more critical notions of disability as a difference of Limits, they were split between questioning the ‘unknowable’ and describing an analysis of their own personal experiences. In one such utterance, a participant drew on multiple lenses to explicate how disability was so crucial for understanding power, identity, and imposed limits:

My big question is what about students who do not yet have those skills? Why don’t we simply extend the understanding that we have to listen and attempt to see the world through the lens of another human being who adds value because of their cultural difference to those individuals that we label as disabled because of their “inability” to communicate with us … What about our inability to communicate effectively with them? Isn’t that just as important? Learning to communicate across “ability” lines is just as important as learning new languages and slang.

Indeed, this critical interrogation of disability was further adopted when a participant asked a set of questions that, at the present time, they could not answer, nor discern:

I am left with several questions. 1) How do we dismantle the social construction of disability, if our current education structure depends so heavily on it? How do you create assessments with cultural validity and standardization? How do you determine whether an exam is culturally valid? Who do you employ to create such exams? Why have we privileged issues of race, class, and gender, but not disability?.

This more critical notion of difference as Limitation problematized difference beyond the three other categories. This Limiting nature of difference made evident the need to interrogate disability as a concept among the participants of this course. Moreover, as one participant noted eloquently, this Limiting nature prevented a reflection that could change classroom practice when the participant reflected on their experiences when teaching students with disabilities:

I have expected that these students cannot attain high academic achievement and that they can easily get involved in problem behaviors. In such a vein, I was not able to see
who they really are and what they are really able to do, and, furthermore, I did not even try to take a look at such things because I could not get my preconceived notions out of the way. Simply put, by perceiving them differently, when they answered my questions, I did not value their responses as equal to typical students’ answers.

Below in Figure 4.10 is a graphical representation of the shifting descriptions of thinking of the participants around Disability as Limitation. The data showcase an increase in critical and intra-personal ways of thinking about this category, with decreasing inter-personal and contextual ways to think about this Limiting category as it manifests within disability as a social construct.

As the data showcase below in Figure 4.11, the overall shift in the participants’ ways of thinking about ‘difference’ exhibited an increase in critical thoughts and a minimal decrease in contextual thinking. Intra- and Inter-personal ways of thinking, while fluctuating, showcased relative stability in their prevalence between the first and second half of the course. This pattern of change in percentage for the critical type of thinking was the goal of the course, and thus the data exhibit that the goal of the course was met based on the data set as a whole. The data, however, also showcases relative stability in other forms of thinking that should exhibit change.
Figure 4.11: Percentages, showing shifting Prevalence in Ways of Thinking of All Categories of Descriptions of ‘Difference’ Longitudinally across the course; Total number of utterances = 158.

**Research question 2c.** As noted in research question 1a, there were no significant changes in the cohort’s abilities to choose inquiry-based lessons for inclusive science classroom scenarios (See Table 3 for these descriptive statistics). As for the responses to this pre-/post-course POSTT-DIS measure where the participants where asked to discern why they chose each of the pedagogical types for the scenarios presented to them, the data suggest that their justifications remained within the ‘Reformative’ level (starting at 86% and ending at 95% of the responses provided by the participants). These types of responses increased in their use from pre-to post-course. The prevalence of participants’ ‘Critical’ and ‘Tradition/Routine’ discernments for their choices on this measure decreased from pre- to post-course. Figure 4.12 below showcases this maintaining of Focus on guided inquiry-based pedagogical views toward inclusive science classrooms (i.e., as explained before in Table 2, as a Focus on changing the Structure of the course, but not the Purpose, which would indicate a ‘Critical’ discernment).
Figure 4.12: Percentages, showing Participants’ Response Type from POSTT-DIS Measure Pre-/Post-Course, represented in Percentages of the Overall Number of Responses, N = 620.

Like that of the POSTT-DIS responses, the lessons designed by the participants showcased a focus and increase in ‘Reformative’ type, with a slight decrease in ‘Traditional/Routine’, and a slight increase in ‘Critical’. Figure 4.13 below showcases this data set. With these two data sets combined, conclusions can be made about participants’ capacities to bridge the theoretical underpinnings of the course to very literal pragmatic influences within urban classroom, namely reflections on why some pedagogies should be used and how to plan for ‘Science-for-all.’

Overall, the findings from this research can be described in both predictable and unpredictable ways. In terms of Research Question 1, the inquiry on how the participants conceptualized disability, it was predictable that they maintained their alignment with medical and SPED perspectives of disability in that the course only provided two readings to problematize those more traditional and familiar conceptualizations of disability. These participants maintained their understandings of disability through the lenses that have been used around them throughout their lives, and since no substantial conversations were had within the class about a disability studies perspective, these conceptualizations were not challenged.
Anecdotally, it should be noted that the one participant that utilized a ‘critical’ view of Perceiving disability did so while explicitly referencing ‘what my partner would do since they work with these students’, placing the important change not on the course but on the outside resource of a knowledgeable other that has experience in the field with this population that they could draw on for help.

<table>
<thead>
<tr>
<th>Shifting Lesson Plan Type</th>
<th>1st Half (N = 62)</th>
<th>Median Point (N = 19)</th>
<th>2nd Half (N = 58)</th>
</tr>
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<tbody>
<tr>
<td>Critical</td>
<td>9.7</td>
<td>10.5</td>
<td>10.3</td>
</tr>
<tr>
<td>Reformative</td>
<td>77.4</td>
<td>89.5</td>
<td>84.5</td>
</tr>
<tr>
<td>Traditional/Routine</td>
<td>12.9</td>
<td>0.0</td>
<td>5.2</td>
</tr>
</tbody>
</table>

*Figure 4.13: Percentages, showing Participants’ Shifting Lesson Plan Type, N = 139*

**Summary of Findings**

In terms of Research Question 2, how the participants conceptualized difference, it was unpredictable that they would not be capable to transfer their conceptualizations about traditional markers of difference (such as race, class, gender, language, and the like) into the similar sub-category of difference ‘disability.’ Herein, the participants were limited in their capacities to envision disability as a form of difference similar to race, class, gender, language, and the like. This course’s purpose was to engage students with *all* forms of difference and Research Question 2 exhibits that this purpose may need specific design within the course so that this goal can be achieved since ‘Disability Studies’ go against all other conceptualizations these participants held.
Chapter V

DISCUSSION

Given that the nature of this research was phenomenographical, the discussion chapter addresses the two research questions as larger themes, with each discussed in its own section. After both research questions are discussed individually, a third section discusses how these two research questions intersect and the implications for this research as a whole.

Research Question 1

To what extent does a ‘Science for All’-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?

As referenced in Chapter I and II, disability is a pervasive form of diversity that has been neglected in the multicultural literature, even as it parallels movements for social justice more broadly related to race, class, and gender. Moreover, these two chapters also highlighted how disability is constructed through direct connections to medical and scientific ideology being propagated from their respective fields into the social contexts where disability is then experienced (i.e., schools, the workplace, and the like). Given these realities, we must come face-to-face with the ways that these two fields (i.e., multiculturalism and science) have placed disability outside of the conversation of what concepts are important for teachers to learn if they wish to teach in urban contexts. Through this lens, we can begin to understand the findings for Research Question 1 as contained in Chapter IV.

To reiterate, the course under inquiry was the sole diversity requirement for all students enrolled in the science education department at the university where this study took place. With this in mind, the course was then charged with interrogating culture and difference as they manifest as factors that influence the teaching and learning of science in urban contexts. This
‘Science-for-all’ course is therefore the crux through which all graduate students in this program would prospectively be taught how to engage with students of diverse cultural backgrounds and the markers of difference that influence these teachers’ conceptual understandings of their students’ positionalities, as well as these teachers own subject positions. For disability, in the context of the course, the ten subset of participants from the larger course population did not grow substantially as a cohort to conceive of disability as a form of diversity on par with the more familiar markers of difference related to race, class, gender, language, and the like.

The participants initially were capable of attending to how disability was constructed through the medical perspective (as in the Labeling category from Chapter IV) and could also conceive of disability through the special education (SPED) perspective (as in the Integrating category from Chapter VI). They could also attend to the contextual factors that influence how disability could be interpreted (as in the Perceiving category from Chapter IV), but few did in this way (2/10 participants). Thus, as participants entered the course they held two main categories of description that they used to make sense of disability, and discerned how disability may affect instruction. Also, when coming into the course, the participants held a high regard for guided inquiry as the most appropriate way to teach science, even if the instruction was taking place in urban contexts that contained students with disabilities.

With this incoming reliance on guided inquiry as the ‘right way’ to teach science to students, no matter the context or disability labels that exist within the classroom, this evidence of the participants’ perceptions showcased that they were focused on inquiry as a ‘catch-all’ way to approach urban contexts of culturally diverse students that may or may not have been labeled with disabilities. Given this strong alliance on disciplinary pedagogy coordinated with medical and SPED perspectives of disability at the onset of this course, a possible hypothesis could have
been that these participants would grow in their capability to discern disability as a form of diversity on par with critiques of race, class, and gender, therein changing their approaches to the contexts where these markers of difference exist. This emergent understanding would hopefully lead to a more poignant attendance to the complex nature of the needs of the students within these classrooms (i.e., to first and foremost participate in a critical scientific literacy), but unfortunately that was not the case.

While there was one participant that was able to discern disability critically by the end of the course, and two more that were able to maintain their conceptualization of disability as a way to perceive contextual differences, the majority of this subset of participants (7/10) did not discern disability as a form of difference critically. Even more, the data support that 90% of the participants still used the medical perspective of disability to conceptualize its use. In other words, the majority of the participants (7/10) did not develop the capacity to discern disability as a form of difference, nor did the vast majority of them (9/10) challenge the medicalized perspective they inherited from their personal experiences, which leads to another question: Why does a ‘Science for All’-driven graduate course not help a subsample of ten students develop capacities to critically discern disability as a form of diversity? One explanation could be that disability was not in the foreground of the curriculum of the course and instead was siphoned into only two readings that specifically discussed disability in a critical way, one in the first half of the course and the second in the latter half of the course. This attention to disability only from these two sections is highlighted once more in the findings for Research Question 2.

More concertedly, through almost all of the science education readings, the course was focused on culture as a proxy for talking about race, class, discourse, and gender (as seen within its curriculum). However, as shown in the literature review in Chapter II, these publications
neglect disability as a form of difference. The extant literature in the multicultural science education field neglects to address disability, and the course did not address disability as a form of difference on par with race, class, gender, and language. Therefore, the concept of disability was relegated – quite literally (as in the curriculum) and metaphorically (as in the lack of purposeful inclusion in understanding culture) – to a ‘separate but equal’ status. It is not surprising, then, that the subset of participants did not develop the capacity to discern disability as a form of difference – it was by design excluded from having a seat at the proverbial ‘equity’ table! In all, this leads to a conclusion that science education literature (multicultural or not) is not sufficient to challenge students’ conceptual understandings of disability beyond the medical and SPED perspectives that neglect the sociological aspects of this concept as it plays out in classroom practice.

This neglect, seen more thoroughly throughout the literature and now explicitly identified in this research, maintains that disability is a ‘special’ case of difference, particularly one that does not ‘emerge’ from merely discussing culture more broadly in the context of racialized, classist, gendered, and linguistic critiques of systemic oppression writ large. This observation of disability as a ‘special sub-class’ of difference is also seen within the findings of Research Question 2, discussed below. Indeed, the literature in Chapter II highlighted that disability is one of the primary tools for excluding students of color from instruction in the general education classroom and that this exclusion is disproportionately hindering poor youth of color from access to appropriate science instruction taught by content specialists. Thus, courses such as this one have not yet recognized the limitations in their own conceptualizations of difference toward disability, in their curriculum or their lenses toward both difference and disciplinary learning. Without such an interrogation based on empirical support such as this, what do we really mean
by inclusion and whom are we *really* thinking about when we say ‘Science for all.’ It is with lack in mind that this dissertation now turns to addressing the nature of how difference was conceptualized by the whole cohort, and their ability to bridge theory to practice – the defined goal of this course and many other courses like it.

**Research Question 2**

To what extent did this course help the entire cohort of students embrace a critical lens, and bridge theory to practice?

Difference as a broad conceptual category of inquiry for Research Question 2 provided a larger grain size analysis using phenomenographic methods in this study. For instance, while disability came up within the participants’ reflections in the course, these only occurred when readings about disability were assigned. It is important to note that forms of difference analyzed in this research question (labels such as race/class/gender, goals for learning, and language) were observed throughout *all* of the course’s response data bank. However, by contrast, the nature of disability was seen as outside of these more manageable forms of difference and indiscernible for the twenty-two participants in the class as a whole. This connects quite specifically to the literature already referenced above in Research Question 1 of this chapter in that the majority of the ten subset of participants (7/10) were not thinking critically about disability as a concept, even when confronted with disability and given a chance to showcase how they think about this form of difference, or even when probed to think about multiple markers of difference.

This larger grain size analysis used in Research Question 2 focused on a data set that was open-ended (bi-weekly course reflections) and not designed to elicit forms of difference in specific manners. Consequently, more finite claims about why participants may have shifted in their thinking about each category could not be made. In other words, these course reflections
were not designed to interrogate the participants’ specific conceptualizations more thoroughly with respect to defined categories of describing difference. Instead, they were focused on primarily emergent categories used to draw claims about difference as a larger conceptual construct. Therefore, the shifts in each category’s descriptions of thinking cannot be defined causally (i.e., a claim cannot be made about why some ways of thinking were relatively stable and why others shifted from intra-/inter-/and contextual to critical). However, as the focus of this research question is on to what extent the course helped these participants think about difference in a critical way, the findings for Research Question 2 still provide valuable insight.

Across all categories of description the participants increased the prevalence of using a critical lens when thinking about difference in all its forms. Nonetheless, their capabilities to discern why they chose particular pedagogies for urban science classrooms that contained representative difference in the demographic sense did not focus on difference as an important component for these choices. Moreover, when asked to create ‘Science-for-all’ lessons, these twenty-two participants revealed, again, their preoccupation with disciplinary-based pedagogies as par excellence for teaching science, no matter the demographic being taught. In other words, the cohort can think and talk about difference in critical ways by the end of the course; however, their capabilities to discern and create such learning environments for the forms of difference that they conceptualize critically about are less than desirable.

These participants, indeed, learned how to talk the talk when it comes to how to speak about difference in a multitude of ways, and also learned that critical talk was important when thinking about students that come from demographics that are foreign from their own experiences. We should expect nothing less from the singular course that is defined to serve this role! However, when participants were asked to walk the walk, as it were, they relinquished the
importance of this critical talk and thought for disciplinary-specific choices (i.e., inquiry-based pedagogy). Thus, they show little to no regard for how these pedagogies may need to be modified to meet the needs of the diverse student populations that have not been being served by the inquiry movement in the present day science education reform climate.

What, therefore, can we say about courses such as this when it comes to fulfilling their purpose and their implementation? Moreover, what might a course such as this one adopt to infuse and design such elements so that the bridging of theory to practice is purposeful rather than assumptive or speculative? Indeed, this area of research in multicultural teacher education has been done, and the analyses are on-par with those reported here (Gorski, 2009), however we still must take a step back and think about how multiculturalism frames their own narratives of difference in these analysis. For example, in Gorski’s 2009 analysis of syllabi for multicultural teacher education courses, there is no recognition to disability amongst his analyses, nor does ability come up as a conceptual framework from which to think about a cross-cutting concept that unites the justifications that are used to exclude students based on all markers of difference. This subconscious and/or unintentional disregard for (dis)ability leads to a lack of critique for the ideologies of ability that connect difference through historical construction of the student and the expectations of the ‘normal’ citizen based on economic, sociological, cultural, and political waves of change (Erevelles, 2011; Nielsen, 2012; Siebers, 2008).

Given the outcomes of this research study, I propose we recognize that students’ capacities to think and talk like critical pedagogues does not necessarily translate into discerning and creating learning contexts like that of critical pedagogues who work toward specifically designing these contexts to embody a critical framework for social justice. More simply, we must not assume just because students speak the vernacular of criticality that they will then act on
those ideas in their future classrooms and meet their students’ needs, at least not without support with how to make this leap from theory to practice. More emphatically, we must take charge to make explicit in our curriculum, in our pedagogical practices, and in our assessment measures within courses such as this to design for the fostering of these conceptual changes. This is where critical praxis becomes the pivotal frame from which both research questions can be discussed.

**Intersection of the Research Questions**

What do these findings mean for the research base of multicultural education and science education, and what implications can be made from this study?

In 2012, Arnold, Edwards, Hooley, and Williams remarked on the state of teacher education and argued for critical praxis to be brought to the forefront for how to conceptualize our field more broadly in terms of its purposes and goals; in this proposal, the authors explained:

> critical praxis searches for a set of conditions across the school curriculum including mathematics, science and history where educational practices encourage such ‘flashes of insight’ on a regular basis for teachers and students alike. This cannot be achieved when the creative leaps of others achieved in another place and time are decontextualised and sanitised for passive transmission and adoption … Teacher education as ‘critical praxis’ locates teaching and learning within the context of ideology critique, self-reflective consciousness and emancipatory action. (p.286, 290)

With this conceptualization of teacher education more broadly in mind, we can start to make sense of the findings presented in this dissertation in terms of their application to multicultural education, science education, and the teacher education sub-field within both disciplines.

In multicultural education, as noted in Chapter 2 and empirically supported in both research questions, disability has been actively relegated to a ‘separate but equal’ status for conceptualizing difference. On the one hand, multicultural education purports that *inclusion* and *transformative* (critical) pedagogy are the pillars to changing our school systems, for both our teachers and the students they serve. On the other hand, multicultural education does not regard
disability as a significant label of difference to explore more fully in terms of this inclusive and transforming process. Our expectation is that teachers walk into classrooms and can begin to negotiate the realities that students of color embody in terms of disability as a marker of difference, on par with that of race, class, and gender. However, when multicultural education articulates disability outside of their purview to engage with in their literature base, their inclusive and transformative process, instead, upholds the silencing discourses and exclusionary practices that they seek to disrupt.

Moreover, in enacting and imposing this ‘separate but equal’ status for disability, the scholars use the same logical and reductionist perspectives of isolationism and indiscernibility that were the foundational arguments for the exclusion of students with other ‘special’ categories and labeled as deficit because of race, class, gender, language, and the like in the Jim Crow eras of the US. This, unfortunately, is continuing post-Brown v BOE. This is not just insufficient ideological critique; this silencing and denial actively prevents reflection of one’s own actions arising from this exclusionary consciousness. Consequently, it denies the teacher’s capacity to adopt a critical praxis toward one marker of difference (disability), that all too often is now used to prevent students from even being included in the general education classroom. Where and from whom, then, would these students be attaining their ‘critical’ disciplinary instruction?

This is not to say that new teachers coming into our current educational climate aren’t without pressures. Indeed, the political economy of education as it exists right now (after the election of Donald Trump and his appointment of the new Secretary of education) is set to apply new and more high-stakes pressures on these new teachers – many of these pressures were not even around just a few decades ago. With these realities in mind, the nature of teaching is becoming more and more focused on a technical job to collect ‘tools’ rather than a professional
career to foster a consciousness that values teacher agency. Therefore, there is a need to embrace the notion of criticality, now more than ever. Critical pedagogy, and critical theory more broadly, does not emphasize a ‘quick fix’ Band-Aid for the ills of education and therefore provides a different approach than the disciplinary teacher education agenda that is widely supported.

Criticality in education means something more, something vibrant, something creative and alive. Therefore, when I argue for this critique of courses that are charged with fostering a critical perspective and bridging the theory-to-practice divide, one thing must be made clear: I do not believe teaching is an objective practice that can be merely measured by the nature of designed curriculum, implemented pedagogy, and appropriate assessment alone. However, the nature of teaching and learning in this political climate means that teachers will face realities that they will have to navigate with their own understandings and meaning-making processes. To be critical in this climate, then, requires that we both challenge more traditional, disciplinary understandings of teaching and learning, while also fostering teachers’ creative capacities to envision how to implement these more critical ways of viewing teaching and learning. This becomes increasingly important in highly disciplinary-centered fields of teacher education and begs the question: Do we do equity work because it’s easy, or do we do it for social change?

Given the nature of science education being deeply couched in inquiry-based pedagogies, it has, indeed, been a long and hard journey for multicultural theories to transfer into this disciplinary field. However as noted in Chapter 2, and the empirical findings from this dissertation, even as these ideological critiques become more prominent within science teacher education research (limited as they are to address disability), their impact on graduate students’ learning of both disability and difference more broadly are limited in their applicability for critical praxis, for reflection and action. With the empirical findings of this dissertation as a
guide, we can no longer assume that multicultural science education courses (such as the one under inquiry in this research) are effective in their goals by virtue of students being able to adopt an *ideologically-based* critique of all markers of difference.

No, I argue, we cannot assume that fostering graduate students’ capabilities of presenting critical arguments transfers into capabilities to critically reflect on why particular pedagogies should be used in contexts where diverse populations are supposed to be at the forefront of understanding science teaching and learning. No, I purport, we cannot assume that being able to articulate critical arguments will then transfer into critical action by virtue of classes such as this being a required check box in their program guide. These courses, if not specifically designed to meet this goal (within courses themselves and within the program’s scope and sequence), will not attain such critical praxis – they will not help their students transfer ideological critique into critical reflection or transformative action. Therefore, given these findings, a new research agenda looking at disability and difference is needed, both by those in multicultural education and science education. Without such a self-critique, disability will continue to remain in the proverbial realm of ‘separate but equal’ from the ‘real issues in education’ and difference as a larger conceptual construct will also not meet its goals for bridging theory to practice for graduate students in education. This task, indeed, will not be easy, but it our charge as critical teacher educators when we seek to help others make sense of ‘the word and the world.’
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APPENDICES

APPENDIX A

Research Question and Data Alignment

Research Question 1
To what extent does a 'Science for All'-driven graduate course help a subsample of ten students develop capacities to discern disability as a form of diversity?

<table>
<thead>
<tr>
<th>Primary Data Sources</th>
<th>Secondary Data Sources</th>
<th>Data Collection Time Interval</th>
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<tbody>
<tr>
<td>a) POSTT-DIS Multiple Choice Questions</td>
<td>POSTT-DIS Reflections</td>
<td>Pre-/Post-course</td>
</tr>
<tr>
<td>b) In-depth Interviews</td>
<td>Course-required assignments</td>
<td>Pre-/Post-course; Throughout course</td>
</tr>
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Research Question 2
To what extent did this course help the entire cohort of students embrace a critical lens, and bridge theory to practice?

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<tr>
<th>Primary Data Sources</th>
<th>Secondary Data Sources</th>
<th>Data Collection Time Interval</th>
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</thead>
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<tr>
<td>a) Classroom Learning Environment Questionnaire</td>
<td>-</td>
<td>Post-course</td>
</tr>
<tr>
<td>b) Course Readings Reactions</td>
<td>POSTT-DIS Reflections; Lesson Plans</td>
<td>Bi-weekly</td>
</tr>
<tr>
<td>c) POSTT-DIS Reflections; Lesson Plans</td>
<td>Course Readings Reactions</td>
<td>Pre-/Post-course; Bi-weekly</td>
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## APPENDIX B

Phenomenographic Interview Scenarios and Teacher Responses

### PRE-COURSE PHENOMENOGRAPHIC INTERVIEW PROMPTS

<table>
<thead>
<tr>
<th>Scenario 1: Mary P.1</th>
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</thead>
<tbody>
<tr>
<td>“Mary consistently fails to retrieve important information from memory (e.g. their next classroom), misplaces important papers or objects (e.g. worksheets given to them at the beginning of class are lost shortly afterwards), misinterprets the language and behavior of others (e.g. reacts defensively when any student or teacher talks to them or even accidentally touches them), and resists transitions from one activity to another (e.g. doesn't go back to their seat after group work when asked).”</td>
</tr>
</tbody>
</table>

**Teacher Response to Scenario 1:**

*I would talk with whoever the school specialist is because if it's not just a disorganized thing, if she is, in fact, thrown off behaviorally even by slight changes in my lesson, I would say that's not a pedagogical thing to deal with and I would want to make sure that someone has actually addressed her, like, ‘what's going on’. See if anyone has any ideas of what's that about. I would probably go to guidance first. I would probably go to her counselor and find out if there's some additional information I should know about her and potentially if there were additional information I should know or concerns I have about her behavior being abnormal classroom behavior, I might ask a special education person. But I would go to her counselor first to see if maybe I missed some documentation somewhere along the way.*

<table>
<thead>
<tr>
<th>Scenario 2: Gus P.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Gus frequently has uncontrollable behaviors varying from soft, personal noises to screaming episodes at school, often in the middle of your class.”</td>
</tr>
</tbody>
</table>
Teacher Response to Scenario 2:

I've had students in my class that do those types of things and most of the time I have simply tried to go on with the routine. Well it depends, if the person has Tourette’s and those are parts of the ticks that you have to deal with, and unless it is truly disruptive, I would just go about my lesson and try not call attention to it and hope other students don't call attention to it. If, in fact, it's outbursts of screaming that don't seem like ticks but more like major eruptions then I would probably again, ask for additional support to find out what specifically that student I need to know if I don’t. I'm assuming I would already know enough information about my students to know where the source of that is coming from because if it is a simple issue of ticks and a medical diagnosis then I would do whatever is appropriate for that student. If it's actually outbursts that are behavioral and not related to something that is an 'outbursty' disorder, then I would address it with the counselor.

Scenario 3: Mary P.2

The teacher finds out that the school counselor and school psychologist have labeled Mary “emotionally unstable” and “learning disabled”

Teacher Response to Scenario 3:

I would first of all try and get more specific information about what challenges she has to overcome whether it is mostly organizational, kind of executive challenges with keeping her on track. If, in fact, it's primarily those challenges to kind of organizing her day, organizing her files, organizing her notes, then I would try and work specifically on strategies to, you know, keep her notebook, keep her assignments, things like that on track in class and I would probably check in with her kind of throughout the class in subtle ways but check in with her 'did you get, did you write that down, did you get your, did you put your worksheet in your backpack, did you
write in your homework book that you, that you have this to do tonight’. That kind of stuff and see if those more minor interventions are effective first and then kind of go from there. If she needs more one-on-one kind of time, more direction, I would kind of gradually set it up until I've scaffolded it to a level where she's more functional in class.

Scenario 4: Gus P.2

You observe other students mocking Gus's uncontrollable behaviors, especially during group work that consistently causes students within the group and outside Gus's group to get off task.

Teacher Response to Scenario 4:

Whenever I see kids being disruptive or mocking other kids I don't address it as a group. I might, the first time, walk over to the group and say 'you know, listen, you're off task, this is what you need to do' but if it is a persistent behavior, if they are actually making fun of him, my personal strategy in terms of classroom management is to pull kids aside individually from the class because I find that they are much more uncomfortable having to address that behavior one-on-one with me then when they are in a group being silly. If I see kids giving other kids a hard time I will pull them aside first individually and methodically and if they, and typically that's as far as it goes because once they get called out on an individual level, that's like really uncomfortable as an adolescent, that typically takes care of it, but if I had to go beyond that then, in every school there's kind of procedures for next steps if a kid is actually harassing another kid, you're going to have procedures you need to follow but most of the time you can kind of nip it in the bud in class by calling their attention to the fact that you're watching and know what's going on in a subtle way. And if they don't take to subtly very well, which sometimes adolescents don't, I pull them aside one-on-one and tend to target who the group leader is first and see if that doesn't settle thing down and then if need be go to the other individuals involved. But, I wouldn't make it an
issue of the kid that's got the issue. Right? Because clearly, no adolescent, unless they have a real behavioral or medical issue wants to call that much attention to themselves in a negative way.

POST-COURSE PHENOMENOGRAPHIC INTERVIEW PROMPTS

Scenario 1: Mary P.1

“Mary consistently fails to retrieve important information from memory (e.g. their next class room), misplaces important papers or objects (e.g. worksheets given to them at the beginning of class are lost shortly afterwards), misinterprets the language and behavior of others (e.g. reacts defensively when any student or teacher talks to them or even accidentally touches them), and resists transitions from one activity to another (e.g. doesn't go back to their seat after group work when asked).”

Teacher Response to Scenario 1:

First thing I would do is pull her aside and speak to her privately and figure out if there's something going on either with me or with some other student in the class. If that doesn't work, I would get her guidance counselor involved and the guidance counselor would take it to the next level, probably counsel her a little bit, and then I would probably call her parents, call her house to see if anything is going on at home. If all that doesn't work, we'd probably have the parents come in, myself, the guidance counselor, and maybe the assistant principal and we would have a meeting to try to figure out what the issues are. If she's not a special education student, then that might be one of the issues that maybe she does need to be evaluated. And that's an official process but as time goes by you realize that that is the logical way to do it.

Scenario 2: Gus P.1
“Gus frequently has uncontrollable behaviors varying from soft, personal noises to screaming episodes at school, often in the middle of your class.”

**Teacher Response to Scenario 2:**

*The first thing I would do is talk to the student privately and figure out what the issues are. If it's uncontrollable behavior, in terms of disrupting the class, I would also let the student know that if they do it again and they disrupt and stop the class, then I would have to get the dean's involved because they're preventing their peers from getting an education. If that doesn't work and disciplinary action doesn't work, then we would again get the guidance counselors and the parents involved. That's what we do.*

**Scenario 3: Mary P.2**

The teacher finds out that the school counselor and school psychologist have labeled Mary “emotionally unstable” and “learning disabled”

**Teacher Response to Scenario 3:**

*Number one, if she's labeled emotionally unstable she would probably either be put in a self-contained special education class or an inclusive class, which is a class that has a general education teacher and a special education teacher, like a co-teaching class. The co-teacher and I (the special education teacher and I) would try to formulate a plan for her and differentiate the lessons based on that. So whatever lessons we're teaching that day the special education person would just kind of manipulate everything to make sure that we can get it to her, you know. In terms of the behavior, I would say that if they have diagnosed her and we know what her IEP says, then we would probably try to formulate some method of calming her down or figuring out some way to help her transition properly because she probably not going to respond like a normal student would*
<table>
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<th><strong>Scenario 4: Gus P.2</strong></th>
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<td>You observe other students mocking Gus's uncontrollable behaviors, especially during group work that consistently causes students within the group and outside Gus's group to get off task.</td>
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<th><strong>Teacher Response to Scenario 4:</strong></th>
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<td><em>If it is kids that are in his group I would re-assign him. When, in a situation like that, I think the teacher has to be hyperaware of the social interactions of every student in the classroom. And one of the things is that when we do grouping, you know, it's very purposeful. I would pick, in Gus's situation, I would pick the best performing student, the most well-behaved student to be his group member, to be his partner. Maybe I would break the groups down from 4 into just 2, you know, because sometimes I group of 4 doesn't work. In fact, a lot of times a group of 4 doesn't work, they just get off task. So I would pick the student in the room that's most well-behaved, and there's always, you know, at least one kid that is most well-behaved, and I would partner Gus with that particular student. Because the most well-behaved student is probably going to encourage him the most, give him the most praise, and help him the most. And when the other kids in the room see that, they're going to back off. They will, from experience, that's usually what happens, not all the time.</em></td>
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APPENDIX C
POSTT-DIS 1 Questionnaire

Dem. Please write your last name:

Q1.

Mr. Goodchild is a Biology teacher in NYC and has a special education specialist with no background in science co-teaching with him. Mr. Goodchild wants to do a frog dissection with his science class that contains 30 high school students (20 general education and 10 special education) to help teach them learn about anatomy. Thinking about how you would teach this lesson, of the following, which is most similar to what you believe is the best way for Mr. Goodchild and his co-teacher to incorporate a dissection into his lesson:

○ It should be used as a stand-alone step-by-step activity for students to explore the frog’s anatomy and raise discussion questions on their own;

○ It should be used as a follow-up step-by-step student activity after Mr. Goodchild explains exactly what students will need to notice about the frog anatomy;

○ It should be used as a step-by-step student activity while answering probing questions, followed up by teacher-led discussion and clarifications;

○ It should be used as a step-by-step demonstration by Mr. Goodchild while he explicitly points out what students need to know about frog anatomy.

Q1a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q2.
Ms. Pendleton is a Biology teacher in NYC and wants to teach her 30 high school students (20 general education and 10 special education) that living organisms respond to their environment, she has a special education specialist with no background in science co-teaching with her. The students did an experiment on how earthworms respond to their environment. Then in small groups they discussed a series of questions about the experiment. Ms. Pendleton now needs to wrap up the lesson. Of the following, which one is most similar to how you think this co-teaching pair should wrap up this lesson?

- Have the students come up with a general conclusion based on the evidence they gathered from their earthworm experiment, guiding them toward the concept objective.
- Restate the concept objective for the students, and ask students to provide supporting evidence from their earthworm experiment
- Have students report their conclusions, based on the evidence gathered from their earthworm experiment.
- Restate the concept objective for the students, relating it to the observations they gathered in their earthworm experiment.

Q2a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q3.

Ms. Rice is an Earth and Space Science teacher in NYC that has a special education specialist with no background in science co-teaching with her and is about to begin teaching her 30 high school students (20 general education and 10 special education) that the rotation of the Earth causes day and night. She begins by shining a light (the sun) on a rotating globe (the earth). She asks the students to pay attention to a bright red dot she has placed on the globe, and asks several questions about where the dot is in relation to the light. Ms. Rice reinforces student learning by explaining how day and night are related to the Earth's
rotation, while again demonstrating this with the light and globe. Thinking about how you think this idea would be best taught, of the following, how do you think this pair of teachers should change this lesson?

○ First I would have begun the lesson by explaining how day and night are related to the Earth’s rotation. The class could then predict if the red dot would be in the light or dark during demonstration.

○ First, I would have had students closely observe what happens at the red dot as I rotated the globe. Then, I would ask the students to draw their own pictures of their observations. The lesson would end with a class discussion of their observations.

○ I would have begun the lesson by explaining how day and night are related to the Earth’s rotation using the light bulb and globe to demonstrate my explanation.

○ I would conduct this lesson in a similar way to Ms. Rice.

Q3a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q4.

Ms. Brandt is a Physics teacher in NYC with a special education specialist with no background in science co-teaching with her and is preparing a lesson to introduce her 30 high school students (20 general education and 10 special education) to the relationship between force and motion, namely that a net force will cause an object to speed up or slow down (Newton’s 2nd Law). The classroom has available a loaded wagon to which a pulling force can be applied. Ms. Brandt is considering four different approaches to the lesson. Thinking about how you think this concept would be best taught in this context, of the following, which one should they do?
Write a clear statement of Newton’s 2nd Law on the board and explain it carefully to my students. Then I would demonstrate the law by pulling on a loaded wagon with a constant force in front of the class as they observe the motion.

Raise the question of what kind of motion results from a constant force. I would then guide my students to explore the question themselves by pulling on a loaded wagon and observing what happens. From the evidence they would then propose a possible law.

Write a clear statement of Newton’s 2nd Law on the board and explain it carefully to my students. I would then have the students verify the law by pulling on a loaded wagon themselves and confirming what type of motion results.

Raise the question of whether there is any relationship between force and motion. My students would then be free to explore this safely in the lab. Afterward we would have a class discussion of their findings.

Q4a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q5.

Ms. Harvey and her co-teacher that is a special education specialist with no background in science have a high school Chemistry class with 20 general education and 10 special education students in NYC who have been learning about matter. She now wants her students to learn that gases (like those in air) are also a form of matter. She plans to introduce her lesson by raising some questions with her students about whether air is matter, and how they could find out. Ms. Harvey is still considering what to do next. Thinking about how you think this concept is best taught, of the following, which one should this pair of teachers do?
I would ask students to think up ways to test if air is matter using whatever equipment we have in the classroom. I would then allow them to go ahead and try their ideas.

I would help the students develop ways to test the question of whether air is matter, allow them to investigate with fans, and use their findings to conclude that it is.

I would tell the students that air is indeed matter, and that although air is not very dense, there is something there that can be felt. I would then ask them to use fans at their desks to see if they could find evidence that air was indeed matter.

I would tell the students that air is indeed matter, and that although air is not very dense, there is something there that can be felt. I would then demonstrate this property to the class by having them feel the air from a fan.

Q5a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q6.

Mr. Nelson is a NYC Earth and Space science teacher with a special education specialist co-teaching with him that has no background in science. Their classroom contains 30 students (20 general education and 10 special education) that have just completed a unit in their earth science class. As a “wrap-up,” Mr. Nelson would like students to re-examine the three learning objectives that served as the focus for this entire unit. Of the following, which way do you think would be the best option for them to conduct the wrap-up?

I would ask the students what the main things are that they have learned in the unit, according to their own ideas of what is important or interesting, and have them list these as the unit wrap-up.

I would restate the three learning objectives for the students, and then relate each of them to the specific concepts that arose in the unit.

I would ask the students to reflect back on their work, and identify for themselves what the important central ideas of the unit were, then have them relate these to the original learning objectives.
I would restate the three learning objectives, then ask the students to say how the various concepts that arose in the lesson related to each of these.

Q6a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q7.

Mr. Danzit is a high school Biology teacher in NYC that will be teaching his 30 students (20 general education and 10 special education) a lesson on “structure and function” as applied to digestive systems with his special education specialist co-teaching with him, however this co-teacher has no background in science. He has a set of pictures showing the mouths of different animals, including a finch beak, a dog jaw with teeth, and horse jaw with teeth. He also has a chart that he can distribute to the students, which will allow them to fill in information about what each of these animals can and cannot eat. Thinking about how you think it would be the best way to teach the concepts of this lesson, of the following, which is the best statement on how these teachers should begin the lesson?

Mr. Danzit should begin the lesson by carefully explaining the concept of structure and function as it relates to the digestive system, specifically mouth parts. He should then ask the students to fill out the chart using the pictures and his discussion as a guide.

Mr. Danzit should allow the students to explore a set of photos showing animal mouths. He should then have the students write their own stories about how these animals are similar and different, including what they eat.

Mr. Danzit should begin the lesson by carefully explaining the concept of structure and function, while helping students fill in their charts, so they can clearly see examples of this concept as it relates to digestive systems.

Mr. Danzit should begin the lesson by showing his students a picture of a shark mouth, asking student what this animal might eat. After a discussion, he should give each student a
copy of the chart and the other pictures, asking students to complete the chart based on their early discussion.

Q7a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q8.

Ms. Piper is an Environmental Science high school teacher in NYC with a co-teacher that has no background in science but is a special education specialist. This co-teaching team are taking their 30 student (20 general education and 10 special education) environmental science class to the local nature center with additional chaperones not familiar with science. Because they are currently studying food webs, they would like to use the field trip as a way to learn more about this topic. Thinking about how you think this trip would be best utilized to teach this concept, of the following, how should this team use this field trip to teach students about food webs?

- I would inform them that on our upcoming field trip they will be looking for examples of food webs. During the field trip, students could make their own list of interactions they observe relating to food webs, which we would discuss later as a group.

- I would inform students before the field trip that we are going to look for specific examples of food webs, providing them a checklist of interactions they should see. During the field trip, I would point out to them interactions, having them mark off each as we go.

- I would not tell students exactly what to look for during the field trip, but would ask them to make observations about any of the interactions they see between organisms. Afterward we could discuss what they saw relating to food webs.
I would inform students before the field trip that we are going to look for specific examples of food webs, providing them a checklist of interactions they should see. During the field trip, students could look for those examples and mark them off as we go.

Q8a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q9.

Mr. Peoples is a high school Biology teacher in NYC that has a co-teacher who specializes in special education but has no background in science. They are conducting a unit on food chains and are about to introduce their 30 students (20 general education and 10 special education) to predator/prey relationships. They have a good computer simulation game for this subject that they can use with this class. Thinking about how this concept would be best taught in this lesson, of the following, which is the best advice for conducting this lesson?

Mr. Peoples should explain to his students that balance typically exists in nature such that the numbers of predators and their prey are related. For example, he can tell them that a rabbit population will increase if disease reduces the coyote population in the same region. He should then project the simulation game to demonstrate relationships between rabbit and coyote populations.

Mr. Peoples should explain to his students that balance typically exists in nature such that the numbers of predators and their prey are related. For example, he can tell them that a rabbit population will increase if disease reduces the coyote population in the same region. Using the computer simulation game, he should have the students monitor and record the rabbit levels over a simulated ten year period during which the population of coyotes rises and falls, so that they can confirm the predator/prey concept he explained.
Mr. Peoples should ask what would happen with rabbits if many coyotes died suddenly of disease. After some discussion, Mr. Peoples should suggest that the students explore their ideas using the computer simulation game he has for this subject, by recording yearly counts over a simulated period of ten years. The students will then have data to be used in a class discussion on predator/prey relationships.

Mr. Peoples should begin by asking the students what they know about predators and prey. Without responding other than to encourage their ideas, Mr. Peoples should then show them the computer simulation game he has for this subject and invite them to use the simulation in any way they wish to explore their ideas. The lesson would end with students writing up their findings.

Q9a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q10.

Ms. Cubbage’s high school Environmental science class in NYC has been learning about soil types by observing soil color and texture (particle size). She is co-teaching this class of 30 students (20 general education and 10 special education) with a special education specialist with no science background. While making observations of soil samples, the students notice that some soil types seem more “fluffy” than others. Ms. Cubbage realizes that her students are referring to porosity (how densely the materials are packed together, ability to allow water to move through) which is one of the key concepts later in her unit. Thinking about how you think this concept would be best taught in this lesson, of the following, which is the best way that Ms.Cubbage and her co-teacher should respond to the students’ observation?
I would congratulate the students on such a good observation, then explain to them that porosity is a description of how densely packed soils are. I would then tell students how to test soils for it, and follow up by doing tests on our soil samples for porosity.

I would congratulate the students on such a good observation, and ask them what they thought they were looking at. Through discussion I would try to get them to think about packing and how one might test for packing. We would do tests and based on their findings, I would introduce the concept of porosity.

I would recognize that what is most important here is that the students were being independent investigators, not necessarily that they were stumbling upon the idea of porosity. I would simply encourage their scientific attitudes and have them continue their investigations.

I would congratulate the students on such a good observation, then explain to them that what they observed was called porosity. Using a demonstration, I would show the students that more porous soils are less packed and that water moves more easily through porous soils.

Q10a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q11. Ms. Walters is a high school Environmental science teacher in NYC that co-teaches with a special education specialist that has no background in science. They want to start teaching their 30 students (20 general education and 10 special education) about water movement and bodies of water on Earth, i.e., to understand that when rain falls on Earth the water flows downhill into bodies of water (streams, rivers, lakes, oceans), or into the ground. Thinking of how they should design a lesson for their students, which of the following approaches would you suggest Ms. Walters and her co-teacher take?
Have student groups shape soil into hills and valleys and sprinkle water onto it, but don’t tell them in advance what it is about or what to focus attention on. Have them report what they observe happens and suggest if this is similar to anything on Earth.

Project a diagram showing rain falling onto the earth, and water running downhill to form streams, rivers, lakes and oceans, with some going into the ground. Then go over each aspect carefully while pointing to it on the diagram, taking questions along the way.

Tell students that rain falling on the ground will flow downhill to form streams, rivers, lakes and oceans. Demonstrate this with a model: a large shallow box of soil, shaped into hills and valleys. Students watch as she sprinkles water from the spray nozzle of a watering can, and asks them to notice how it flows downhill to form streams and then ponds.

Provide a box of soil at each bench and have groups shape landscapes in it with hills and valleys. Have them suggest what might happen if they sprinkle water on it to represent rain. Then have them try it out, report their observations and relate that to what happens on Earth.

Q11a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q12.

Mr. Golden is a high school Physics teacher in NYC that co-teaches with a special education specialist with no background in science. They have introduced the topic of magnetism to their 30 students (20 general education and 10 special education), and they have learned that bar magnets attract certain kinds of materials that have iron in them. For today’s new lesson, they have available bar magnets and a variety of food containers, made of plastic, iron,
aluminum, steel, and glass. Thinking about the best way to teach this concept, of the following, which is the way this team should conduct this lesson?

☐ I would tell the students that our assignment for the day is to solve the puzzle of which food containers contain iron and which do not. Students would be asked to think of how they could find out, and they would either come up with or be prompted to use bar magnets to test the various kinds of food containers.

☐ I would remind the class that magnets attract materials which contain iron (including most steels), and then show them how the bar magnet attracted the containers made from steel or iron, but not any of the other containers.

☐ I would tell the class to recall that magnets attract materials which contain iron (including most steels), and then have small groups of students use bar magnets to sort the food containers into those which do contain iron and those which do not.

☐ Each group of students would be provided with a bar magnet and the various kinds of food containers. I would not outline a specific task but ask them to find out what they can about the collection, and report back their observations and conclusions.

Q12a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q13.

Ms. Baker is a high school Physics teacher in NYC and is teaching her 30 students (20 general education and 10 special education) the law of reflection: when a ray of light strikes a mirrored surface, it leaves at the same angle as when it arrived. Ms. Baker has to decide how she will co-teach the lesson with her special education specialist that has no
background in science. Thinking about the best way to teach this concept, of the following, which is the best way they should teach the lesson?

- I would write the law of reflection on the board and illustrate with a diagram. Next I’d show them a real example, using a light ray source, mirror, and protractor. Then we would discuss any questions the students might have.

- I would ask students to find out what they can about light behavior around mirrors by exploring on their own with an assortment of available items, including light ray sources, mirrors, and protractors. Then the students would report back on what they did and what they found out.

- I would first pose a question about reflection for the students to explore. The students could investigate using light ray sources, mirrors, and protractors, and then discuss their findings. I would close the lesson by giving them a summary of the law of reflection.

- I would write the law of reflection on the board and illustrate with a diagram. Then I’d have the students verify the law using light ray sources, mirrors, and protractors. We would then discuss their findings.

Q13a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option

Q14.

Ms. Adams’s 30 high school Chemistry students in NYC (20 general education and 10 special education) have learned that light travels in a straight path and that shadows arise when an object blocks light. Ms. Adams, co-teaching with a special education specialist with no background in science, wants her students to be able to apply these ideas to make predictions about shadow behavior. They turns out the main room lights, and have one child Sam stand in the light from a lamp on the floor, casting a shadow on the wall. Students draw ray diagrams in their notebooks showing how Sam’s shadow is being formed. They state that once we understand how shadows form we can predict what will happen to the shadow if Sam moves further from the lamp. Thinking about the best way to teach this concept, how would you suggest this co-teaching team continue this part of the lesson?
Have students follow her directions to make a second diagram in their notebooks with Sam further away, and point out to them how this shows the shadow becomes smaller. Then have Sam move to confirm the prediction.

Draw a ray diagram on the board to show that the shadow will be smaller when Sam is further from the lamp. Then have Sam move to confirm this prediction.

Ask students to predict what will happen to the shadow, in whatever way they wish, and explain their predictions. Then have Sam move to check the predictions. If there are discrepancies let the students discuss and resolve.

Ask each student to make their own prediction of what will happen to the shadow, based on what they have learned about shadow formation, using a ray diagram. Then have Sam move to check their predictions. If there are discrepancies, discuss with the students and resolve.

Q14a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q15.

Ms. Katinka is teaching her high school Chemistry class in NYC about the concept of volume with her co-teacher that specializes in special education but has no background in science. They begin the lesson by showing her 30 students (20 general education and 10 special education) two differently sized jars, each filled with jelly beans. They explain that the jelly beans are a kind of measurement with the number of jelly beans telling how much room is in the jar, that is, the volume of the jar. They then have the students count the number of jelly beans in each jar and compare the volume. They then finish their lesson on volume. Thinking about the best way to teach this concept, of the following, which is the best evaluation of this lesson so far?
I would teach this lesson much the same way, except that I would tell the students how many jelly beans were in each jar, so there were no mistakes.

I would have begun by asking students which jar they believe holds more jelly beans and how they could find this out, which would naturally lead to counting the jelly beans. After this I would suggest that the jelly beans could be used as a way to measure volume.

Rather than the teacher explaining that the jelly beans are a kind of measurement, she should have first allowed the students to experiment by filling jelly beans into jars of different sizes and shapes, and then elicited the students’ ideas about what the different numbers of jelly beans tells us about the different jars.

I would teach this lesson much the same way.

Q15a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?

Q16.

Ms. Luna and her co-teacher (who specializes in special education but has no background in science) had taught their 30 NYC high school Earth and Space science students (20 general education and 10 special education) how the phases of the moon are due to its illumination by the sun at different angles. As part of their lesson they used a picture of the moon phases, illustrating how the various phases look at night. Toward the end of the lesson one student Max looks out the window at the sky. He is surprised: he excitedly tells Ms. Luna and the co-teacher he can see the moon but it is daytime! He is puzzled and asks how that can be. The co-teaching team wants to use this as a ‘teachable moment’ to enhance their understanding of how moon phases arise. They congratulate Max on his observation and has everyone go outside to look before coming back in. Thinking about how to harness this experience the best way possible to teach this concept, how would you suggest this co-teaching team to continue when back in the classroom?
Throw back Max’s question to the students: ask them to explain the observation by drawing sky diagrams for that day showing moon and sun and applying what they have learned about light and illumination.

Tell the class there is no reason that the moon cannot be seen in the daytime. Then ask students to apply what she has taught them and draw diagrams showing how the moon is being illuminated by the sun that particular day.

Tell the class there is no reason that the moon cannot be seen in the daytime. Then draw a sky diagram on the board showing how the moon is being illuminated by the sun that particular day.

Throw back Max’s question to the students: have them come up with ideas and possible explanations and report these to the class, followed by discussion.

Q16a. Please elaborate why you chose the answer you did for the previous scenario. For instance, was it a guess, did you remember an example you experienced in a class that you compared it to, and/or have you done this lesson before?

Also, what other option would you choose if you were able to pick another choice? Why would you choose this other option?
APPENDIX D

Course Syllabus

URBAN AND MULTICULTURAL SCIENCE EDUCATION
The chief goal of this course is to prepare students for research and practice in science education that considers culture as a fundamental component of effective science teaching and learning. The class will interrogate the term “multicultural science education” and will lead students to question whether or not multicultural education/multiculturalism has true meaning in current research and practice for science educators. Together, we will challenge whether or not the notion of “science for all” is sufficient for effective teaching of marginalized populations, will read and discuss articles related to multiculturalism and science education, study videotape of urban classrooms, and discuss the role of culture in how individuals form their views of science. We will also interrogate the outline of multi-cultural science education laid out above and discuss whether or not this is an accurate way of looking at multicultural science education.

**Instructional methods implemented in the course**
1. Direct instruction
2. Reflection through Discussion
3. Reflective Personal Narratives
4. Small group cooperative project work
5. Small group cooperative curriculum development

**Required text**

**CLASS ASSIGNMENTS: All submitted online through Course Portal**

**Read and Reflect Papers (R&Rs)**
R&R 1, Due Class 2: (3-4 pages, Times New Roman, double-spaced, 12 pt. font)
Address the following two questions:
1) What science experiences have I had in my life, both in and out of school, and how did those experiences frame my vision of science?
2) In what ways were those experiences unique to me given my own cultural histories?

Provide a timeline of the science experiences you have had in and out of education from Kindergarten to now in a concept map graphic form in the appendix of your paper as a reference so as to guide your reflection on your experiences (5 points)
R&R II, Due Class 7: (3-4 pages, Times New Roman, double-spaced, 12 pt. font)

Based on the feedback and questions provided in R&R I by your instructor and the additional readings you have done up to now in the course, reflect on your understandings of the relationship between science and culture. Explain how culture influences your current vision for science and science education. (5 points)

R&R III, Due Class 13: (3-4 pages, Times New Roman, double-spaced, 12 pt. font)

Based on the feedback and questions provided in R&R I and II and the additional readings you have done up to now in the course, reflect on what it means to teach a form of science that is multicultural and include your conceptual and philosophical perspective on multicultural science teaching and learning. Then describe how this ties in (or not) with your science experiences. Include your goals for continuing the process of becoming a science educator with a multicultural perspective (5 points)

Teaching “Science for All” Final Essay

Due Class 15: (12-15 pages, Times New Roman, double-spaced, 12 pt. font)

Write a final paper connecting science, culture, human values, human rights, ability, and society. Use your R&Rs as a starting point, but make extensions to your current and future students, their cultures, and their communities. Be attentive to culture as it is framed by: ethnicity and race, gender, socioeconomics, language, disability, sexuality, religion, and other factors. Be sure to include a discussion of how an understanding of science, culture and human valued impacts (and should impact):

- Perceptions of students in and out of your classroom,
- Influence of experience on perceptions and conceptions,
- Pedagogies you consider using to teach all students,
- Assessment designs to include all students,
- Student groupings to engage all students in discussions,
- Topic selections for your curriculum to engage all students,
- Community connections for concepts to include diverse worldviews.

Reading Reactions/Lesson Plans

Every week we will write either a lesson plan or a reflection. We will try to reserve the last five minutes of class to start this activity, which will be submitted online. Reflections will be structured around pertinent topics for that week. The lesson plans will be centered around multicultural science education theory and practice that you intend to employ.

Reading Reactions are NOT:

- Article summaries. We’ve all read the articles—we don’t need a summary.
- Stream of consciousness. I expect complete sentences, punctuation, etc. While the reactions are certainly more informal than a short paper, you should use them as practice for improving your writing.
- A place for uncritical rants. While you should feel free to be passionate and opinionated in your reactions, you should continue to be thoughtful and critical in your response.
Reading Reactions ARE:
• Opportunities for you to express your agreement, disagreement, confusion, etc about the readings assigned for the week.
• Opportunities for you to see how your classmates are making sense of the articles.
Likewise, they are also a space for informal discussion about the readings based on your own personal experiences, your perceptions of your future classrooms, and the like.

Class 1: Why are we here? What do we want to accomplish in the course?

READING REACTION DUE BY MIDNIGHT

Class 2: What philosophies have you adopted and envision for your practice?

R&R 1 DUE BY MIDNIGHT
READING REACTION DUE BY MIDNIGHT

Class 3: How does space and place influence access and ability?

LESSON PLAN DUE BY MIDNIGHT

Class 4: How does education adapt for non-traditional students?

READING REACTION DUE BY MIDNIGHT

Class 5: How do educators perceive diverse students for science education?

LESSON PLAN DUE BY MIDNIGHT

Class 6: How can we conceptualize science education in diverse and critical ways? Why is it important to do this for our practices?

READING REACTION DUE BY MIDNIGHT

Class 7: How can race, gender, class, and disability intersect in science education?


**R&R 2 DUE BY MIDNIGHT**

**LESSON PLAN DUE BY MIDNIGHT**

Class 8: How does science education 'play out' in classrooms? What influences it? What place does the teacher have in mediating teaching and learning?


**READING REACTION DUE BY MIDNIGHT**

Class 9: How does culture play a role in the development of science educators?


**LESSON PLAN DUE BY MIDNIGHT**

Class 10: What type of science “education” is valued amongst science teachers? Why do you think this is the prevalent way to teach? Who does it benefit?


**READING REACTION DUE BY MIDNIGHT**

Class 11: What does it mean to be 'smart' in a science classroom?


of Intersections between Whiteness and Disability Studies. *Teachers College Record, 113*, 2206-2232.

**LESSON PLAN DUE BY MIDNIGHT**

**Class 12:** Does having a different worldview of science and science education influence teaching and learning practices teachers perform? Why or why not?


**READING REACTION DUE BY MIDNIGHT**

**Class 13:** How can we engage science through critical understandings of the world?


**R&R 3 DUE BY MIDNIGHT**

**LESSON PLAN DUE BY MIDNIGHT**

**Class 14:** What do we mean by 'achievement' in science education? How can we measure it more effectively and why does it matter if we do so or not?


**READING REACTION DUE BY MIDNIGHT**

**Class 15:** *LESSON PLAN DUE BY MIDNIGHT*
# CLASSROOM LEARNING ENVIRONMENT QUESTIONNAIRE

Please circle one number in each row, for each question

<table>
<thead>
<tr>
<th>#</th>
<th>Question</th>
<th>DISAGREE</th>
<th>AGREE</th>
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</thead>
<tbody>
<tr>
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<td>This class provides an environment for free and open expression of ideas</td>
<td>-3</td>
<td>+1</td>
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<tr>
<td>2</td>
<td>The physical environment was comfortable and accessible for all students</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>3</td>
<td>Grades are assigned fairly and impartially in this class</td>
<td>-3</td>
<td>+1</td>
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<tr>
<td>4</td>
<td>The instructor encourages mutual respect among all students</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>5</td>
<td>Instructor takes into consideration differences among students in teaching this course</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>6</td>
<td>The instructor is fair and unbiased in treatment of all students</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>7</td>
<td>Sometimes instructor makes inappropriate comments about people who are different</td>
<td>-3</td>
<td>+1</td>
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<tr>
<td>#</td>
<td>Question</td>
<td>DISAGREE</td>
<td>AGREE</td>
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<tr>
<td>8</td>
<td>The instructor is sensitive to the difficulty of course work for students</td>
<td>-3</td>
<td>+1</td>
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<tr>
<td>9</td>
<td>The instructor encourages equal participation of all students</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>10</td>
<td>Inappropriate comments are not tolerated in this class</td>
<td>-3</td>
<td>+1</td>
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<td>11</td>
<td>The instructor values the diverse life experiences of the students in this class</td>
<td>-3</td>
<td>+1</td>
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<td>12</td>
<td>The instructor recognizes that I have important ideas to contribute</td>
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<td>+1</td>
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<tr>
<td>13</td>
<td>The instructor respects me as a person</td>
<td>-3</td>
<td>+1</td>
</tr>
<tr>
<td>14</td>
<td>Sometimes I am singled out because I am diff from most of other students</td>
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<td>+1</td>
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<tr>
<td>15</td>
<td>The instructor makes me feel welcome in his/her classroom</td>
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<td>+1</td>
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<tr>
<td>16</td>
<td>Sometimes I am called on to be representative of a particular demographic group</td>
<td>-3</td>
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<td>17</td>
<td>The instructor expects that I will do well in this class</td>
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<td>+1</td>
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<tr>
<td>18</td>
<td>I feel isolated in this class</td>
<td>-3</td>
<td>+1</td>
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<tr>
<td>19</td>
<td>I am often ignored in this class even when I attempt to participate</td>
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<td>#</td>
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<tr>
<td>20</td>
<td>When I make a comment in this class I am usually taken seriously by the instructor</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
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<tr>
<td>21</td>
<td>When we work in small groups in this class, I have the opportunity to be the leader</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
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<tr>
<td>22</td>
<td>When we work in small groups in this class, I am often ignored by my classmates or given trivial jobs</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
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<tr>
<td>23</td>
<td>The courses I enjoy most are those that make me think about things from a different perspective</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
</tr>
<tr>
<td>24</td>
<td>The courses I enjoy most emphasize traditional values and perspectives</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
</tr>
<tr>
<td>25</td>
<td>I enjoy taking courses that challenge my beliefs and values</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
</tr>
<tr>
<td>26</td>
<td>I enjoy talking with people who have values different from mine</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
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<tr>
<td>27</td>
<td>Learning about different cultures or perspectives is a very important part of college education</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
</tr>
<tr>
<td>28</td>
<td>The real value of college education lies in being introduced to different values and perspectives</td>
<td>-3 -2 -1</td>
<td>+1 +2 +3</td>
</tr>
<tr>
<td>#</td>
<td>Question</td>
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<tr>
<td>29</td>
<td>Contact with individuals who are different from me is an essential part of my college education</td>
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<td>-2</td>
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<td></td>
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<td>-1</td>
<td>+3</td>
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<tr>
<td>30</td>
<td>If I work hard I am almost always assured of getting the grade I want to achieve</td>
<td>-3</td>
<td>+1</td>
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<td>-1</td>
<td>+3</td>
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<tr>
<td>31</td>
<td>Based on my experience in this course, I am looking forward to taking more courses in this department/major</td>
<td>-3</td>
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<td></td>
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<td>-2</td>
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<td>-1</td>
<td>+3</td>
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<tr>
<td>32</td>
<td>Based on my experience in this course, I think I have a good chance of being successful if I continue to study this subject</td>
<td>-3</td>
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<td>-1</td>
<td>+3</td>
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<tr>
<td>33</td>
<td>Compared to other students in this class, in order to succeed I had to work</td>
<td>-3</td>
<td>+1</td>
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</table>
APPENDIX F

Open-Ended Questioning for Bi-Weekly Lesson Plans

Who are you teaching?

What are you teaching them?

How will you teach them this topic?

Why are you teaching them this topic?

How will you know what they have learned?
### APPENDIX G

#### POSTT Keys

<table>
<thead>
<tr>
<th>POSTT 1 (Item page number &amp; response key)</th>
<th>POSTT 2</th>
<th>POSTT 3</th>
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<tbody>
<tr>
<td>POSTT 1</td>
<td>POSTT 2</td>
<td>POSTT 3</td>
</tr>
<tr>
<td>1 – Frog dissection 1</td>
<td>1 – Frog dissection 1</td>
<td>1 – Water cycle</td>
</tr>
<tr>
<td>A – 4 → open inquiry</td>
<td>A – 4 → open inquiry</td>
<td>A – 4 → open inquiry</td>
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<tr>
<td>B – 2 → active direct</td>
<td>B – 2 → active direct</td>
<td>B – 2 → active direct</td>
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<tr>
<td>C – 3 → guided inquiry</td>
<td>C – 3 → guided inquiry</td>
<td>C – 3 → guided inquiry</td>
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<tr>
<td>D – 1 → didactic direct</td>
<td>D – 1 → didactic direct</td>
<td>D – 1 → didactic direct</td>
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<td>2 – Organisms respond to environment</td>
<td>2 – Lesson on force and motion</td>
<td>2 – Air takes up space</td>
</tr>
<tr>
<td>A – 3 → guided inquiry</td>
<td>A – 3</td>
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<td>B – 2 → active direct</td>
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<td>3 – Earth rotation</td>
<td>3 – Bar charts</td>
<td>3 – Plants and life</td>
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<td>4 – Frog dissection 1</td>
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<tr>
<td>5 – Air is matter</td>
<td>5 – Thermometers and how they work</td>
<td>5 – Clouds</td>
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<td>6 – General wrap-up of unit</td>
<td>6 – Inheritance</td>
<td>6 – Lesson on force and motion</td>
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<td>7 – Structure and function</td>
<td>7 – Standard</td>
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<td>8 – Field Trip</td>
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<td>9 – Predator and prey</td>
<td>9 – Succession</td>
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<td>10 – Soil properties</td>
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<td>10 – Static electricity</td>
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<td>11 – Rain and water flow</td>
<td>11 – Rain and water flow</td>
<td>11 – Fixed quantities: a teachable moment</td>
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<td>12 – Magnets and materials</td>
<td>12 – Sediments and water</td>
<td>12 – Rain and water flow</td>
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<td>13 – Light reflection</td>
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<td>13 – Stream table</td>
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<td>14 – Light &amp; shadows (a teachable task)</td>
<td>14 – Photosynthesis</td>
<td>14 – Final miss exceptions</td>
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</tr>
<tr>
<td>B – 1</td>
<td>B – 1</td>
<td></td>
</tr>
<tr>
<td>C – 4</td>
<td>C – 4</td>
<td></td>
</tr>
<tr>
<td>D – 3</td>
<td>D – 3</td>
<td></td>
</tr>
<tr>
<td>15 – Volume 4</td>
<td>15 – Sink or float</td>
<td>15 – Light reflection</td>
</tr>
<tr>
<td>A – 1</td>
<td>A – 1</td>
<td>A – 1</td>
</tr>
<tr>
<td>B – 3</td>
<td>B – 3</td>
<td></td>
</tr>
<tr>
<td>C – 4</td>
<td>C – 4</td>
<td></td>
</tr>
<tr>
<td>D – 2</td>
<td>D – 2</td>
<td></td>
</tr>
<tr>
<td>16 – Moon in the daytime (a teachable moment)</td>
<td>16 – Variety of wheat</td>
<td>16 – Linear nomenclature system of classification</td>
</tr>
<tr>
<td>A – 3</td>
<td>A – 3</td>
<td>A – 3</td>
</tr>
<tr>
<td>B – 2</td>
<td>B – 2</td>
<td></td>
</tr>
<tr>
<td>C – 1</td>
<td>C – 1</td>
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</tr>
<tr>
<td>D – 4</td>
<td>D – 4</td>
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</tr>
</tbody>
</table>
## APPENDIX H

Initial Teacher Reflection Rubric Content (Ward & McCotter, 2004)

<table>
<thead>
<tr>
<th>Focus (What is the focus of concerns about practice?)</th>
<th>Routine</th>
<th>Technical</th>
<th>Dialogic</th>
<th>Transformative</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-disengaged from change</strong></td>
<td><strong>Instrumental response to specific situations without changing perspective</strong></td>
<td><strong>Inquiry part of a process involving cycles of situated questions and action, consideration for others’ perspectives, new insights</strong></td>
<td><strong>Fundamental questions and change</strong></td>
<td></td>
</tr>
<tr>
<td>Focus is on self-centered concerns (how does this affect me?) or on issues that do not involve a personal stake. Primary concerns may include control of students, time and workload, gaining recognition for personal success (including grades), avoiding blame for failure.</td>
<td>Focus is on specific teaching tasks such as planning and management, but does not consider connections between teaching issues. Uses assessment and observations to mark success or failure without evaluating specific qualities of student learning for formative purposes.</td>
<td>Focus is on students. Uses assessment and interactions with students to interpret how or in what ways students are learning in order to help them. Especially concerned with struggling students.</td>
<td>Focus is on personal involvement with fundamental pedagogical, ethical, moral, cultural, or historical concerns and how these impact students and others.</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX I

List of Abbreviations

CC = Conceptual Change

CLE = Classroom Learning Environment (Questionnaire)

POSTT = Pedagogy of Science Teaching Test

SPED = Special Education

UMSTE = Urban and Multicultural Science Teacher Education