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Complexity Of Affective Disposition And Reflective Transphenomenality: An Exploratory Study Of Middle School Mathematics Teacher And Student Self-Positioning And Positioning-By-Others Toward Mathematics, Mathematics Teaching, And Learning

Ruby Lorilee Lynch-Arroyo
University of Texas at El Paso, rllynch@miners.utep.edu

COMPLEXITY OF AFFECTIVE DISPOSITION AND REFLECTIVE TRANSPHENOMENALITY: AN EXPLORATORY STUDY OF MIDDLE SCHOOL MATHEMATICS TEACHER AND STUDENT SELF-POSITIONING AND POSITIONING-BY-OTHERS TOWARD MATHEMATICS, MATHEMATICS TEACHING, AND LEARNING

RUBY LORILEE LYNCH-ARROYO, MPA

Department of Teacher Education

APPROVED:

____
Mourat Tchoshanov, Ph.D., Chair

____
William Medina-Jerez, Ph.D.

____
Lawrence Lesser, Ph.D.

____
Benjamin C. Flores, Ph.D.
Dean of the Graduate School

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By

RUBY LORILEE LYNCH-ARROYO, MPA

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Abstract

The purpose of the mixed methods study was to examine the phenomenon of transphenomenal simultaneity between teacher and student disposition that contributed to the phenomenological conflict of teacher self-positioning and positioning-by-others toward mathematics, mathematics teaching and learning. The intent was to provide a view of self-reported and observed middle school teacher and student experiences in mathematics, based on the analysis of affective dispositional characteristics within the context of its complexity.

There is evidence that documents a relationship between teacher and student disposition, but to what extent and encompassing what characteristics and factors has not been sufficiently substantiated. Beyers (2011) identified two key impacts of disposition on learning: (1) "…teachers play an essential role in shaping students dispositions with respect to mathematics", and (2) "students dispositions with respect to mathematics affect student learning by means of opportunities to learn" (p. 70). The study investigated and delineated the nature of positioning, as evidence of transphenomenality in self-positioning and positioning-by-others, addressing a gap in the research. The research questions were 1) *Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self- positioning and positioning-by-others?*; 2) *How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning?*; and 3) *What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics*?

Utilizing survey/case study research in multiple stages, the findings suggest middle school mathematics teachers' self-positioning was challenged by positioning-by-others (students) revealing simultaneous transphenomenality as a manifestation of complexity of the main

construct of the study – teacher affective disposition. Simultaneity of transphenomenality that reflected “events or phenomena that exist or operate at the same time” (Davis, 2005, p.14) was recognizable in the dynamic and multifaceted nature of disposition which contributed to emergent and shifting mathematical disposition. Fluidity in teacher positioning, measured by multiple instruments, was representative of metamorphoses between teacher-as-engineer and teacher-as-technician positioning (Tchoshanov, 2011) and resultant student disposition. Additionally, analysis of the question “*Would you consider yourself a mathematician?”* showed no statistically significant relationship between gender and consideration of oneself as a mathematician among participating students existed.

The importance of this study is three-fold: 1) an overall neutral with a slight positively inclined affective disposition and self-positioning for middle school teachers and students existed. This finding challenged existing claims of prevalent negative dispositions toward mathematics; 2) no statistically significant gender difference among middle school students in considering oneself a mathematician was observed. This finding indicates a shift in affective disposition toward mathematics from prior studies in stereotype; and 3) self-positioning and positioning-by-others demonstrated simultaneity of transphenomenal affective characteristics of disposition toward mathematics, mathematics teaching and learning.

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

The study of the affective domain of dispositional constructs was situated within the context of Positioning Theory (van Langenhove and Harré, 1999), guided by Complexity Theory of Education (Davis, 2005) and Social and Sociotransformative Constructivism frameworks (Bogdan & Biklen, 2010; Grbich, 2007; Rodríguez, 2005). The purpose of the study was to ascertain if there was a pattern of middle school mathematics teachers' self-positioning challenged through positioning-by-others (students) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. The intent was to provide a view of self-reported and observed middle school teacher and student experiences in mathematics, based on the analysis of affective dispositional characteristics within the context of its complexity.

There is evidence (Beyers, 2011) that documents a relationship between teacher and student disposition, but to what extent and encompassing what characteristics and factors has not been sufficiently substantiated. Beyers' (2011) synthesis of the literature identified two key impacts of disposition on learning: (1) "…teachers play an essential role in shaping students dispositions with respect to mathematics", and (2) "students' dispositions with respect to mathematics affect student learning by means of opportunities to learn" (p. 70). For purposes of this study, positioning was defined as habitual inclination formed by teacher and/or student in response to and in order to navigate through academic content, settings, and interactions, Simultaneity of transphenomenality is defined as "…events or phenomena that exist or operate at the same time" (Davis, 2005, p.14) (Appendix A - Glossary). The intent of this study was to investigate and delineate the nature of the positioning, as evidence of transphenomenality, or a

reality that is beyond or above that which is apparent to human senses, in self-positioning and positioning-by-others.

The guiding research questions were:

1) *Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self-positioning and positioning-by-others?;*

2) *How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning?;* and

3) *What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics?*

These questions were attended to through an exploratory study of the affective domain of dispositional constructs. Chamberlin (2010) stated, "…dispositions and motivation are the components of education that are potentially the items most frequently neglected as a result of increased attention to standardized assessments" (p. 167). To address this research gap, the intent of this study was to demonstrate that a key element of educational reform should be analysis of the unique dispositions and positioning of *who* is teaching and learning, in addition to the *what* and *how* in the instructional process, that is, a tri-modal approach with a focus on disposition and positioning.

Analysis of productive, neutral, and non-productive dispositional inclination toward mathematics and positioning as evidence of transphenomenality facilitated development of analytical models and establishment of connections among extraneous variables. Extraneous variables included demographic characteristics such as gender, grade-level occupied or taught, ethnicity, primary language spoken, and state assessment scores in mathematics. Study settings

included middle schools (grades 6-8) located in a border region, with unique demographic attributes which were comparatively analyzed (elaborated in Chapters Three and Four). The objective was that analytical models developed be considered in the future as a means to identify complexity and dynamics of instructional practice that result in construction of obstacles to teacher and student engagement in mathematics content, teaching, and learning. Additionally, identification of components that contributed to decreased levels of teacher commitment to teaching mathematics and student commitment to learning mathematics, results in fewer students being recruited into Science, Technology, Engineering and Mathematics (STEM) careers, and provides a lens of clarity to address mathematics recruitment and reform efforts.

Historical Approach to Educational Reform

Reforming education has been a convergent point of studies conducted in the United States (ECS, 2011; Leana, 2011) including the most recent report *US Education Reform and National Security* (2012), conducted by the Council on Foreign Relations. *A Nation at Risk: The Imperative for Educational Reform* (US Department of Education, 1983), written nearly thirty years earlier, identified similar issues in education that were deemed to contribute to the demise of education – standards, expectations, interventions and accountability. Tyack and Cuban (1995) defined educational reform as "…planned efforts to change schools in order to correct perceived social and educational problems" (p.4); emphasis was placed on 'change schools' or *what* and *how* of education as the key elements considered. These components have been studied and identified as areas of reform for decades as evidenced by the lapse of time between the aforementioned reports. With due respect for these studies and their findings with recommendations, past implementation of reform measures has not resulted in significant advances in student achievement as related to mathematics, and as substantiated in a variety of

published studies including The Nations Report Card: Trends in Academic Progress 2012 (NAEP, 2013), Trends in International Mathematics and Science Study (TIMSS, 2013), and Program for International Student Assessment (PISA, 2010). Looking for a panacea to become internationally competitive (National Science Board, 2006), it appears that, as a nation, we continue to address mathematical content and instructional delivery systems without taking into consideration the interconnectedness between mathematical dispositions and positioning of the provider/teacher and the consumer/student, as well as the presence of transphenomenal conflict. As evidenced by the *US Education Reform and National Security* (2012) and *A Nation at Risk: The Imperative for Educational Reform* (1983) reports, previous reform efforts appear to connote doing the same things over and over, expecting different results.

It is asserted that mathematics achievement advances will not occur with the spotlight solely on the content standards and expectations, or teaching practice addressed from the same perspective year after year (Peterson, 2003; Zhao, 2009). Reform approached from an integrated perspective, recognizing the influence of teacher dispositions and positioning reflecting in student disposition and positioning, cultivates and provides opportunities for awareness of self-positioning and positioning-by-others. This awareness contributes to navigation in complex educational settings by not only the knower, but the learner and addresses methods of knowledge delivery through an understanding of reflective positioning stances. In turn, introduction of reform that opens the doors for content and practice adjustments encouraging more students to enter STEM fields (specifically mathematics).

"The time has come for mathematical scientists to reconsider their role as educators" (Bass, 1997, p.2); a decade and half later, this time *was* still looming. Due to a research void in this arena based on an exhaustive search of the literature, a study of teachers' self-positioning

challenged through positioning-by-others (students) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct– teacher affective disposition contributes to the body of mathematics education. Additionally, provision of a view of teacher and student experiences with mathematics and mathematics education based on the interaction of dispositional constructs manifested in self-positioning and positioning-by-others addresses a research agenda not fully explored to date. In order to affect change or a paradigm shift, an understanding of perceived and asserted educational issues was a necessary component of the research process.

Problem Statement

Issues identified were three-fold: commonly perceived problems (*what* and *how* of instructional practice), teacher self-positioning and positioning-by-others or teacher-as-technician versus teacher-as-engineer (Tchoshanov, 2011) reflecting in student positioning resulting in transphenomenal conflict, and student dispositions toward mathematics as related to gender. In order to fully explore the identified issues, contributing factors were delineated and described.

Commonly Perceived Problems

Through comparison of the 2012, *US Educational Reform and National Security* and the 1983, *A Nation at Risk: The Imperative for Educational Reform* reports, parallel data and conclusions indicated a lack of significant mathematical progress over the last thirty years. The data substantiated findings of low skill levels and shallow critical thinking in mathematics, lack of college and career readiness, and lack of skills needed for the workforce among US students. Table 1.1 illustrates the similar findings presented in these reports.

Table 1.1: Parallel Comparison of Academic Mathematics Progress between 1983 and 2012

A Nation at Risk (1983)	**US Education Reform and National Security (2012)**
"…on 19 academic tests American students were **never first or second** and, in comparison with other industrialized nations were **last seven times**" (A Nation at Risk, 1983, n.p.)	2009 PISA Report: US ranks 25th in Math (Council on Foreign Relations, 2012, p.23)
Between 1975 and 1980, **remedial mathematics courses** in public **4-year colleges increased by 72 percent** and **now** constitute **one-quarter of all mathematics courses taught in those institutions** (A Nation at Risk, 1983, n.p.)	ACT Testing: Only "… **22 percent** of tested high school students in the United States **met "college-ready" standards** in English, mathematics, reading and science" (Council on Foreign Relations, 2012, p.21)
Business and **military** leaders complain that they are required to spend millions of dollars on costly **remedial education** and training programs in such basic skills as…**computation** (A Nation at Risk, 1983, n.p.)	ASVAB Testing: "… **approximately 30%** of high school graduates who *do* graduate **but do not know enough math**…to perform well on the mandatory Armed Services Vocational Aptitude Battery (Council on Foreign Relations, 2012, p.4)
"The College Board's Scholastic Aptitude Tests (SAT) demonstrate a virtually **unbroken decline** from 1963 to 1980… **average mathematics scores dropped nearly 40 points**" (A Nation at Risk, 1983, n.p.) **Average achievement** of high school students on most standardized tests is now **lower** than 26 years ago when Sputnik was launched (A Nation at Risk, 1983, n.p.)	National Assessment of Educational Progress (NAEP) shows a trend of slow educational progress in average scores. 8th grade mathematics average scores **increased minimally an estimated 30 points** from 1970 to 2010 and **remains in the 250 to 300 point range on a 500 point scale**. (Council on Foreign Relations, 2012, p.19)

Consistent findings (A Nation at Risk, 1983; TIMSS, 2013; NAEP, 2013; PISA, 2009; US mathematics nationwide, as evidenced by achievement scores and data collected. The need to not only reform education but transform our perspective and thinking about education, standards, expectations, and accountability was substantiated in these reports. Expansion of reform efforts to include examination of teacher and student disposition and positioning within the context of simultaneous transphenomenality will shed light on the complexity of affective disposition and

positioning influences on instructional practices, ultimately impacting student mathematical positioning.

Disposition Problems

Disposition problems identified and discussed in the literature included shifts in instructional expectations (Hambrick & Svedkauskaite, 2005; Copley, 2010; Klein, 2002), and impact of culture and cultural data sets on the development of dispositions leading to teacher and student positioning toward mathematics (Nasir, et al., 2006, 2008; Moghaddam, 1999). The issue of teachers self-positioned and positioned-by-others as teacher-technicians or teacher-engineers is situated in reflective theory of didactics (Bourdieu, 1991; Uljens, 1997), as well as addressed through stereotype threat as an influence on development of disposition (Picker & Berry, 2000; van Langenhove and Harré, 1999).

Shift in Instructional Expectations

Teacher disposition toward mathematics and teaching mathematics has shifted in response to a focus on accountability, and has in turn influenced shifts in self-positioning and positioning-by-others. Copley (2010) stated, “Research strongly indicates that young children have a strong, intuitive understanding of informal mathematics” (p.3). Children embark on their school experience with productively inclined dispositions toward mathematics and further develop their positioning with each mathematical experience. Klein (2002) in her research of mathematics learning in early years posited, “Although many children come to school ready and eager to learn mathematics, it can happen that their classroom experiences alienate and disenfranchise them” (p.311). The role and culture of mathematics education has significantly shifted from a concentration on core mathematical concepts to a necessity to address increasingly

diverse populations and rapidly changing and competitive societal demands (Hambrick & Svedkauskaite, 2005). Based on the research of Hambrick and Svedkauskaite (2005), this shift in instructional expectations was considered as an external influence on mathematical dispositions and positioning of teachers and students and was accounted for in the research study.

Impact of Culture and Cultural Data Sets

One of several positioning influences identified was the influences of culture in the development of disposition of teachers and students toward mathematics. It was asserted that disposition was a product of the lack of or inclusion of *cultural data sets* (Nasir, et al., 2006, p.497) in the development of instructional practices. Nasir, et al., (2008) when referring to cultural data sets are considering "…the importance of discerning how the features of different social contexts, in interaction with proclivities and dispositions of students, mediate what is learned" (p. 190). Teachers enter classrooms and students enter school with dispositions and positioning toward mathematics that have been influenced by social, cultural, and educational contexts (background knowledge or prior experiences). Identification and acknowledgement of background or disposition facilitates the learning process, particularly as related to the interactional influences between teacher and student positioning. Nasir, et al. (2008), expounded on the interaction of cultural data sets and social contexts as "…the intersection of individual learners (their preferences, sensibilities, and histories of participation in math classrooms) and social contexts with sets of norms and conventions for engagement, availability of supports, and assumptions about learners" (p. 190). Hence, disposition toward mathematics may have resulted from mathematics learning experiences that did not acknowledge cultural data sets.

Conversely, Moghaddam (1999) speculated that disposition may be culturally embedded and a product of membership in a social group. Direct situational forces on disposition may

include environmental, social, political, and spiritual influences that the teacher or student possess as a member of a particular social group. An example of a social group influence would be the belief that only males are "*good*" at math. A product of this belief could be a non-productively inclined disposition toward mathematics resulting in teacher-technician positioning; for example, positioning that demonstrates 'I can be a mathematics teacher, but not a mathematician'. Development of learning encompasses acknowledgement of positioning toward mathematics in order to be conducive to productively inclined dispositions (Nasir, et al., 2006 & 2008; Moghaddam, 1999).

Teacher-Engineer or Teacher-Technician

Within educational environments and learning cultures, and as dictated by the philosophy of those environments and cultures, teachers self-position in the role of transmitting knowledge to their students (*knower*). In interaction with the student and content, positioning-by-others may evolve in one of two ways: as teacher-engineer or teacher-technician (Tchoshanov, 2011). Attributed to Bourdieu (1991), Uljens (1997) situated positioning as teacher-technician or teacher-engineer in reflective theory of didactics, describing it as a method of ascertaining "…how instructional processes in the institutionalized school may be experienced" (p.v) in relation to the teacher's positioning. For purposes of this limited discussion, reflective theory of didactics will be considered as a theory of instruction and education, helping "to structure and understand pedagogical practice", or the influence of teacher positioning on the "learners intentional activity" (Uljens, 1997, pp. 51-52). Teachers may engineer learning through the process of reflection on their pedagogical practice, or as teacher-technicians, functioning solely as conduits of information. If a perceived component of reform is to create a didactical approach

(Bourdieu, 1984), knowledge of self-positioning and positioning-by-others of teachers needed to be researched.

Complexity of Education: Knower, Knowledge and Transphenomenality

Teachers may self-position as teacher-engineers, yet in practice function as teacher-technicians that is, displaying multiple dispositional and positioning stances. Students may self-position as nonproductively inclined in one school year and demonstrate positioning shifts in the following school year. Davis (2005) describes multiplicity as a component of the complexity of transphenomenal simultaneity in education or "events or phenomena that exist or operate at the same time" (p.14). *Transphenomenality* is one explanation for identified conflict in self-reported and observed data. This is not to say that fluid movement from one disposition to another was occurring. Rather the core disposition remains reasonably unchanged while self-positioning in divergent and convergent discourses occurred simultaneously. Complexity theory in Davis' view "…offers a means of helping educationists to get past many of the this-or-that debates that have frustrated efforts to understand what it is we are doing when we claim to be educating" (p.14). Rather than "thinking in terms of *discontinuities* around such matters as theory and practice, knowers and knowledge, self and other, mind and body, art and science, and child and curriculum" (p.14), consideration of simultaneities, such as *knower*, *knowledge* and *transphenomenality* provided an understanding of complexity of affective disposition.

Specific to the study of the reflection of teacher affective dispositional characteristics in student disposition and positioning toward mathematics, it was important to take into consideration that "*knowledge-producing systems* (knowers) and *systems of knowledge produced* (knowledge) are simultaneous, but non-collapsible" (Davis, 2005, p.15). It was contended that the disposition of the *knowers* or teachers reflected in the *knowledge* the students acquire and in

the development of their disposition toward mathematics. Therefore, investigation with consideration of "the relational dynamics" (Davis, 2005, p.15) of *knowers* and *learners*, provided clearer avenues for elucidation.

Davis (2005) dubbed the simultaneity of phenomena as "transphenomenal hopping" (p.17) which is relevant to understanding the dynamics of disposition and positioning through multi-levels of analysis. He asserts, "…teacher-participants did not seem aware that they were jumping among different levels of phenomena…" (p.18), stating that "a reason for this unconscious but fluid level-hopping is that the relevant phenomena evolve at radically different paces… - a realization that demands simultaneous attendance to many categories…" (p.19). In essence, transphenomenality is a basis for understanding the complexity and fluidity of disposition and positioning toward mathematics. Observed teacher self-positioning did not necessarily remain consistent and was demonstrated to be positioning-by-others exhibiting evidence of transphenomenal conflict. Using Complexity Theory as a lens to view disposition and positioning allowed for a deeper examination of the *who* in the reform puzzle within the context of Positioning Theory and the larger frameworks of Social Constructivism and Sociotransformative Constructivism.

Simultaneities of disposition and positioning toward mathematics may have been influenced by stereotypes resulting in non-productive dispositions toward mathematics and a significant decrease in the numbers of individuals entering fields that are predominantly mathematics driven (NCES, 2009). To understand the effects of stereotype threat (that is, negative perceptions of mathematics) on disposition, research examples are provided.

Stereotype Threat

Stereotype threat can be a key contributor to the development of non-productive dispositional inclinations toward mathematics. Picker and Berry (2000) posited, "…pupils are surrounded by stereotypes of mathematics in our culture" (p.84). Stereotypes are perpetuated in music, advertisements, movies, home environments, school experiences, and cartoons, to identify a few venues. The negative stereotype of mathematics is formed through a process of belief systems that are generalized in a limited set of experiences resulting in stereotyping and non-productive positioning inclinations toward mathematics and mathematicians (Picker & Berry, 2000, p.87). van Langenhove and Harré (1999) identified two groups of stereotypes, in terms of socio-cultural causes and in terms of intrapersonal processes, and defined stereotype as "generalized expectations about how others are motivated, behave, feel, etc." (p.128). Specific to mathematics, intrapersonal stereotypes ascribe traits to others and convey a belief or contribute to the development of affective disposition constructs, such as self-concept, anxiety, worthwhileness, sensibleness, usefulness, attitude, and nature of mathematics, impacting positioning toward mathematics.

Summary

Examination of disposition constructs and types of positioning required multiple facets of knowledge. Knowledge of disposition characteristics, as influenced by shifts in instructional expectations, culture and cultural data sets, didactics of teacher self-positioning and positioning-by-others, transphenomenal simultaneity and stereotype threat, was necessary to acquire. These components provided a basis for further examination of disposition inclinations of middle school (grades 6-8) teachers and students. Each factor identified above and within the problem statement possessed unique influences on teacher and student disposition toward mathematics,

mathematics teaching and learning. In accounting for those influences on teacher and student disposition, the elements were contextual factors implicated in the discourse analysis of self-reported responses to research instruments and observation of practice and behavior. Thus, each component identified as contributing to the problem statement was considered through the lenses of the theoretical and contextual frameworks.

Theoretical Framework

As illustrated in Figure 1.1 below, the theoretical framework of the study is grounded in Social and Sociotransformative Constructivism and is guided by Positioning and Complexity Theories.

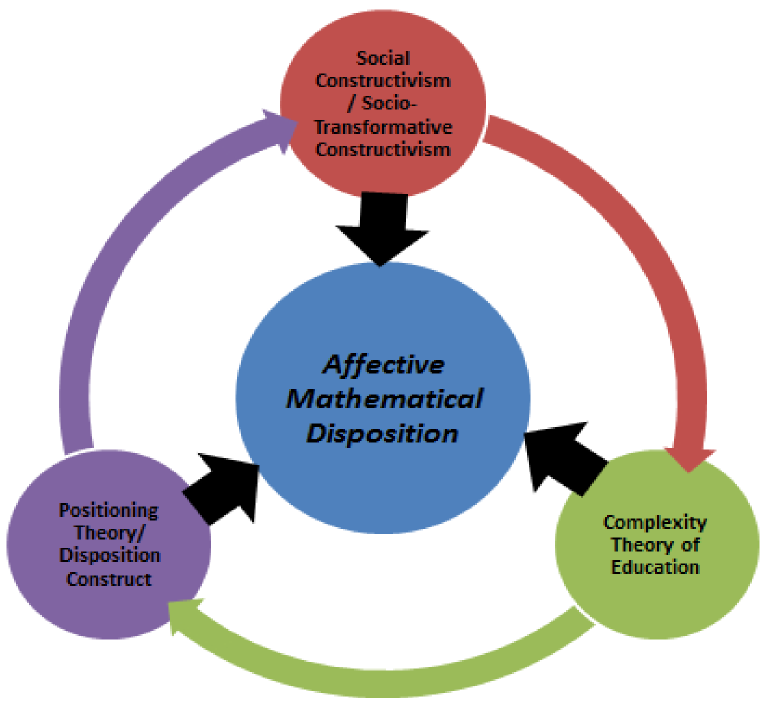

Figure 1.1: Theoretical Framework

Each component of the theoretical framework was found to have influenced development and understanding of positioning and simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. Additionally, each

of the theories and constructs had interrelated elements that provided connectedness within the framework. All elements of the framework played equally important roles in guiding the research study. To further concentrate and narrow the conceptual framework, the affective domain of disposition was the basis for examination and evaluation of teachers' self-positioning challenged through positioning-by-others (students). Each component and rationale is described briefly in the following paragraphs and further elaborated upon in Chapter Two.

Social Constructivism

Social Constructivism is the theoretical framework which best supported research to view human experiences, dispositions, and relationships developed through discursive practices. Creswell (2007) sees social constructivism as a view that provides an understanding of the world through analysis of the meanings of self-reported experiences, or the participant's view of the situation (p.20). He further stated that "social constructivism... (*includes*) subjective meanings (*that*) are negotiated socially and historically… formed through interaction with others and through historical and cultural norms that operate in individuals' lives" (p.20). From a social constructivist perspective, the focal point is on the "…processes of interaction among individuals" (Creswell, 2007, p.21), or as applicable to this study, interpretative research of affective disposition, positioning and simultaneous transphenomenality.

Bogdan and Biklen (2010) identified social constructivism as a framework to understand phenomena or "…the meaning of events and interactions to ordinary people in particular situations" (p.33). Mathematical disposition and positioning are then reflections of the fluidity and dynamic nature of interaction among phenomena and individuals. Although Bogdan and Biklen based this process in symbolic interaction theory, in terms of this study, meaning-making of events and interactions were related to disposition. This in turn led to exploration of

positioning and opening the door to view transphenomenal conflict within affective domain (Moghaddam, 1999), much as Sociotransformative Constructivism allowed for narrowing the examination of disposition and positioning.

Sociotransformative Constructivism

As an extension of Social Constructivism, and a means of further refinement of perspective, Sociotransformative Constructivism (sTc) was included as a component in the theoretical framework. Integrating social contexts and learning (Vygotsky, 1978) with authentic learning experiences (Dewey), dialogue becomes the vehicle for meaning-making (Rodríguez, 2005).

Specifically, Sociotransformative Constructivism (sTc) played a role in delineation of teacher and student positioning through consideration of power structures embedded in discourses. Power is the mechanism through which change is affected. Rodríguez defined the process of socio-transformative constructivism as "…knowledge *(that)* is socially constructed and mediated by institutional, historical, and social codes, but at the same time sTc seeks to engage the learners in (de)constructing the structures of power from which those established codes spring" (p.17). Codes – cultural, historical, and institutional – are the resulting components of establishment of power in interactions. Critical to reform is a development of an understanding of positioning manifested in power dynamics and the codes that are resultant. Change cannot occur in knowledge produced, dispositions and positioning toward mathematics without addressing the Sociotransformative component of positioning and the transphenomenal conflict in the main construct of affective disposition.

Disposition Constructs

Historically, the constructs of disposition have been recognized by psychologists as mental activities originating in the times of Plato and Aristotle in terms of a "three-fold division of knowing, feeling and willing" (Kolbe, 2002, p.3) or cognitive, affective and conative disposition constructs. The literature references Mendelssohn's, Tetens' and Kant's 18th century discussions of *three faculties of the mind* comparing "… reason to intellect or cognition, judgment to feeling, pleasure or pain, therefore affection, and practical reason to will, action or conation" (Kolbe, 2002, p.4). The *Tripartite Theory of the Human Mind* (Johnston, 1994) continued to be seen as "…commonsensical and noncontroversial" (Kolbe, 2002, p.3, citing Hilgard, 1980), as evidenced in the writings of McDougall (1923) and Hilgard (1980). Johnston (1994) asserted, "…recently cognitive psychologists have shown a renewed interest in the tripartite theory of the mind" (n.p.). Additionally, "In the last twenty years or so, students' mathematical dispositions have received considerable attention (e.g. National Council of Teachers of Mathematics (NCTM) 1989, 2000) as have their dispositions toward mathematics (e.g. Kilpatrick, Swafford, and Findell, 2001) and how those dispositions can influence students' development of mathematical knowledge" (Beyers, 2011, p.69). However, renewed interest in disposition primarily has addressed the cognitive construct and the affective domain with little attention to the influence of affective mathematical disposition of teacher positioning reflecting in student positioning.

Knowledge is embedded within artifacts and tools: "Persons are situated in the physical, artifactual, and social worlds and continually use and redesign them to achieve the activities they desire" (Pea, 1993, p.80). At the same time, "Students extend their knowledge using cognitive/intellectual resources fuelled, directed or impeded by related processes – including

attitudes, goal striving, and other affective and conative (i.e. motivational and volitional) qualities and dispositions" (Randi & Corno, 2005, p. 48). The learning process is an integrative model of three dispositional constructs - cognitive, affective, and conative. Beyers (2011) stated "…research shows that isolated components of students' dispositions can influence their engagement in tasks; however, precisely how or to what extent is not entirely clear" (pp.77-78). Purposefully, the aim of this study was to identify how affective disposition manifests in student and teacher positioning toward mathematics, and what characteristics or isolated components (Byers, 2011) contributed to those manifestations.

Complexity Theory of Education

Davis and Phelps (2005), suggest educational research "…prompts attention to the transphenomenal character of education…" and "complexity thinking provides a means…by emphasizing the need to study phenomena at the levels of their emergence…" (p.2). Identification of disposition and positioning is governed by moments in time and multiple discourses (self-positioning and positioning-by-others). Complexity thinking allows the researcher to interpret discourse not only as language use, but as "interdiscurvity – that is, how discourses intersect, overlap, and interlace" (p.3). Further, Davis and Phelps perceive the structural domain of discourse as including

> …activities associated with the use of that language that organizes and constrains what can be said, done, and thought. Every discourse has its own distinctive set of rules, usually operating implicitly, that govern the production of what is to count as meaningful and/or true. Discourses always function in relation to, or in opposition to, other discourses (p.3).

In order to unpack the complex characteristics of affective disposition and resulting positioning toward mathematics, mathematics teaching and learning without "… collaps*ing* phenomena with knowledge of phenomena", consideration of simultaneities (knower, knowledge and

transphenomenality) afforded a means of untangling interdiscurvity "…beyond the boundaries of intersubjective constructions…" (Davis, 2005, p.21).

Fels, as cited by Davis, et. al (2004), contends "Becoming a teacher is realized within messy, chaotic, generative spaces that we call learning, as emergent possible worlds-as-yet-unlived unfold". She further asserts that we must "…recognize the complexities and complicity inherent within pedagogical spaces." (p.6). With the research purpose of understanding the dynamics of teacher and student disposition and positioning toward mathematics, "Particular attentions are paid to the networked structures of ideas/concepts/information that, in a sense, 'pass through' knowledge producing systems" (Davis, 2006, p.5) as a necessity. Acknowledging that *Knowers* and *Knowledge* are inextricably intertwined, continuous, and simultaneous, allowed for broader examination of dispositional characteristics and positioning.

Citing Osberg (2005), "…education purposely shapes the subjectivity of those being educated." (p.81); hence perceiving transphenomenality as a component contributing to disposition and positioning is essential to appreciating the dynamic fluidity of disposition and positioning and process of developing affective mathematical dispositions. Osberg posits,

> To do this we have to get away from linear deterministic logic *without giving up the idea that education is about purposely shaping human subjectivity.* We don't want to give up the idea of education, just the idea that we have to do it in a linear deterministic fashion (p.82).

Transphenomenality provides a venue to "use complexity to understand education differently" (p.82) and to account for multiple simultaneous variables – the messiness of disposition and positioning due to its dynamic nature.

Positioning Theory

Standpoint Theory and Positioning Theory have similar perspectives allowing for the analysis of positions and dispositions. Sprague (2010) stated that a social constructivist

framework allows researchers to see participants "…as people who are located in specific positions in the social relations…" (p.92), what he terms as "*standpoint theory*". van Langenhove and Harré (1999) presented Positioning Theory as a framework to study social phenomena as opposed to the study of the concept of role. Opposite of role, which in their opinion is static, Positioning Theory allows examination of disposition and positioning as "…multicultural interactions… and all sorts of storylines … *(which)* open up with …tacit and contested positioning acts" (p. x). van Langenhove and Harré further state that positions develop "out of the conversational and social context" (p.18) located in a tri-polar structure of position, storyline and social force. The positioning triad, as illustrated in Figure 1.2, represents the interactive components of the positioning process and the essence of the theoretical framework offered by van Langenhove and Harré.

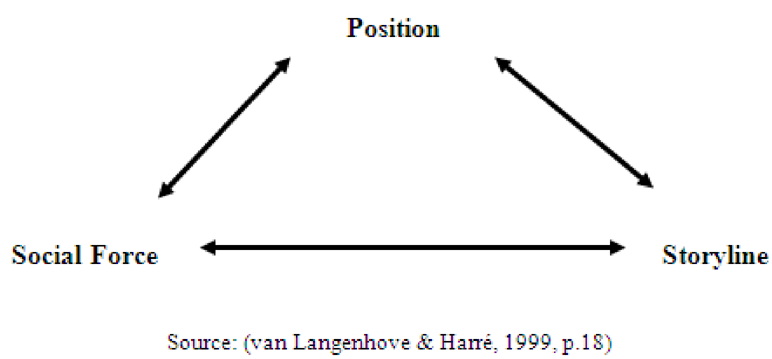

Figure 1.2: Positioning Triad

In a more recent description of positioning theory, Harré (2011) succinctly defined *position* and *positioning* as distinct elements of Positioning Theory. Specifically, Harré defined *position* as "…a cluster of rights and duties recognized in a certain social milieu…" and *positioning* as "The corresponding act by which a person claims certain rights and opts for

certain duties, or has them thrust on a certain social actor…" (p. ix). McVee (2011), citing Tan and Moghaddam (1999), stated,

> Positioning involves the process of ongoing construction of the self through talk particularly through 'the discursive construction of personal stories that make a person's actions intelligible and relatively determinate as social acts and within the members of conversations have specific locations' (p.183)" (p. 4).

Position and positioning are not freely constructed, but are developed interactively within context and in response to disposition and positioning-by-others and self (van Langenhove & Harré, 1999). Additionally, as identified by van Langenhove and Harré, there exist multiple modes of positioning, including first order (locating oneself in relation to others), second order or reflexive positioning (imposing positioning on others), and third order (positioning someone outside of the context). Modes of positioning do not have to occur in isolation, but can occur at different levels and simultaneously.

Moghaddam (1999) identified three levels of positioning: intrapersonal, interpersonal, and intergroup. It is his contention that individuals can position themselves (self-positioning) or be positioned (positioning-by-others) in more than one level at a time or instigate *parallel positioning.* For purposes of this study, concentration was on teacher self-positioning and positioning-by-others as products of transphenomenal conflict within the affective disposition construct. It was important to establish that positioning is the *process or act* of situating responses in situations driven by disposition or the *point on a continuum* of feelings, thoughts and behaviors toward the context, in this case, mathematics (Figure 1.3).

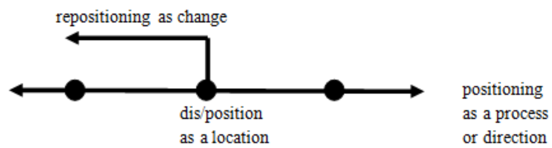

Figure 1.3: Continuum of Disposition and Position

Purpose of Study

The purpose of the study, *Complexity of Affective Disposition and Reflective Transphenomenality: An Exploratory Study of Middle School Mathematics Teacher and Student Self-Positioning and Positioning-by-Others Toward Mathematics, Mathematics Teaching, and Learning*, was to ascertain if there was a pattern of middle school mathematics teachers' self-positioning challenged through positioning-by-others (students) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. Data collected from the survey instrument employed open-ended question items and metaphorical prompts (Stage One), case study Likert-type ratings (Stage Two), case study interview prompts (Stage Three), case study classroom observation protocol and field notes (Stage Four) were the foci of coding and meaning analyses of self-reported and observed participant responses (Appendix B – Methods of Inquiry). Critical to this study were identified variances in self-reported positioning and positioning-by-others. (supplementary description of methods is included in Chapter Three).

Identification of Paucity in the Research

Identification of affective characteristics and transphenomenal conflict that influenced teacher self-positioning and positioning-by-others, as well as reflection in student positioning,

addressed a gap in the research that has primarily attended to student disposition with less attention paid to teacher disposition and the mirroring between teacher and student positioning. Ghazali, et al., (2009) concluded “Teachers play a big role in students’ education. Not only do they impart knowledge to students but they also help shape students’ attitudes toward education, school and more specifically, the subjects that they teach” (p.55). The teacher is viewed as being “responsible for organizing substantive classroom discussions that can serve as primary means of supporting students’ induction into the values, beliefs, and ways of knowing the discipline” (Cobb & McClain, 2006, p.182). Nevertheless, knowledge production is in the context of the *knower* or the disposition of the teacher and how they self-position or are positioned-by-others (students) in response to situational storylines of narratives. The simultaneity of *knowers* and *knowledge* (Complexity Theory) supported analysis in terms of transphenomenality rather than examining a teacher’s role through isolated activities as advocated by Cobb and McClain’s view.

Nasir, et al., (2006) pointed out, “…that learning in academic disciplines includes more than mastery of a body of conceptual knowledge. Critical engagement with epistemological assumptions, points of view, values, dispositions and positioning is also involved in the development of a learning culture (Collins & Ferguson, 1993; Lee, 2001, Perkins, 1992; Warren, et al., 2005)” (p.496). Wenger and Dinsmore (2005) having considered teachers’ practice from an ethnographic point of view concluded, “Teachers cannot take their students where they themselves cannot go…” (p. 10). Through identification of productively inclined affective disposition and positioning, teachers can self-assess their dispositions and positioning, and make informed alterations in disposition and positioning that will contribute to learning environments conducive to the students’ construction of knowledge and development of productively inclined affective mathematical dispositions.

Rationale and Significance

Based on thirty years of reports (*US Educational Reform and National Security*, 2012 & *A Nation at Risk,* 1984) connoting the necessity for education reform and the documented minimal increases in mathematical content mastery (NAEP, TIMSS, PISA), as well as, fewer entries into STEM education and careers (Caperton, 2012), the time has come to include the *who* of education as a critical reform puzzle piece. The major focus of the study was not on a relationship between teacher and student disposition: as expected the relationship was not comprehensive and produced an insignificant correlation (Pearson's $r = .05, p=.651$). Moreover, the correlation did not help the researcher to fully unpack the phenomenon of teacher disposition and it provided only superficial description of teacher disposition without accounting for positioning. Additionally, self-reported teacher disposition was negatively correlated to student state assessment data (Pearson's $r = -.2795$). Self-reported teacher dispositional characteristics did not contribute value to initial analysis due to factors related to inflation and/or deflation of the self-reported disposition. Therefore, the self-reported teacher disposition was triangulated with observed positioning-by-others data collection and analysis. The significance of this study is rooted in a multiple stage-approach to analysis and the resultant identification of transphenomenal conflict in teacher self-positioning and positioning-by-others (students). Further case study of the selected teachers' disposition as teacher-engineers or teacher-technicians and reflective student positioning led to a more holistic view of the phenomenon. With all reform puzzle pieces in place (*who, what*, *how*) informed conclusions led to transformational perspectives of education, recognizing complexity, which encourages designing learning environments that meet standards, expectations, and accountability requirements through the acknowledgement of teacher and student disposition and positioning.

As described in the literature review (Chapter Two), obtaining data and information that filled a gap in knowledge of transphenomenal conflict, exemplified in the dispositions of teachers and students, provided a venue of analyses of disposition and positioning in teaching and learning. These analyses led to the opportunity for self-identification of teacher or student disposition and positioning that encourages development of productive mathematical disposition inclinations. Existing research in the areas of cognitive and affective dispositions is not explicitly directed toward establishing the characteristics and reflective nature of productive disposition and positioning inclinations of teachers and students. Developing an understanding of teacher self-positioning and positioning-by-others informs teaching and learning practices through an awareness of those positions within the context of simultaneous transphenomenality or the impact on what Brahier (2011) has termed in *The Hidden Curriculum.*

> One goal of education in general might be to move students from setting external goals to more internal goals, helping them recognize that the mathematics they are learning is useful and worth learning, regardless of whether doing so involves grades and other devices (p.5).

This study is significant in that it gives voice and ownership of affective disposition and teacher and student positioning toward mathematics to those occupying unique roles and as participants in dynamic discursive practices within the complexity of educational practice.

Research Questions

The notion that research projects can be unbiased and totally objective was rejected in the development of the research goal and questions. The development of the questions were shaped by prior studies, the impact of transphenomenality in mathematical positioning, and the researcher's personal view of and involvement with teachers and students for over twenty years in a variety of educational capacities. Boaler (2008) declared,

> There are two versions of math in the lives of many Americans: the strange and boring subject that they encountered in classrooms and an interesting set of ideas that is the math of the world, and is curiously different and surprisingly engaging. Our task is to introduce this second version to today's students, get them excited about math, and prepare them for the future (p. 5-6).

It was the intent of this research study to identify mathematics teacher self-positioning and positioning-by-others that influence Boaler's two versions of math. In an effort to determine how to best answer Boaler's challenge to educational providers, the guiding research questions posed were:

1) *Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self-positioning and positioning-by-others?;*

2) *How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning?;* and

3) *What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics?*

With an understanding of affective dispositions and positioning of teachers and students within Positioning and Complexity Theories, discursive practices were addressed that inform mathematics teaching practices.

Research Approach Using Nested Sampling Design

Through identification of affective disposition characteristics, the heart of this study determined teacher self-positioning and positioning-by-others that was reflective in student mathematical positioning and representative of transphenomenal conflict. The research agenda driving the study involved multiple levels of study and analyses (described in Chapter Three, Methods). The data set was developed in stages, data collection narrowing from a large sample

of middle school teachers and students to two teacher case studies linked with six students (described in Chapter Three, Methods).

Utilizing a nested design of sampling addressed concerns identified by Denzin and Lincoln (2005) of representation, legitimation and praxis. Onwuegbuzie and Leech (2007) described nested sampling designs as "…sampling strategies that facilitate credible comparisons of two or more members of the same subgroup, wherein one or more members of the subgroup represent a sub-sample (e.g. key informants) of the full sample" (pp. 239-240). As described in Chapter Three, Methods, representative findings from the key informants' voices allow for statistical and analytical generalizations to the non-informant sample members (Onwuegbuzie & Leech, 2007, p.247).

Participants

Voluntary participants in the study were middle school (grades 6-8) mathematics teachers and students in a large school district (approximately 10,873 middle school students) in a border region. Teacher and student surveys were distributed based on the willingness of school principals, teachers, and students to voluntarily participate in the study at eight of the seventeen middle schools (grades 6-8) in the district.

Teachers

A sample of thirty-two teachers responded to the seventy-five surveys distributed out of a target population of 161 middle school mathematics teachers. The school district teacher population consists of approximately 63% of teachers classified as Latino/a, and approximately 31% classified as White (TEA, AEIS, 2011 District Report).

Students

4000 student surveys were distributed to the 75 teachers of 10,873 middle school (grades 6-8) mathematics students. A sample of 1,429 students responded to the survey, including students of teachers not responding to the teacher survey. The district student population is approximately 83% Latino/a, (Texas Education Association (TEA), AEIS, & 2011 District Report) with a large percentage (70%) of students considered to be economically disadvantaged (TEA, AEIS, & 2011 District Report).

Students and Teacher Linked Surveys

Surveys received from teachers and their respective students yielded a sample of twenty-two teacher surveys and 890 corresponding student surveys. Linked surveys are representative of seven of the eight participating middle schools in the target district.

Case Studies

Two teacher case studies were identified with criteria-based sampling of self-reported positioning as teacher-engineer and teacher-technician and were recruited to participate in semi-structured interviews and classroom observations. Linked to those two teachers (Figure 1.4), six students were chosen for semi-structured interviews. Due to the time lapse (one year after the survey administration) students were not in classes observed.

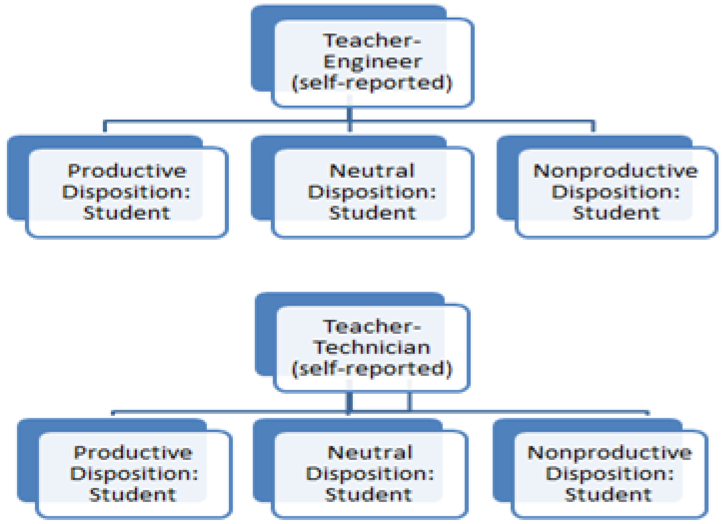

Figure 1.4: Linked Case Study Structure

Analysis of demographics of the participants is given greater description in Chapter Four, Findings, Results and Analysis.

Outcomes

The overarching expected outcome was evidence of teachers' self-positioning challenged through positioning-by-others (students) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. This study obtained data and information that attended to paucity in knowledge of affective disposition characteristics, transphenomenal simultaneity of teacher self-positioning and positioning-by-others, and student positioning as a reflection of teacher positioning. Findings of this study provide impetus to those who evaluate and analyze education in terms of reform to recognize the importance of reviewing all components, especially transphenomenality conflict in teacher self-positioning and positioning-by-others prior to making recommendations.

Positioning within the context of teacher-as-engineer or teacher-as-technician demonstrated the existence of transphenomenal simultaneity in teacher positioning contributing to conflict and complexity impacting teaching practices. Additionally, there was evidence of reflection of teacher positioning in student positioning with the potential of impacting student learning outcomes, further supporting Beyers' (2011) assertion of relationships between teacher and student disposition. Patterns, models, and relationships among extraneous variables were identified and developed to further associate findings to demographics of teachers based in geographic locations of schools and demographics of student populations. Findings of this study inform mathematics teachers and education evaluators in the development of learning cultures that recognize and address parallel positioning of teachers and students.

Researcher Assumptions

It was assumed by the researcher that information provided in the surveys and Likert-type ratings was authentic, done individually, and not produced in collaboration with other participants. It was, also, assumed that participants were provided with ample opportunity/time for completion of the survey. Every effort was made to communicate guidelines for survey administration to mathematics instructional coaches at each participating campus and the researcher was available to assist in data collection, as requested.

It is assumed by the researcher that information in the interviews was authentic and honestly provided. Participants were given ample time for response, as measured in interview transcription. Every effort was made to provide a comfortable, open interviewing environment.

It was assumed that alterations to 'normal' everyday teaching practice were not made during classroom observations. Classroom observation protocol and formats for field notes were provided to outside observers. An assumption was made that multiple coding of responses,

interviewing and classroom observation was done within the developed protocol, coding framework/rating system designed without insertion of personal biases or opinions. Multiple ratings and coding were done for each data set to insure inter-rater reliability and consensus.

Researcher Perspective

The researcher acknowledges possessing a preconceived notion of the importance of identifying and understanding teacher self-positioning and positioning-by-others and student positioning as a reflection of teacher positioning. This notion is based upon education experience and observation, including as a mathematics teacher and a middle school mathematics instructional coach. Additionally, the researcher's assertion that identification of simultaneous transphenomenality in teacher positioning within the affective disposition construct is absolutely critical to addressing issues of education reform and transformation. This perspective is based on scholarly study and pre-service teacher disposition/positioning research begun in the last three years in collaboration with my committee chair and a fellow doctoral student. Trend analyses of educational reform agendas and resulting findings have fueled and possibly biased this perception. Prior research findings and analysis (described in Methods, Chapter Three) have influenced the structure of this research study, the development of the multiple modes of data inquiry, as well as data collection protocol, and methods of analyses proposed.

Organization

In Chapter Two the reader will find a review of the literature, specifically addressing mathematics teaching and learning in the context of Social Constructivism, Sociotransformative Constructivism, Positioning Theory, Complexity Theory of Education, and the construct of disposition. Teacher self-positioning and positioning-by-others was explored in terms of

characteristics of teacher-engineer and teacher-technician. Relevant research was introduced supporting the development of this study's research questions and approaches to data collection and analyses.

Chapter Three presents background descriptions of prior studies driving the development of a larger research agenda and the structure of the study addressed. Sub research questions were introduced in relation to the guiding research questions. Also included is a discussion of research methodology and methods, specifically identifying survey research, Likert-type ratings, semi-structured interview and classroom observation as methods of inquiry. The research context of mixed methods (Creswell, 2006: Eisenhardt, 2002; Grbich, 2007) was described and nested sampling design supported; descriptions of sampling for semi-structured interviews and classroom observations was included. Methods of data collection and analyses were described including open-coding frameworks/clustering of linguistic and deconstruction analysis delineated by affective domain characteristics of disposition construct. Descriptions of testing reliability of rating degrees of target, productivity and intensity, and semi-structured interview/observation coding and rating were included, addressing inter-rater coding, reliability, and consensus.

Glossary/Definitions of Terms

A glossary of terms is included as Appendix A

Chapter 2: Theoretical Framework and Literature Review

Purpose

The purpose of Chapter Two was to provide the reader with background in the theoretical and contextual frameworks guiding this study, and to present supporting research and literature exemplifying the importance of identifying patterns of middle school mathematics teachers' self-positioning challenged through positioning-by-others (student) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. The purpose of the chapter was to build a theoretical basis of knowledge to facilitate the reader's understanding of the research components and topics, as well as to provide exposure to prior studies and literature in mathematics education research, Positioning Theory (van Langenhove and Harré, 1999; Harré, 2011; Harré & Moghaddam, 2003), Complexity in Education Theory (Davis, 2005; Davis, 2006; Davis, et. al, 2005; Osberg, 2005), Social and Sociotransformative Constructivism (Bogdan & Biklen, 2010; Grbich, 2007; Rodríguez,2005), and disposition constructs (Beyers, 2011; Kolbe, 2002; McVee, 2011; Obara, 2009; Tait-McCutcheon, 2008; Chamberlin, 2010; Snow & Jackson, 1997; Johnston, 1994; Randi & Corno, 2005; Corno, 2011).

Introduction to the Theoretical and Contextual Frameworks

Addressing the importance of establishing theoretical and contextual frameworks when conducting research, Bogden and Biklen, (2010) stated,

> … all research is guided by some theoretical orientation. Good researchers are aware of their theoretical base and use it to help collect and analyze data. Theory helps data cohere and enable research to go beyond an aimless, unsystematic piling up of accounts (p. 32).

Utilizing Positioning and Complexity Theories, guided by a Social and Sociotransformative Constructivist theoretical framework, an exploratory study of transphenomenality exhibited in teacher self-positioning and positioning-by-others (students) toward mathematics, mathematics teaching and learning was conducted. As depicted by the adapted positioning triad (Figure 2.1), the researcher employed and measured characteristics of affective disposition and positioning in order to respond to the research questions,

1) Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self-positioning and positioning-by-others?;

2) How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning?; and

3) What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics?

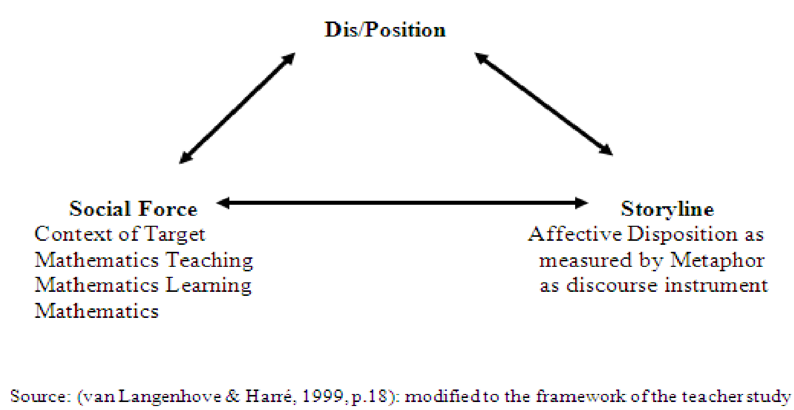

Figure 2.1: Adapted Positioning Triad

In the following paragraphs, the reader is introduced to the research supporting an exploratory study based on Positioning Theory (van Langenhove and Harré, 1999) and Complexity in

Education Theory (Davis, 2005). Additionally, mathematics education research is presented within the context of the positioning/complexity theoretical framework.

Theoretical and Contextual Frameworks

The components of the theoretical and contextual frameworks were grounded in Positioning and Complexity Theories guided by Social and Sociotransformative Constructivism. Syntheses of prior research were included to provide background and a basis for the exploratory study of simultaneous transphenomenality in teacher self-positioning and positioning-by-others toward mathematics, mathematics teaching and learning.

Social Constructivism

A guiding theoretical framework of the study was Social Constructivism. Social Constructivism has a basis in the theoretical writings of Vygotsky (1978) that is, the process of learning and social development as products of social interaction, including the roles of those seen as more ‘knowledgeable’ (e.g. teachers in education). In a description of components of Social Constructivism, Grbich (2007) stated “Knowledge is subjective, constructed and based on shared signs and symbols which are recognized by members of a culture” (p.8). Grbich further identified the major characteristics of social constructivism to include: 1) A research focus on interpretation of experiences within the context of the experience as defined by constructed understandings; 2) Researcher interpretations are limited by their experiences and understandings; and 3) Interpretations are subjective (p.8) – in all components of the study.

Bogdan and Biklen (2010), citing Berger and Luckmann (1967), stated “Reality, consequently, is ‘socially constructed’” (p.33). Sprague (2010) visualized the individual as being socially constructed, adjusting and refining or fluid as mediated by discourse. Hence, if

knowledge was socially constructed, and dispositions were formed from interpretations and knowledge leading to positioning, then Social Constructivism provided an overall framework and worldview for the study of transphenomenality in teacher self-positioning and positioning-by-others toward mathematics, mathematics teaching and learning. In an effort to further refine and extend the research perspective, Sociotransformative Constructivism, as a component of the theoretical framework, acknowledges the role of power structures, locations, and institutional codes in the development of affective dispositions and interpersonal positioning. In the following section, signs and symbols, as components of historical, social and institutional codes (Sociotransformative Constructivism) are introduced.

Sociotransformative Constructivism

Greene (1978), as referenced by Bogdan and Biklen (2010), asserted that if reality is constructed from experiences, and experiences are socially constructed, then reality is socially constructed. Rodríguez (2005), expanding on Social Constructivism, identified four elements that constitute Sociotransformative Constructivism (sTc) "… the *dialogic conversation, authentic activity, metacognition, and reflexivity*" (p.18). Figure 2.2 presents a synthesis of major subcomponents of sTc to include, positioning impacted by power (agency) relationships, institutional codes (institutional, historical, and social), and locations (social, ideological and academic)

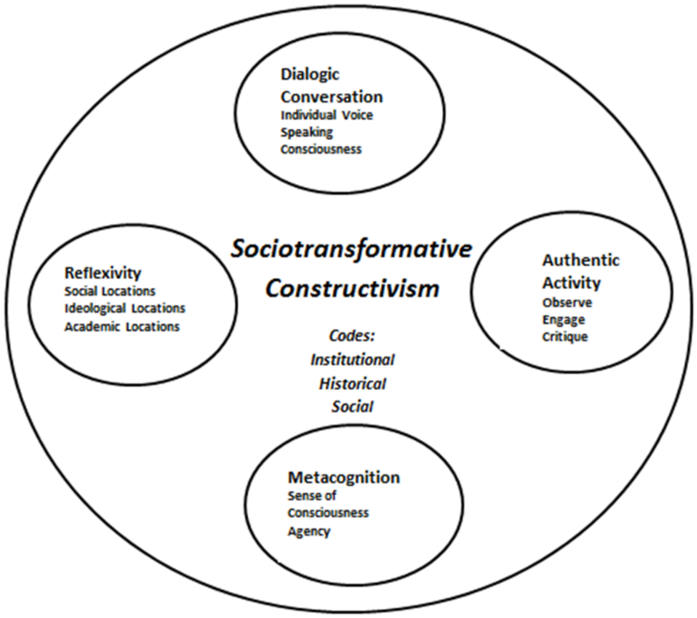

Figure 2.2: Components of Sociotransformative Constructivism (sTc)

Dialogic Conversation, as a component of sTc, was indicative of the study commitment to give the participants *voice* and identification of disposition and positioning through linguistic deconstruction. *Authentic Activity* was realized not only through self-reported data, but through observational data when teachers were engaged as teacher-engineer or teacher-technician (Tchoshanov, 2011). *Reflexivity*, as pertinent to this study, was a component of participants' positioning as evidenced in the data as social, ideological, and academic locations. The component of *Metacognition* became evident through data coding and linguistic deconstruction leading to awareness of levels of agency evident in participant disposition and positioning. Agency was specifically identified frequently in this study as the "*sage on the stage*" or "*I have the knowledge and I am giving it to the students".* There is an adage "*Knowledge is Power*", yet

in discovery of disposition and positioning, perceptions of knowledge keepers or the possessors of power were coded and rated as characteristics of disposition and positioning.

Within the perception of sTc as a theory of learning, codes were considered to originate from structures of power, acknowledging positions and roles defined within the codes. If knowledge was socially constructed, then knowledge construction and meaning-making was mediated by institutional, historical, and social codes (Rodríguez, 2005). An illustration of a cultural or social code would be the opinion that males, more so than females, are expected to pursue mathematics careers, thus defining mathematics roles as male dominated and granting power to male students. An instance of a historical code would be the perception that mathematicians are brilliant individuals responsible for highly advanced work, outlining authority roles above the student. Lastly, a model of an institutional code would be placing power and authority with policy makers/interpreters who predetermine potential, and frequently place students in lower level classes (tracking). The importance of sTc in identifying affective teacher disposition characteristics reflecting transphenomenal simultaneity in teacher positioning was in the recognition of the context (codes and locations) from which positioning developed and acknowledgement that "Power is the currency of social change" (Rodríguez, 2005, p.18). Dialogue was, then a mechanism to exert power and authority in positioning acts.

Dialogic conversation, or engaging in conversations with others (Bakhtin, 1981, 1986, cited by Rodríguez, 2005), was particularly important to understanding the dispositions and positioning of teachers and students. When delineating the influence of dialogic conversation, Rodríguez stated "…a dialogue moves beyond merely understanding what is being said to understanding the reasons a speaker chooses to state what he or she chooses to say in specific historical, institutional, and sociocultural contexts" (p.19). Specific to affective disposition

characteristics of teacher and student positioning, the influence of sTc guided evaluation of what values, beliefs, interests and voice were being conveyed by teachers and students. Rodríguez further elaborated "…the instructor is in a better position to implement effective strategies of counteresistance, strategies that would effectively assist… the need to learn to teach for diversity and understanding in a pluralist society" (p.19). Analysis of dialogic conversations led to understandings of disposition and positioning as measured with data collected from multiple instruments and forms of inquiry. To understand the influence of dialogic conversation in positioning and simultaneous transphenomenality, one must have knowledge of locations or dispositions of the participants in the conversations. Dialogic conversations were within the parameters of contexts and were defined by individual location/disposition.

Locations as dispositions and components of sTc, provided reflective portals to explore social (ethnicity, cultural, and socioeconomic status - positioning), ideological (belief systems and values – characteristics of affective disposition construct), or academic (education level and skills or cognitive disposition construct) influences on positioning. Rodríguez (2005) hypothesized that teachers are frequently in "privileged positions" and are "resistant to ideological and pedagogical change" (pp. 21-22) based on location (disposition). Through identification of the affective disposition characteristics influencing teacher self-positioning and positioning-by-others, this resistance potentially could be interrupted through the process of reflectively looking at disposition and positioning through the lens of complexity and from a reformatory perspective.

Integration of analysis of authentic activities or "…spaces in which students explore how the subject under study is socially relevant and connected to their everyday lives" (Rodríguez, 2005, p.20), and analysis of metacognition and habits of mind were not included at this point in

the research agenda. These components of Sociotransformative Constructivism were acknowledged as components of the theoretical framework, but were not within the contextual framework of the current research study and were thus delimitations. Guided by Social Constructivism and Sociotransformative Constructivism, Positioning and Complexity Theories were the heart of the theoretical framework in which the exploratory study of transphenomenality in teacher self-positioning and positioning-by-others was based.

Positioning Theory

Positioning Theory (van Langenhove and Harré, 1999) provided a framework for evaluating the influence of affective disposition characteristics on teacher self-positioning and positioning-by-others within dialogic conversations. As pertinent to the study, analyses of teacher and student dialogic conversations were focused on the social realm of positioning toward mathematics, mathematics teaching and learning as influenced by affective disposition characteristics. van Langenhove and Harré perceived Positioning Theory "… as a starting point for reflecting upon the many different aspects of social life" (pp. 9-10), rather than as a general theory. Utilizing the components of the positioning triad (Figure 2.1), position, social force and storyline, Positioning Theory "… pictures a dynamic stability between actors' positions, the social force of what they say and do, and the storylines that are instantiated in the sayings and doings of each episode" (van Langenhove & Harré, p.10). Encompassing diversity of purpose, Positioning Theory allowed for framing research focus and concepts within social discourse analysis of transphenomenal conflict utilizing constructs of affective disposition to ascertain positioning. van Langenhove and Harré asserted,

> A powerful aspect of the use of positioning theory as an analytical tool is that not only persons and their identities both individual and social, but also societal issues on a cultural level can be tackled with the same conceptual apparatus (pp. 11-12).

Positioning Theory, guided by tenets of Social Constructivism and Sociotransformative Constructivism, was an appropriate framework for evaluating and analyzing affective disposition characteristics that contributed to teacher and student positioning toward mathematics, toward mathematics teaching and learning, traversing through simultaneous transphenomenality.

McVee (2011), referencing van Langenhove and Harré (1999), saw positioning in relation to Vygotsky's (1978) focus on meditational activities and zones of proximal development (ZPD). In a symbiotic relationship, positioning "… acts both as a *tool* – an outwardly focused, interactional means to achieving external activity and as *sign* – an inwardly focused means for carrying out and shaping mental functions" (McVee, pp.8-9). Creations of Zones of Proximal Development assist learners to become independent critical thinkers capable of analysis and conjecture. ZPD provides venues for educators to become facilitators (teacher-engineers) creating scaffolds of knowledge acquisition grounded in "discourses in the social, cultural, and political contexts of one another's lives and in the collective life they are shaping together in school" (Leander, 2002, p.245). Based on the work of Leander, McVee, and van Langenhove and Harré, creation of Zones of Proximal Development that are conducive to learning, or individual dispositions and positioning of teachers and students, were critical components for consideration.

Many perceptions of success and failure in academic spaces are developed through communications emphasizing that ability, and outperforming others, are the avenues to success for teachers and students (Turner, Midgley, Meyer, Gheen, Anderman, Kang, & Patrick, 2002). "Discourse analysis assumes that what teachers say sends powerful messages about what counts as learning in their classrooms, thus creating different instructional environments" (Turner, et al., p.90). In Covington's (1992) view, one of the highest priorities for humans is achieving self-

acceptance and "in schools, self-acceptance comes to depend on one's ability to achieve competitively" (p.74). Interpretations of these messages lead to development of identity, through goals designations and assumption of roles providing mechanisms of navigation of the learning and teaching environments.

There was evidence that there was a relationship between teacher and student disposition and positioning, but to what extent and encompassing what characteristics and factors had not been sufficiently substantiated. This was particularly applicable to teacher self-positioning and positioning-by-others (students). van Langenhove and Harré (1999) posited,

> Someone can be seen as acting like a teacher in the way his/her talk takes on familiar form: the storyline of instruction, of the goings-on in the classroom. Living out in one's speech and actions one of the pedagogical storylines involves adopting such and such apposition, for example having certain obligations to the students, and at the same time it makes one's sayings and doings relatively determinate as social acts of instruction, correction, reprimand, congratulation and so on (p. 17).

For purposes of this exploratory research study, positioning was defined as the roles assumed and identities formed by teachers and students in response to, and in order to navigate, academic content, settings, and interactions. Positioning (response) was driven by disposition (location); position and disposition were fluid and dynamic, dependent on the knowledge construction intertwined in dialogic conversations and codes – cultural, historical and institutional (sTc). Andreouli (2010) relating Positioning Theory to discourse and dialogic conversations affirms,

> Positioning theory provides a detailed view of such dialogical asymmetries because it emphasizes both, the attributed characteristics of actors as well as their associated rights and duties in a particular context. Positioning theory conceptualizes power dynamics and legitimacy in terms of entitlements for action and participation (p.14.6).

McVee (2011) identified specific contexts to be considered when analyzing and interpreting disposition and positioning data including the impact of lived experiences and background

knowledge (voices we hear), interrelationships in the positioning process, and the component of power and agency. It was important to this study to succinctly delineate positioning as a unique transphenomenal stance responsive to situational interaction and discourse or dialogic conversations, as measured by characteristics of affective disposition, but not as a defined component of affective disposition. The intent of this exploratory study was to go beyond positioning as a teacher or student in terms of role identification, to investigation and delineation of the nature of teacher self-positioning and positioning-by-others manifesting in transphenomenal conflict reflective of affective disposition characteristics.

Complexity Theory of Education

Education, by the very nature of the concept, is complex. The complexity of education is rooted in the nature of discourse, multiplicity and simultaneity. Osberg (2005) suggests that the process of education is dynamic, with intertwined variables and that "We educate in what might be called a space of emergence." Teachers and students participate in the educational process "…from a position of extreme flexibility and responsiveness to the moment or space we are in" (p.82). To conduct educational research from a limited narrow perspective without regard for transphenomenal characteristic of education or the relationship between the *knower, knowledge*, and the *learner* is not accounting for "how discourses intersect, overlap, and interlace" with the phenomena (Davis & Phelps, 2005, p.3).

Social Constructivism, Sociotransformative Constructivism, and Positioning Theory all have a basis in discourse. Complexity Theory of Education offers an interpretive and analytical theoretical extension to look beyond instances of discourse to simultaneity of discursive practices and transphenomenality or unconscious transphenomenal "*level hopping*" (Davis, 2006). In *A Summary of the origins of personal understandings of multiplication, as understood by a*

collective of K-12 mathematics teachers, Davis & Simmit, 2006 (Davis, 2006, p.8) demonstrated that in one hour, the collective generated approximately twenty different contributors to understanding of multiplication ranging from innate abilities to a variety of recursive practices that is multiple transdisciplinary phenomena occurring simultaneously. “An interesting aspect of the piece of research mentioned above is that the teacher-participants did not seem aware that they were jumping among different levels of phenomena during the discussion” (p.8). Davis demonstrated through this reference the simultaneity of transphenomenality and transphenomenal conflict indicative to Complexity Theory.

Multiple sources of data in this study exemplified transphenomenality and became more revealing in analyses using this theoretical perspective. Discourse, identified in multiple sources of data, was the primary conduit of data for identifying affective disposition characteristics and transphenomenal simultaneity of teacher self-positioning and positioning-by-others in this study. Complexity Theory of Education offered a mode of interpretation acknowledging transphenomenality and simultaneity of discourse, as well as, a tool for unpacking and unveiling complex characteristics of disposition and positioning toward mathematics, mathematics teaching, and learning.

Summary

Guided by a Social and Sociotransformative Constructivist theoretical framework, there was a basis in multiple realities (Kincheloe & McLaren, 2005, p.317) which created a point of exploration of disposition. Social Constructivist Theory, as described by Powell & Kalina, (2009), is the construction of knowledge in an environment that encourages knowledge acquisition as a component of social interaction through the use of open skills, creative and critical thinking, and negotiation. With Social and Sociotransformative Constructivism as a basis

and from the perspectives of Positioning and Complexity Theories, affective mathematical disposition characteristics were identified through social discourse, simultaneity and transphenomenality analysis, and placed within a larger scenario of teacher self-positioning and positioning-by-others toward mathematics, toward mathematics teaching, and learning.

Literature Review

The intent of this review was to provide the reader with descriptions of scholarly works that substantiated the need for an exploratory study of teacher self-positioning and positioning-by-others. Additionally, extraneous variables of the research that necessitated recognition and background knowledge to understand the influences of the variables in the research process were introduced. When analyzing the influences on development of dispositions and positions toward mathematics, mathematics teaching and learning within Complexity Theory, one such variable requiring introduction was stereotype threat.

Stereotype Threat as an Extraneous Variable

Spencer, Steele, and Quinn (1999) submitted the following definition of stereotype threat: "Stereotype threat… is conceptualized as a situational predicament - felt in situations where one can be judged by, treated in terms of, or self-fulfill negative stereotypes about one's group" (p.6). Steele (1997) identified historical background studies of stereotype threat, which were important in terms of understanding stereotype threat is not a new area of research.

> Beginning with Freud (as cited in Brill, 1938) in psychology and Cooley (1956) and Mead (1934) in sociology, treatises on the experience of oppression have depicted a fairly standard sequence of events: Through long exposure to negative stereotypes about their group, members of prejudiced against groups often internalize the stereotypes, and the resulting sense of inadequacy becomes part of their personality (*sic* Allport, 1954; Bettelheim, 1943; Clark, 1965; Grief & Coobs, 1968; Erikson, 1956; Fanon,1952/1967; Kardiner & Ovesey, 1951; Lewin, 1941) (p.617).

With substantial research in stereotype threat and the role it plays in individual experiences, stereotype threat warranted investigation and consideration as an influential extraneous variable. Within the context of this study, impact of stereotype threat was evaluated specifically as to disposition of teachers and students toward mathematics.

Stereotype threat does contribute to the development of dispositions, including mathematical dispositions, as evidenced in the research (Chee, 1997; Fein & Spencer, 1997; Osborne, 2006; Rydell, Rydell & Boucher, 2010; Singletary, Ruggs, Hebl, & Davies, 2009; Spencer, Steele & Quinn, 1999; Steele, 1997). Stereotype threat manifests in the formation of self-identities or self-concept. “A central focus of socio-cultural and social-cognitive approaches to psychology has concerned the ways in which individuals' self-concepts are defined and refined by the people around them” (Fein & Spencer, p.31). Self-identity or self-concept is a key component of disposition, which leads to positioning. Fein and Spencer posit, “The results of these studies suggest that at least part of the negative evaluation of people who are stereotyped may result from people trying to affirm their self-image” (p.34). Succinctly, this means that stereotyping may be reinforced when teachers or students want to feel better about their own personas and self-position in dialogic conversations based on positioning-by-others influenced by accepted stereotypes.

With a focus on commonly held stereotypical gender-oriented threats based in perceptions of mathematics (e.g. women are not good at mathematics), Spencer, Steele, and Quinn (1999) asserted,

> …stereotype threat that women experience in math-related domains may cause them to feel that they do not belong in math classes. Consequently they may ‘‘disidentify’’ with math as an important domain, that is, avoid or drop the domain as an identity or basis of self-esteem - all to avoid the evaluative threat

> they might feel in that domain (Major, Spencer, Schmader, Wolfe, & Crocker, 1998; Steele, 1992, 1997). Such a process, then, originating with stereotype threat, may influence women's participation in math-related curricula and professions, as well as their test performance (pp. 6-7).

Osborne (2006) supported the contention of gender disparities in mathematics by citing multiple studies and statistics demonstrating an imbalance in the numbers of girls and women participating in mathematics advanced education and careers. Referencing Steele (1992, 1997) Osborne substantiated that stereotype threat is a "situationally-specific cause of underperformance" (p. 113) or storyline and "not a trait of a group" (p.114). Osborne attributed an increase in anxiety levels (affective disposition construct characteristic) to the influence of stereotype threat. Osborne further cited a study of Asian-American female undergraduates (Shih, Pittinsky, & Ambady, 1999) that found student achievement was enhanced when Asian identity was emphasized and undermined when gender was emphasized. This study exemplified the tenet that "acceptance of, or belief in the stereotype is not a necessary condition" (p.114) influencing disposition and positioning. Rather the basis of the stereotype - gender, ethnicity, etc. - is the influential factor in the development of disposition and positioning. Removal of or diminishing stereotype threat, regardless of the basis, may result in transphenomenality within self-positioning and positioning-by-others toward mathematics, mathematics learning, and teaching.

Steele (1997) viewed "…social structure and stereotypes as shaping the academic identities and performance outcomes of large segments of society" (p.614). Further, Steele, based on his research findings, posited the following general features of stereotype threat:

1) Stereotype threat is a general threat not tied to the psychology of particular stigmatized groups. It affects the members of any group about whom there exists some generally known negative stereotype…Stereotype threat can be thought of as a subtype of the threat posed by negative reputations in general;

2) When such a setting integrates stereotyped and nonstereotyped people, it may make the stereotype, as a dimension of difference, more salient and thus more strongly felt. Reducing the interpretive relevance of a stereotype in a setting, say in a classroom or on a standardized test, may reduce this threat and its detrimental effects when the setting is integrated;

3) Different groups experience different forms and degrees of stereotype threat because the stereotypes about them differ in content, in scope, and in the situations to which they apply;

4) To experience stereotype threat, one need not believe the stereotype nor even be worried that it is true of oneself. One's daily life can be filled with recurrent situations in which this threat pressures adaptive responses; and

5) The effort to overcome stereotype threat by disproving the stereotype…can be daunting… if possible at all (pp.617-618).

The importance of including descriptions of these characteristics of stereotype threat for this exploratory study was in the development of a contextual framework to evaluate the impact of stereotype threat on advancement of mathematical dispositions. Using these characteristics as a guideline informed the researcher of stereotype threat, as well as established descriptors in an analysis model of extraneous variables for consideration. Draw-a-Mathematician research of Picker and Berry (2000) and Rock and Shaw (2000), further provided evidence of the influence of stereotype threat in the development of mathematical dispositions.

Draw-a-Mathematician Research

The international research of Picker and Berry (2000), involving interpretation of student drawings of images of mathematicians, produced identification of seven themes as evidence of

stereotyping: *mathematics as coercion, foolish mathematicians, overwrought mathematicians, mathematicians who can't teach*, *disparagement of mathematicians*, *Einstein effect*, and *mathematicians with special powers*. *Mathematics as coercion* represents the component of agency (sTc) and power that is, mathematicians have the knowledge therefore the power. Drawings in Picker and Berry's research included pictures of teachers with machine guns representing self-positioning in roles of control. *Foolish mathematicians* represented positioning-by-others (positioning theory) or an inability to make connections to realities of those who are not mathematicians and are seen as being in a different world. The theme of *overwrought mathematicians* exemplified the perception that problem solving in mathematics is difficult at best, possibly unattainable by most. *Mathematicians who "can't" teach* demonstrated a divide (transphenomenality) between the academics of mathematics (content) and the academics of education (pedagogy); there was a grasp of content, but an inability to convey content to students. *Disparagement of mathematicians* was an example of the inter/intra-relationship in positioning or positioning-by-others. That is to say, if a mathematician is positioned-by-others in a nonproductive dispositional location, then the positioner may self-position in a productive dispositional location or control the dynamics of the discourse event (reflective transphenomenal conflict). *Einstein effect* was the most prominent stereotypical perception of mathematicians and was evidenced in the presented exploratory study survey responses to the question *Do you consider yourself a mathematician? Why or why not?* More often than not, the response was "*No*" with narratives outlining a need for greater knowledge than currently possessed – brilliance not yet achieved. Lastly, the perception that *mathematicians have magical powers* is reinforced in presentation of mathematical 'tricks' and short-cuts, rather than critically understanding the basis of calculation and problem solving, thus giving the perception of illusion. In this

exploratory research study, the use of metaphor provided avenues for authentic response that supported or disputed the influence of stereotype and perceptions of mathematicians in development of affective mathematical disposition.

As substantiated by the findings, dispositions and positioning are significantly influenced by perceptions and beliefs about mathematics and mathematicians. In extending the studies of Picker and Berry (2000), Rock and Shaw (2000) "…concluded that students believe that a mathematician's job is to do the mathematics that no one else wants to do" (p.553) or an image of mathematicians functioning beyond the student cognitive levels. Rock and Shaw (2000) advocated, "On the basis of what children think about mathematicians, teachers might alleviate misconceptions and facilitate and broaden children's thinking about their roles as future mathematicians" (p.550) through recognition of teacher self-positioning and positioning-by-others as influenced by the presence of transphenomenal simultaneity. van Langenhove and Harré (1999) stated, "...change of stereotypes can be achieved by changing the discursive conventions by which a self-positioning and the reciprocal positioning of others is achieved on a local basis" (p. 137). The primary focus of the study was to ascertain if there was a pattern of teachers' self-positioning challenged through positioning-by-others (student) which revealed simultaneous transphenomenality as a manifestation of complexity of teacher affective disposition.

Disposition

Dispositions are characterized by Obara (2009) as, "…psychological…constructs with perceptual preference, and performance facets, and as individual attributes, socially constructed and individually shaped which embodied, and influenced cognitive, affective and conative behavior" (p.3). Appropriately, disposition was an integral lens through which to study teacher

self-positioning and positioning-by-others (students). Malmivuori (2001) stated "…dispositions within the classroom and the school context constitute the significant sources as well as conditions for pupils' constructive and interpretative processes with mathematics" (p.158). A focus on the affective disposition construct narrowed the analysis and identification of teacher and student disposition to facilitate identification of transphenomenality in models, patterns, and factors contributing to the formation self-positioning and positioning-by-others.

Disposition Domains and Constructs

To identify and classify mathematical dispositions, three levels of mental processing or modes of disposition functioning: cognitive, affective and conative constructs (*trilogy of mind*), were important contributing factors (Beyers, 2011; Chamberlin, 2010; Corno, 2011; Johnston, 1994; Kolbe, 2002; Randi & Corno, 2005; Snow & Jackson, 1997; Tait-McCutcheon, 2008). "The literature is clear that it is these patterned action tendencies (Philip, 1936) which direct an individual to repeat procedures and consistently perform overt actions which produce specific products" that is, patterns of learning (Johnston, 1994, *The Tripartite Theory of the Human Mind: An Integrated Conceptualization* section, para.10). As illustrated in Figure 2.3, the three domains of disposition work as interactive factors developing mathematical disposition; disposition, as a location on a continuum, is fluid and dynamic in interaction with the learning environment.

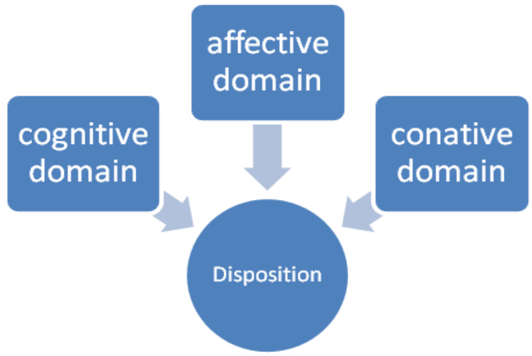

Figure 2.3: Domains of Disposition

Cognitive disposition: Making mathematical connections. Cognitive models are contributors to the development of cognitive dispositions. Cen, Koedinger, and Junker (2006) stated, "A good cognitive model captures the fine knowledge components in a curriculum, provides tailored feedback and hints, select problem with difficulty level and learning pace matched to individual students, and eventually, improves student learning" (p.1). Koedinger and Corbett (2006) provided elaboration of the definition of a cognitive model emphasizing that cognitive models are based on the modularity of knowledge processing leading to production sets which facilitate knowledge acquisition, assimilation and potentially, appropriation. Anderson, et. al, (1995), stated "… that a cognitive skill consists in large part of units of goal-related knowledge. Cognitive skill acquisition involves the formulation of thousands of rules relating task goals and task states to actions and consequences" (p.168). It is logical that knowledge is acquired in stages and levels of cognitive processing; additionally, it is reasonable that knowledge mastery is the culmination of integration of knowledge components to form a production set as the supporting framework of cognition.

With consideration of cognitive models and the cognitive skill acquisition processes, the perspective of *tripartite of knowledge* was that the cognitive domain is an interactive factor in

disposition development, complemented by affective and conative characteristics. Tait-McCutcheon (2008) described the cognitive domain as

> …Students' awareness of their own mathematical knowledge; their strengths and weaknesses; their abstraction and reflection of processes; and their development of links between aspects of the subject (Tanner & Jones, 2000). Cognition refers to the process of coming to know and understand; the process of storing, processing, and retrieving information. The cognitive factor describes thinking processes and the use of knowledge, such as associating, reasoning, or evaluating (p.507).

In these terms, a cognitive disposition is one that involves thinking about thinking, understanding, knowing, and being able to make connections in knowledge. Johnston (1994) stated,

> Throughout the cognitive processing, the learner seeks to identify what aptitude or intelligence is needed to "crack" the learning task (Spearman, 1927). While identifying and initiating cognitive processing, the learner simultaneously instigates the performance of the task using cognitive awareness to begin the "doing" of the learning task in an informed and focused manner (*The Tripartite Theory of the Human Mind: An Integrated Conceptualization* section, para.10).

Critical to the given definitions and identified characteristics of cognitive domain of disposition is the extension of description to include the ability or tendency to make connections and be able to express argumentation. Beyers (2011) included the two characteristics of making mathematical arguments and mathematical connections as key elements of cognitive disposition domain. "Boaler (2002) suggests that some students could have extensive knowledge of multiple areas in mathematics, but not have a tendency to make any mathematical connections among those areas" (Beyers, 2011, p.23). Making mathematical connections is a key ingredient "for the development of new mathematical knowledge" (Beyers, 2011, p.24). Beyers further stated mathematical argumentation as "the process of discerning mathematically acceptable explanations is arguably a mental function which generates an awareness, in the individual, of new knowledge i.e., discerning mathematically acceptable explanations can be thought of as a

dispositional cognitive function" (p.24). Figure 2.4 below represents the synthesized categorical cognitive construct and characteristics as presented by Beyers, Tait-McCutcheon (2008), and Johnston (1994).

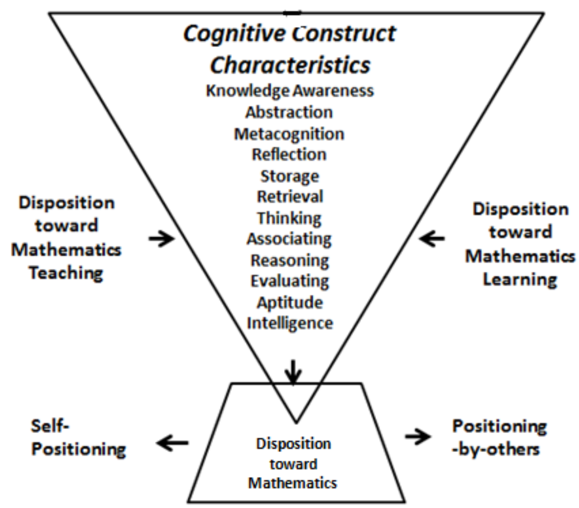

Figure 2.4: Cognitive Domain of Disposition

Beyers succinctly described mathematical cognitive dispositions as present when "a person has a tendency or inclination to engage (or not) in a particular cognitive mental process associated with perceiving, recognizing, conceiving, judging, reasoning, and so on" (p.71). To allow for narrowing the focus of the exploratory study to encompass affective disposition characteristics it was important to have an understanding of the differing characteristics of the conative disposition. Having clarity of characteristics of dispositional domains, although overlapping and all impacting disposition, was the first step to developing coding structures.

Conative disposition: Mathematical behaviors. "The Latin "conatus", from which conation is derived, is defined as "any natural tendency, impulse or directed effort" " (Kolbe, 2002, p.3). From an educational perspective, conation might be thought of as perseverance, initiative, drive,

desire, or inclination to attempt and complete tasks, and develop knowledge. Beyers (2011) and Snow and Jackson (1997) utilized the following definition

> Conative mental functions are "that aspect of mental process or behavior by which it tends to develop into something else; an intrinsic unrest of the organism … almost the opposite of homeostasis. A conscious tendency to act, a conscious striving … It is now seldom used as a specific form of behavior, rather for an aspect found in all. Impulse, desire, volition, (and) purposive striving all emphasize the conative aspect" (English & English, 1958, p.104) (p.71; p.1).

Key to this definition is the emphasis on striving, acting, impulse, desire, and volition; each element contributing to what educators frequently term "effort". Tait-McCutcheon (2008) stated "Conation refers to the act of striving, of focusing attention and energy, and purposeful actions. Conation is about staying power and survival" (p. 507). Included in Tait-McCutcheon's paper are descriptive phrases such as "strive to learn", "inclination to plan, monitor, and evaluate work", employ strategies, and "predilection to mindfulness and reflection" (p. 507). Johnston (1994) identified autonomy and "action tendencies" as characteristics of a conative disposition and simply defined conation as "the directed effort and manner of performance" (*The Tripartite Theory of the Human Mind: The Concept of Conation* section, para. 2).

Corno (1993), in her research, focused on *volition* as a key component of conation, summarily defining volition as "To do something "of one's own volition" is to do it by one's own resources and sustained efforts, independent of external source or pressure" (p.14). Citing Kuhl (1985), Corno went on to say that "post-decisional processing or volition serves as a meditational function; it "energizes the maintenance and enactment of intended actions" (p.90)" (p.14). Snow and Jackson (1997) "see motivation and volition as forming a continuum within the conative category – a kind of commitment pathway from wishes to wants to intentions to actions…" (p.3). Also included in Snow and Jackson's categorization are aspects of

"personality" and "intelligence", although these characteristics are not further developed due to being seen by the authors as "cloudy concepts…too molar and vague for our purposes" (p.3). Corno cited Snow (1992) stating, "…volition can be viewed as one of several key conative aptitudes for education, that is a measurable potential for responsibility, dependability, or conscientiousness predictive of success in educational settings (p.6)" (p.15). While conative disposition is an under researched construct, it was critical to first identify the influence of affective characteristics on disposition and positioning that then lead into conative disposition.

Utilizing Snow and Jackson's (1997) and Corno's (1993) views that motivation and volition are the key components of conation and other characteristics such as acting, initiative, striving, and desire are sub-components, Figure 2.5 represents the combined descriptions and definition of conative disposition domain.

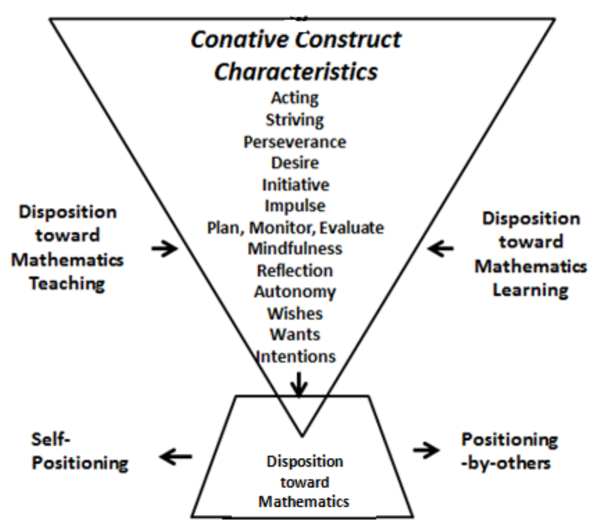

Figure 2.5: Conative Domain of Disposition

Beyers (2011) referenced educators' experiences with students who, when faced with learning challenges, demonstrated different levels of engagement with the task or self-positioning and positioning-by-others. "Students may exhibit high or low levels of persistence or effort, and be

less likely to purposively strive in the face of challenging mathematical tasks, supporting the assertion that conative functions can be thought of as dispositional" (Beyers, p.23). However, it was necessary to have an understanding of affective characteristics of disposition to provide a more substantial basis from which to create knowledge of conative characteristics of disposition.

Of the three components of disposition, the affective domain of disposition was identified as the sole construct for the focus of this exploratory study. In order to narrow and define how the affective domain was applicable to simultaneous transphenomenality as manifested in teacher self-positioning and positioning-by-others, characteristics of affective disposition were explored.

Affective Disposition: Mathematical Beliefs, Values, and Identities. In a study conducted by Stipek, et. al, (1998), comparing teacher practices of three groups of mathematics teachers, and analysis of Positive Affect, it was found "that Positive Affect was the most powerful predictor of student motivation" (Morrone, et al., 2004, p. 24). The study examined beliefs and practices of fourth through sixth grade mathematics teachers with the intent of being able to link beliefs to practices. Further, in their study the researchers "…assessed associations between teachers' and student' enjoyment and self-confidence related to mathematics" (p. 216). This study, albeit narrower in concentration, gave credence to researching affective mathematical disposition with a wider lens on the reflection of teacher self-positioning and positioning-by-others in student disposition and positioning. Teacher and student affective disposition characteristics influence mathematical knowledge developed; thus the importance of identifying and measuring affective disposition characteristics is in the significance of its role in the learning process (Beyers, 2011). Chamberlin (2010) discussed *non-intellectual* characteristics (affective) that are necessary for the development of intellectual characteristics (citing Binet & Simon, 1916; Messick, 1979). Affective disposition characteristics contributed to the development or underdevelopment of

cognitive disposition factors in an integrated disposition model of teaching and learning (Johnston, 1994). Chamberlin asserts "Affect, as hypothesized by Binet and Simon, is arguably the single greatest factor that impacts the learning process" (p. 169). Tait-McCutcheon (2008) put forth the following definition

> Affect is a student's internal belief system (Fennema, 1989). The affective domain includes students' "beliefs about themselves and their capacity to learn mathematics; their self-esteem and their perceived status as learners; their beliefs about the nature of mathematical understanding; and their potential to succeed in the subject" (Tanner & Jones, 2003, p. 277) (p. 507).

Affective domain is a complex construct that was difficult to definitionally operationalize or quantify due to the many characteristics that can be identified as affective (Chamberlin, 2010). In the review of literature, belief systems and self-esteem were consistently identified as characteristics of the affective disposition domain. However, Chamberlin, citing Anderson and Bourke (2000), extended the categorization by identifying eight characteristics of the affective domain including "…anxiety, aspiration(s), attitude, interest, locus of control, self-efficacy, self-esteem and value" (p.168). These eight characteristics contributed to the identification of affective characteristics used for this study, but were considered within the context of characteristics identified by other researchers.

Although Beyers (2011) isolated attitudes and beliefs stating these characteristics "…can be thought of as general reactions toward something, the essential quality of an emotion, feeling, mood, or temperament (McLeod, 1992)" (p.21), he elaborated and expanded the definition of the affective domain to include additional characteristics. As a category of mathematical disposition, Beyers, (2011) defined affective as

> Beliefs about oneself as a learner of mathematics, [b] attitude toward mathematics, [c] beliefs about the nature of mathematics, [b] beliefs about the usefulness of mathematics, [c] beliefs about whether learning mathematics is worthwhile, [b]

> beliefs about whether mathematics is sensible [b]. ([a] associated primarily with the term mathematical disposition, [b] associated primarily with the term disposition toward mathematics, and [c] associated with both terms) (p.73).

To unpack the description of affective characteristics of usefulness, worthwhileness and sensibleness, Beyers (2011) stated

> The usefulness subcategory of dispositional functioning is being defined as the tendency to believe that mathematics is useful for meeting current or future needs in or out of school, for your career, etc… The worthwhileness subcategory of dispositional functioning can be thought of as a tendency to believe that the work that the student has done to learn mathematics is worth it to the student, i.e., it is a value judgment made by the student about whether the "payoff" for doing the work it takes in order to learn mathematics is ultimately worth it to them. The sensibleness subcategory of dispositional functions can be thought of as a tendency to believe that mathematics is composed of ideas that can be made sense of by the student (p.24).

Just as Beyers (2011) and Chamberlin (2010) identified characteristics, Chamberlin further delineated three levels of measurement for each characteristic: target, intensity and direction. Specifically, target identified the "…object, activity, or idea toward which the feeling is directed", intensity refers to the "degree or strength of the feelings", and "direction refers to the positive or negative orientation of the feelings" (Chamberlin, 2010, p.170). Figure 2.6 below represents the categorical constructs to be explored in this study and as presented by Beyers, Chamberlin, Tait-McCutcheon (2008), and Johnston (1994).

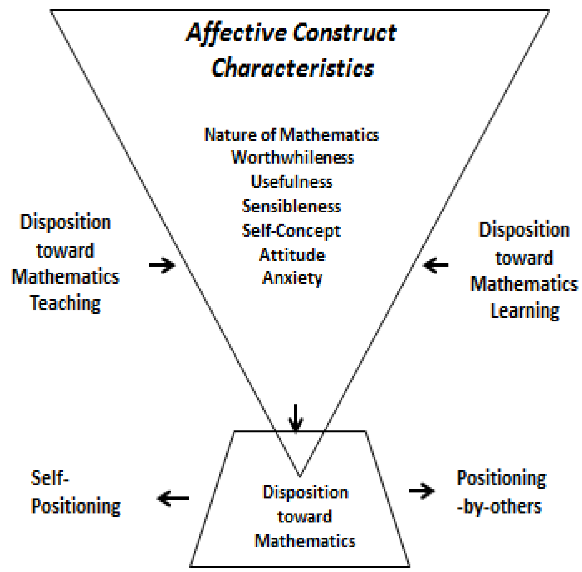

Figure 2.6: Affective Domain of Disposition

Utilizing the components of *Nature of Math, Worthwhileness, Usefulness, Sensibleness, Attitude, Self-Concept* and *Anxiety* provided a succinct framework of characteristics to assess simultaneous transphenomenality, disposition, and positioning toward the targets of mathematics, mathematics teaching and learning. The identified characteristics and measurement classifications provided a lens to view affective dispositions as significant contributors to overall affective mathematical dispositions which warranted further investigation.

Affective Disposition: Construct of Study

Beyers (2011) contended that "Several prominent reform-oriented documents suggest that students' dispositions are a crucial consideration for promoting their success in mathematics (e.g., NCTM, 1989, 2000; Kilpatrick, Swafford, and Findell, 2001)" (p. 76). Additionally, Beyers stated "Research shows that isolated components of students' dispositions can influence their engagement in mathematical tasks; however, precisely how or to what extent is not entirely

clear" (pp. 77-78). Further delving into the concept of disposition and transphenomenality was apparent to determine influences on self-positioning and positioning-by-others toward mathematics, mathematics teaching and learning. Beyers further stated "Students' dispositional affective functioning can negatively influence their learning in mathematics by limiting access to opportunities to learn or by affecting how students take advantage of opportunities to learn" (p.77). Supported by studies such as *US Education Reform and National Security* (2012), conducted by the Council on Foreign Relations and *A Nation at Risk: The Imperative for Educational Reform* (US Department of Education, 1983), mathematics engagement and achievement continues to lag in the United States. Unambiguously, identification of transphenomenal conflict in teacher self-positioning and positioning-by-others, and to the research point, the reflection of teacher positioning in student dispositions and positioning toward mathematics had not yet been fully explored. In order to examine the reflection between teacher and student positioning in greater depth, the study focused solely upon simultaneous transphenomenality and affective domain characteristics.

Hence, the research study structure utilized affective domain characteristics as guiding descriptors of teacher and student disposition and positioning. Based on a review of the literature (Beyers, 2011; Kadijevich, D., 2008; and Maaß, J. & Schlöglmann, W., 2009) and a "…varied and at times inconsistent conceptualizations of the disposition construct…" (Beyers, 2011, p.70), a synthesis of descriptions and definitions of affective domain characteristics was developed. Specifically, the categories of *Nature of Mathematics, Worthwhileness, Usefulness, Sensibleness, Self-concept, Attitude,* and *Anxiety* were incorporated into operational definitions (in Table 2.1) to facilitate and guide the meaning-coding, interpretation, and analyses of teacher and student storylines and positioning described in multiple data collection formats.

Table 2.1: Operational Definitions of Affective Characteristics

Characteristic	Definition	Examples of Semantic Expressions
Nature of Mathematics	A belief about mathematics being procedural/conceptual, logical/irrational, precise/chaotic, beautiful/dull, intellectually challenging/boring, creative/mundane, concrete/abstract, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of applications.	procedural/conceptual, logical/irrational, precise/chaotic, beautiful/dull, intellectually challenging/boring, creative/mundane, concrete/abstract, computational, algorithmic, rule-based, etc.
Worthwhileness	A value judgment that the time and/or effort spent engaging in mathematics has an intrinsic/extrinsic payoff/penalty leading to increased/decreased interest in mathematics.	Worthwhile, payoff, worthless, etc.
Usefulness	A belief about the contribution/detraction of mathematics for meeting current or future need, performance, success, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of practical/impractical applications.	Utility, useful, advantage, serviceable, practical, purposeful, etc.
Sensibleness	A belief that mathematics is (un)reasonable, understandable/confusing, meaningful/meaningless, (dis)connected, etc.	Un/reasonable, ir/rational, un/wise, im/prudent, in/coherent, un/realistic, un/sound, il/logical, etc.
Self-Concept	One's subjective feelings, ideas, and/or self-perception as a confident/insecure learner/user/knower of mathematics, as well as the ease/difficulty or (dis)comfort that one experiences with mathematics.	Confidence, insecurity, comfort, discomfort, easy, hard, difficult, etc.
Attitude	An (un)favorable state of mind/view and/or a positive/negative feeling influencing an emotional (re)action toward a (dis)investment in mathematics.	Like, hate, don't like, love, favorite, least favorite, dis/tasteful, etc.
Anxiety	Experiencing an unpleasant/threatening/stressful/apprehensive psychological/physiological reaction resulting from engagement in mathematics.	Fear, threat, danger, conflict, nervous, apprehension, stress, distress scared, lack of safety, frustration, worry, angst, suffering, agony, misery, grief, anguish, etc.

The methodology for meaning-coding, interpretation and analyses was described further in Chapter Three, Methodology.

Dis/Position toward Mathematics

Beyers' (2011), synthesis of the literature identified two key impacts of disposition on learning: (1) "…teachers play an essential role in shaping students dispositions with respect to

mathematics", and (2) "students dispositions with respect to mathematics affect student learning by means of opportunities to learn" (p. 70). Teachers may or may not present teacher-engineers or teacher-technicians, which in turn may or may not impact the development of student disposition toward mathematics. "As McDermott and Varenne have noted, "*success*" and "*failure*" are particular positions available in American schools for students to inhabit" (Bartlett, 2007, p. 216). Midgley, Maehr, Hruda, Anderman, E., Anderman, L., Freeman, Gheen, Kaplan, Kumar, Middleton, Nelson, Roeser, and Urdan (1998) stated that "Success is defined in relation to the task and progress is measured in self-referential terms" that is, "success is defined in relation to others" (p.114). Tait-McCutcheon's (2008) findings, in evaluation of affective dispositions, supported that students generally believe that math ability is not an inherited trait and that success is attributed to hard work (conative disposition). However, Tait-McCutcheon also reported that students "lacked confidence in self-regulating" and "knowing if they were right or wrong" (p. 509). Based on the studies of Berry and Picker (2000) and Rock and Shaw (2000), students may understand the usefulness of mathematics, but have negative perceptions of mathematics as difficult and mathematicians as "*super-minded*" that lead to self-positioning and positioning-by-others impeding facilitation of success and achievement.

Dis/Position toward Mathematics Learning

In Snow and Jackson's (1997) analysis, "Learning is viewed primarily as constructing meaning and as an interpretative process of understanding reality" (p.18). Further, there are two approaches to learning identified, a deep or surface approach. "In the surface approach, learners regard the particular learning material as what needs to be learned without attempting to link it to a larger conceptual framework"; deep learners see learning as a means or pathway to gaining connections and underlying meanings in knowledge (Snow & Jackson, 1997, p.18).

Review of positioning and transphenomenal conflict facilitated understanding of the manners in which students engage in the learning environment and academic pursuits or disengage in educational endeavors (Urdan, et al., 2002, p. 55). “Rather than conceiving of students as possessing or lacking motivation, the focus is on how students think about themselves, their tasks, and their performance (Ames, 1987)” (Urdan, et al., 1998, p. 114). McClain and Cobb (2001) stated,

> The importance attributed to sociomathematical norms stems from the contention that students reorganize their specifically mathematical beliefs and values as they participate in and contribute to the establishment of these norms (cf. Bowers & Nickerson, 1998: Lampert, 1990; Simon & Blume, 1996; Voigt, 1995). This claim implies that teachers can support their students’ development of appropriate dispositions toward mathematics by guiding the development of sociomathematical norms (p. 238).

McClain and Cobb (2001) concluded from their research that establishment of sociomathematical norms contributed to mathematical positioning, but development must be considered a dynamic process, frequently responding to unanticipated events, situations, or unique storylines.

Wagner and Herbel-Eisenmann (2009), referencing Evans (2000) proposed, “… a notion of the context of mathematical thinking that can be captured by the idea of *positioning in practices*, which referred to the way an individual identifies him/herself in relation to mathematics and other discourses” (pp.7-8). Wagner and Herbel-Eisenmann advocated that dispositions toward mathematics learning can be developed recognizing transphenomenal conflict. “Let students position themselves in various ways and help them recognize that positioning themselves within various storylines in various ways can only strengthen their mathematics” (p. 14). In interaction within and in response to situations, students not only self-position, but are positioning others, as well as being positioned-by-others.

For purposes of this study, teacher disposition toward mathematics learning was exemplified in disposition toward mathematics teaching and student learning. Students' dispositions and positioning toward mathematics teaching were contributors to positioning-by-others. That is to say, student disposition toward mathematics teaching demonstrated during inter/intra-personal positioning was reflective of teacher positioning as either teacher-engineer or teacher-technician toward mathematics teaching.

Disposition toward Mathematics Teaching

Results from the MetLife Foundation research (2001) indicated teachers do not feel well prepared because they perceive a mismatch between the instructional pedagogy they were exposed to in their preservice education programs and the practices in the schools to which they are assigned. Teachers felt their formal preservice training did little to prepare them for teaching a diverse student population. According to the MetLife Foundation (2001) survey findings, about a third (32%) of the new teachers did not think their preservice programs addressed teaching a diverse student population. According to the National Assessment of Educational Progress (2009), White and Asian students outscore Blacks and Latino/as in mathematics, as well as, female students tended to score lower than their male counterparts. Overall students in the United States rarely scored advanced level ratings in mathematics. However, factors contributing to the low achievement of students, according to Bourdieu (1984), has more to do with bias in schools (teacher positioning) than deficiencies in culture or language (Villenas and Foley, 2002).

Yoon (2008) used the concept of self-positioning to describe how teachers placed themselves in the educational setting which impacted their instructional practice:

> Teachers' stated beliefs on their relevant world help to explain how they position themselves in the classroom. Some teachers, for example, might position themselves as teachers for all students and others might position themselves as

> content teachers focusing on regular education students. Whatever the positions teachers take, that positioning guides them in their interactive approaches with students in classroom settings (p.499).

Friedel, Marachi, and Midgley (2002) reported,

> Teacher support has also been found to relate to students' mastery goal orientations and their adherence to classroom rules and norms (Wentzel, 1997, 1998)" (p. 1), "…enthusiastic instruction may be an important motivational element in the classroom context (Brigham, Scruggs, & Mastropieri, 1992)" (p.2), and "…teachers of high-mastery classrooms tended to express more positive affect and support, and made fewer negative comments during lessons (p.2).

Based on these findings, it is clear that mathematical disposition and teacher self-positioning and positioning-by-others reflects in student disposition and positioning.

Positioning Theory and Mathematics Education Research

"Initially introduced to the social sciences by Hollway (1984), the notions of position and positioning are a dynamic alternative to the static concept of a role. That is, one position can only be understood in relation to another position" (Paulus, Stewart, Reece, & Long, 2009, Positioning theory section, para.1). It is also noted that this process must be fluid, responding to changes in positioning and disposition that occur in interactive discourse, events, and situations that contribute to storylines. Howie (1999) asserted, based on his analysis of multiple case study examples, "… our self-manifestations require the mutual cooperation of individuals, can be developed by attempting to elucidate some of the particular moral qualities of the interactive relationship which may enhance positive positioning" (pp.54-55). Succinctly, positioning is an interactive, reflective process demonstrating simultaneous transphenomenality in response to disposition and positioning of other participants involved in the development of storylines.

van Langenhove and Harré's (1999) general description of positioning refers to the way people use action and speech to arrange social structures. Generally, positioning (acts) are

categorized as interpersonal, intrapersonal, or intergroup. These acts may take place in a single category or multiple categories; within multiple categories is considered parallel positioning. The following paragraphs provide descriptions of each category with supporting research examples.

Interpersonal Positioning

Wagner and Herbel-Eisenmann (2009), utilizing 'mythology' or stereotype threat and positioning theory of van Langenhove and Harré (1999) as a basis, explored "the nature of interpersonal positioning within classroom relationships" specifically in mathematics classrooms (p.1). As clarification, Wagner and Herbel-Eisenmann indicated they were using the term *positioning* "metaphorically to represent relationships" or explained that "Interactive positioning occurs when one person positions another; reflexive positioning occurs when one positions oneself in the conversation. Positioning is not necessarily intentional" (p.2). For purposes of their analysis, these researchers identified three levels of positioning: 1) First Order: taking the initiative with initial utterances; 2) Second Order: low-impact, substantiation of the first order positioning; and 3) Third Order: metadiscursive focusing on the construction of mathematics, "it is reflective with explicit conversation about positioning (pp.3-4). Self-positioning and positioning-by-others occurs on any of the identified levels or on multiple levels.

Citing van Langenhove and Harré (1999), Wagner and Herbel-Eisenmann (2009) reiterated the argument that "…all positioning is reciprocal. Thus in every act or speech act, a person simultaneously positions him- or herself and the other people with whom he or she is relating" (p.4). To exemplify this argument, Wagner and Herbel-Eisenmann gave an example of polar opposites based on context. "For example, by positioning oneself as a teacher in a teacher-student relationship, one positions others as students" (p.4). Additionally, Wagner and Herbel-Eisenmann emphasized the impact of context and culture on positioning in a classroom.

> …various students will have learned different ways of positioning themselves effectively in different contexts outside of school. Some of these contexts and their associated positioning approaches are more privileged than others in school settings …these differences may relate strongly to cultural factors (p.5).

In consideration of context, Wagner and Herbel-Eisenmann further stated,

> … context has a powerful influence on both capacity and intention. The cultural capital that serves a student well in her communities outside of school may not allow her to resist teacher-enacted storylines in the classroom. Furthermore, a teacher may enact a storyline that invites or discourages student initiative and thus influence the willingness of a student to risk initiating a new storyline (p.5).

The authors contend that a traditional approach (context) to mathematics is "…a recurring initiation-response-evaluation sequence, the repetitive evaluation reinforces an authority structure that strips initiative from students. This differs from silencing students because even though complicit they respond to the teacher, but not with initiative" or "…systemic power of some practices" (p.5).

This contextual approach supported the myth of mathematics as a discipline rather than seeing mathematics within interactions. Wagner and Herbel-Eisenmann (2009) defined myths (contributing to stereotype threat) in terms of culturally known storylines, which dictate how people position themselves within the storyline. These storylines can then lead to intrapersonal or reflexive positioning.

Intrapersonal Positioning

Positioning and disposition are influenced by self-concept and self-identity. Intrapersonal positioning is a product of private discourse or private dialogue (Moghaddam, 1999) resulting in formulation of a disposition and positioning stance based on the storyline developing in that dialogue. Intrapersonal positioning frequently is influenced by stereotype and perceptions generated from Sociotransformative Constructivist codes. For example, if within a social code,

females are not perceived as having aptitudes for mathematics, through intrapersonal positioning, an individual may develop their own self-identity based on this code or stereotype. For this reason, the frequently heard statement by girls, *I'm just not good at mathematics*, is a form of intrapersonal positioning. The focus of this study included recognition of intrapersonal positioning, and it is important to acknowledge it was a variable that may have impacted disposition toward mathematics, mathematics teaching, and/or learning.

Intergroup Positioning

Within social structures, individuals have shared meanings and understandings of those structures. Individuals position themselves based on the discursive practices of that particular social structure. Intergroup positioning is impacted by defined roles in the structure or as perceived in sociotransformative codes. As with all levels of positioning, intergroup positioning is fluid and dynamic, as opposed to the static nature of roles (Moghaddam, 1999). Intergroup positioning can be developed out of intra- and interpersonal positioning. Although the focus of this study was not on intergroup positioning, it was important to acknowledge it as a variable that may have contributed to transphenomenal conflict.

Parallel Positioning

Parallel positioning is the action of occupying multiple positions concurrently. As indicated above, an individual may be positioned within an interpersonal discourse and within an intergroup interaction while occupying distinct positions simultaneously. Due to the fluidity of positioning, parallel positioning may occur at any point in the discursive practice. In this study, parallel positioning was evident in narrative analyses as contributing to transphenomenal conflict.

Conclusion

In conclusion, the preceding literature review and establishment of contextual and theoretical framework provided the necessary background to support the exploratory research study. The intent of the study, *Complexity of Affective Disposition and Reflective Transphenomenality: An Exploratory Study of Middle School Mathematics Teacher and Student Self-Positioning and Positioning-by-Others Toward Mathematics, Mathematics Teaching, and Learning*, was to address a gap in the research utilizing Positioning and Complexity Theories, tripartite of knowledge and affective disposition constructs guided by Social and Sociotransformative Constructivism. The expected outcomes were self-reported and observed data and information that provided insight and awareness of the existence of simultaneous transphenomenality manifested in teacher self-positioning and positioning-by-others reflecting in student positioning. Identification of affective characteristics was not considered in terms of linear delineation of characteristics contributing to affective disposition, but as identification of primary contributors to positioning that gave rise to simultaneous transphenomenality reflecting conflict and complexity in the construct of affective disposition.

If as a result of sharing the findings of this research, education reform becomes transformative (even if within a single classroom, with a single teacher) gravitating to positioning as teacher-engineer from teacher-technician, then the research efforts were worthwhile. To move to situations that mirror the results Morrone, et al., (2004) found, would be an extraordinary feat:

> …many of the students in this study became willing to engage in meaningful discourse about challenging mathematics problems because the teacher implicitly communicated to them her belief that they would be successful, not through praise, but by honoring their contributions to the classroom discourse. The following journal entry from an E495 student illustrates the changes in students

> that we described at the beginning of this paper: *Math was no longer about formulas, right answers and wrong answers. Math became a way of thinking and looking at things for me. I was learning new paths I could take and what questions to ask myself. I never asked myself questions before, what did I know? I either remembered the formula, or I didn't. I had no clue that I could actually make sense of why and how math worked* (p.35).

Student positioning was generally reflective of teacher positioning, and in fact, teacher positioning-by-others was in response to student positioning. Due to the complexity of the construct and the influence of extraneous factors, action spoke louder than words and was considered to be the authentic depiction of teacher disposition toward mathematics, mathematics teaching and learning. Awareness and acknowledgement of transphenomenality in self-positioning and positioning-by-others may be the first step to addressing the *who* in the reform puzzle.

Chapter 3: Methods, Methodology, and Procedures

Introduction

The research design of the exploratory study, *Complexity of Affective Disposition and Reflective Transphenomenality: An Exploratory Study of Middle School Mathematics Teacher and Student Self-Positioning and Positioning-by-Others Toward Mathematics*, *Mathematics Teaching, and Learning,* utilized a mixed methods approach (Creswell, 2006: Eisenhardt, 2002; Grbich, 2007). Data collected from the survey instrument employed open-ended question items and metaphorical prompts (Stage One), case study Likert-type ratings (Stage Two), case study interview prompts (Stage Three), case study classroom observation protocol and field notes (Stage Four) were the foci of coding and meaning analyses of self-reported and observed participant responses (Appendix B – Methods of Inquiry). Critical to this study were identified variances in self-reported positioning and positioning-by-others. The multi-stage mixed methods approach produced a shift from quantitative methods in Stages One and Two to a heavily emphasized concentration of analysis grounded in and compelled by qualitative examination of data in Stages Three and Four.

Data collection and analyses were developed based on Positioning and Complexity Theories. Specifically, simultaneity of transphenomenality that reflects "events or phenomena that exist or operate at the same time" (Davis, 2005, p.14) and positioning of the teacher, in interaction with the student and content as teacher-engineer or as teacher-technician (Tchoshanov, 2011). The study structure utilized affective domain characteristics of disposition as guiding descriptors of teacher and student disposition. A synthesis of descriptions and definitions of affective domain characteristics were developed as the categories of nature of

mathematics, worthwhileness, usefulness, sensibleness, self-concept, attitude, and anxiety and were used to facilitate and guide the coding and determination of teacher and student self-reported disposition. Open-coding of self-reported and observed data included frequency and meaning-coding performed according to operationally defined clusters and identification of themes or nodes using NVivo software.

In Stage One, survey responses were coded according to levels of defined affective dispositional constructs (Appendix C; Table 2.1), and ranked within an operationally designed scale of one to five measuring highly productive to highly nonproductive disposition toward mathematics, toward mathematics teaching and learning. Additionally, responses were rated as one to three measuring low to high levels of intensity of response (Beyers, 2011).

To facilitate Stage Two analysis, an intensity purposeful sampling of two identified teachers, Sage and Thyme (pseudonyms) and linked students were selected to participate in semi-structured interviews, Likert-type rating and classroom observations for purposes of confirming and disconfirming case studies (Patton 1990, 2002). Interviews, as confirmatory fieldwork, provided venues for in-depth study, to collect additional qualitative data, and to confirm researcher initial coding, rating, and interpretation/analysis (Carey, 1994; Miller & Glassner, 2004).

As part of the interview process, a Likert-type rating instrument containing prompts was used to cross-analyze coding and rating of survey and metaphor responses. Interview prompts were developed based on individual responses to metaphor and Likert-type ratings, identifying convergent and divergent response elements of discourse. Stages Two and Three coding and analysis utilized clusters (Kvale & Brinkmann, 2009) based on characteristics of affective disposition and teacher-engineer/teacher-technician. Clusters were developed for meaning-

coding and frequency of response/observation measurements (Appendix D). Self-reported findings in Stages Two and Three were comparatively analyzed with self-reported findings in Stage One establishing self-positioning as a teacher-engineer or teacher-technician.

In Stage Four, data were analyzed to identify evidence of teacher and student affective disposition characteristics which contributed to phenomenological conflict (Appendix E; Table 2.3) establishing storylines and transphenomenality (Davis, 2005). Cluster analyses, with repeated meaning-coding and frequency of response/observation measurements, were performed with classroom observation and field notes data to establish instances of positioning-by-others that demonstrated conflict with self-positioning (as identified in Stages One, Two and Three).

For purposes of triangulation of multiple instrument findings, academic year 2011-2012 student state assessment data was reviewed for each case study. State assessment data was considered to be outcome data reflective of self-positioning and positioning-by-others. Prior testing of study design, instruments, and protocol was done as described in the following paragraphs to support the above research design.

Background

In order to address the research questions, the efforts of this exploratory study were directed to identify and explore affective dispositions and positioning toward mathematics, mathematics teaching and learning from the perspectives of the teachers and students. Moreover, attention was directed to the interconnectedness and transphenomenal nature of teacher self-reported positioning and positioning-by-others.

Evolution of this research topic originated with an initial review of the literature describing the dichotomy of teachers as engineers in contrast to teachers as technicians, and review of discursive processes (Bourdieu, 1984; van Langenhove & Harré, 1999). Moreover,

many scholarly discussions with professors and peers identifying characteristics of and factors contributing to disposition of teachers and students were components of a mathematics education research seminar (MERS) conducted at the University of Texas at El Paso. The origin of the survey instrument came from review of other instruments used in studies of disposition (Beyers, 2011; Picker and Berry, 2000; Rock and Shaw, 2000) and utilization of the Delphi method of consensus. The design of the study was significantly influenced by a series of prior studies within the framework of a more comprehensive research agenda.

Prior Studies Impacting the Research Design

Several prior studies were undertaken to collect data, evaluate the survey instrument, pilot Likert-type rating prompts, and to investigate interview protocol that would contribute to the development of a framework and protocols for the design of the research study. Each of the prior studies, and components of the studies, has been described to convey the evolution of the study design, structure, procedures, and instrument development phases, as well as providing assurances of appropriateness of the research design to address the purpose of this study.

Baseline Studies

A baseline survey/mini-study utilizing the format of *Draw a Mathematician* addressed data from secondary teachers in a border region of West Texas (Tchoshanov, 2011). These data provided indications that participant perceptions predominantly positioned mathematicians as *teachers*, *all-knowing*, *Einstein-like*, with students in *smaller* perspective that is, a more subservient role. These findings were consistent with the findings of Picker and Berry (2000) and Rock and Shaw (2000). Questioning why these perceptions were present, a survey instrument incorporated open-ended question items, metaphor, and drawing, with the intent of obtaining

self-reported responses about teacher and student dispositions was developed (Appendix B – Method of Inquiry).

The selection of metaphor prompts included in the survey was guided by responses to fifteen proposed metaphor prompts completed by approximately one hundred middle school (Grades 6-8) teachers and students. The responses were evaluated using a draft coding framework and narrowed to five metaphor prompts. Through the use of the Delphi method of consensus, five prompts were chosen to be included in the survey instrument. Analysis of baseline study prompts included evaluation of responses in terms of authentic response, depth of response, levels of intensity of responses, and overall independent ratings by and discussions among three researchers (Tchoshanov, McDermott, & Lynch-Arroyo, 2011).

The draft survey was then administered to and reviewed voluntarily by fifteen middle school (grades 6-8) mathematics instructional coaches; their feedback about the design and format of the survey was addressed in instrument revisions. Specifically, the survey was redesigned to reflect unique prompts and questions identified as pertinent to the teacher and student participant classifications involved in this study (Tchoshanov, McDermott, & Lynch-Arroyo, 2011).

Elementary Pre-Service Teachers Survey

The revised survey instrument was administered to thirty-three participants selected based on their membership in an undergraduate, elementary mathematics methods course offered at a University located in a border region. All participants were senior education students (self-reported), in a teaching practicum, or participating in a practicum in the following semester.

Participant responses to the open-ended metaphor *Mathematics is like … Explain why* were coded through linguistic and deconstruction analysis (Kvale & Brinkmann, 2009). The

intent was to determine the degree of productivity of the elementary pre-service teachers' disposition toward mathematics. The participants' responses to the open-ended metaphor were also characteristically evaluated according to affective disposition constructs that were addressed in the metaphor. The mean value for elementary pre-service teachers' affective disposition was at *3.41* (on a rating scale of 1 (highly nonproductive) to 5 (highly productive) , which was surprising having anticipated a lower rating considering a commonly held belief of elementary teachers' lack of mathematical content knowledge and avoidance of teaching and learning mathematics (Wood, 1988). The "surprising" effect was attributed to the nature of the assessment instrument. It was found that an open-ended metaphor, as opposed to a closed-ended Likert-type scale question, allowed participants to express themselves authentically and not locate their response on a predetermined scale (Tchoshanov, McDermott, & Lynch-Arroyo, 2012).

Elementary Pre-Service Teachers: Confirmation Using Likert-type Scale

Analysis of metaphorical responses led to two conclusions about the research process and design. Additional data was solicited from elementary pre-service teachers in response to *Mathematics is like….* Metaphorical responses to the statements *Mathematics is like…, Mathematics teaching is like…, and Mathematics learning is like…* using a Likert-type scale. The intent was to test the reliability of the open-ended metaphor survey question, namely, confirmation of raters' coding and ranking and to measure movement of disposition over time. The ranking scale ranged from one to five, with one representing a highly nonproductive disposition and five representing a highly productive disposition. Utilizing Pearson's *r*, initial analysis showed an expected weak correlation between open-ended and Likert-type question responses which was attributed to the limited definitional and forced responses of a Likert-type

scale (Tchoshanov, McDermott and Lynch-Arroyo, 2012). Identification of single confirming and disconfirming cases with greatest variability in Likert-type and open-ended metaphor ratings allowed for a purposeful sample of participants (two) to interview, in order to pilot test interview structure and protocol and further confirmation of findings (triangulation of data).

Elementary Pre-Service Teachers: Semi-Structured Interview

Two pre-service elementary teachers (an intensity purposeful sample) were invited to voluntarily participate in a semi-structured interview, with assurances of confidentiality. To insure anonymity of participants, the class instructor (non-researcher) conducted the interviews with semi-structured, open-ended prompts. Interviews were recorded and transcribed. Neither names of interviewer nor participants were used during the interview, but rather participant codes for identification. Preliminary analysis of transcriptions indicated a significant impact of classroom mathematics instructional experiences on disposition towards mathematics, mathematics teaching and learning. In both cases, participants had similar learning experiences with one participant demonstrating productive disposition tendencies and the other demonstrating nonproductive tendencies.

Purpose

The purpose of the exploratory study was to ascertain if there was a pattern of transphenomenal simultaneity between teacher and student disposition that contributed to the phenomenological conflict of teacher self-positioning and positioning-by-others toward mathematics, mathematics teaching, and learning. The intent was to provide a view of self-reported and observed middle school (grades 6-8) teacher and student experiences in mathematics, based on the analysis of affective dispositional characteristics within the context of

its complexity. Maaß and Schlöglmann (2009) cited McLeod (1992) in support of the study of affective disposition as influential in mathematics education: "Although affect is a central concern of students and teachers, research on affect in mathematics education continues to reside on the periphery of the field (McLeod 1992, p. 575)" (p.vii).

Further the central phenomenon was examined and topical sub-questions developed to cover anticipated information that was needed for description of the patterns and models found in data analyses (Creswell, 2007). The following sub-questions were developed to guide the research process of data collection:

1) What are the general categories, themes, or nodes which emerge during the Stage One review that are indicative of affective dispositional characteristics and simultaneity of transphenomenality?
2) What contextual or intervening conditions influenced the development of categories, themes, or nodes?
3) What were the consequences of using open-coding, meaning-coding, clustering procedures, and frequency counting measures?
4) How would themes or nodes be interpreted within larger Social and Sociotransformative Constructivist, Positioning Theory, Complexity Theory, affective disposition and discourse analysis frameworks?
5) What factors contribute to teacher self-positioning as teacher-engineers or as teacher-technicians?
6) What variables may influence teacher positioning-by-others?
7) What are the factors and characteristics that define productive and nonproductive disposition?

8) Does the knowledge of transphenomenal conflict provide a venue for awareness of self-positioning and positioning-by-others resulting in teaching practice adjustments (reformatory measures)?

In order to answer the research questions and sub-questions, the study extended beyond a study of positioning as a teacher or student in terms of role identification to investigation and delineation of the nature of disposition as evidence of transphenomenality in self-positioning and positioning-by-others. Research facilitation was achieved through specific data collection and analysis structures.

Overview of Information Needed

Sets of needed information were identified as follows: coding categories, productive, neutral and nonproductive categories, emergent themes, nodes or general categories, operational definitions of teacher-engineer and teacher-technician, and identification of independent, dependent, contextual or intervening variables. Each set of information facilitated building a foundation from which to conduct participant sampling, data collection, coding, analysis, and the process of making conjectures, interpretations, and inferences about the data.

Coding Categories

Saldaña (2009) identified coding as the initial process toward interpretation and analysis, but it is not just labeling. "…It is linking: It leads you from the data to the idea, and from the idea to all the data pertaining to that idea (Richards & Morse, 2007, p.137)" (p.8). Saldaña, citing Coffey and Atkinson (1996), proposed "…that coding is usually a mixture of data (summation) and data complication … breaking the data apart in analytically relevant ways in order to lead toward further questions about the data (pp. 29-31)" (p.8). In order to code collected data, it was

important to have established operational definitions of affective disposition constructs and have identified categories, clusters, themes, or nodes of discourse allowing for linguistic and deconstruction analysis (Kvale & Brinkmann, 2009), as well as defined levels of intensity and rating characteristics. A glossary of terms is included as Appendix A, Tables 2.1 depicts operational definitions of affective characteristics, and Appendix E describes themes, clusters, nodes including characteristics of teacher-engineer and teacher-technician.

Productive, Neutral and Nonproductive Categories

The National Council of Teachers of Mathematics (NCTM) identified characteristics of productive dispositions to include usefulness and worthwhileness, sensibleness, persistence, self-efficacy, flexibility, interest, curiosity and inventiveness, and reflection (Gerson, Hyer, & Walter, 2011). Further refinement of criteria designating productive, neutral and nonproductive mathematical dispositions within the affective domain was necessary to address the focus of the study.

Moreover, utilizing the prior work of Beyers (2011) as a guideline, first tier coding in Stage One involved a rating continuum of highly productive to highly nonproductive dispositions. Rating was necessary to facilitate identification of directionality of teacher and student disposition as well as categorization of teachers-engineer or teacher-technician (Bourdieu, 1984; Tchoshanov, 2011). Second tier coding in Stage One focused on identification of intensity of response as low, medium, or high on a rating continuum of one to three. Affective domain characteristics were loosely categorized as targets or disposition toward mathematics, disposition toward mathematics teaching and learning, although there is overlap among characteristics. Once an affective characteristic was identified within a response, coded with respect to productive or nonproductive disposition and intensity, a target was identified to be

representative of the components of the positioning triad, or placing disposition within the framework of Positioning Theory.

Emergent Themes or General Categories

As a critical component of the process of coding and interpretation of data, and in an effort to accurately reflect the participants' intent and meaning illustrated in responses, "…data were *(inserted)* segregated, grouped, regrouped and relinked in order to consolidate meaning and explanation…" (Grbich, 2007, p.21; Saldaña, 2009, p.8). Identification of themes, clusters (Kvale and Brinkmann, 2009) general categories (vehicles), or nodes expressing or representative of affective disposition characteristics was a critical component facilitating trend analysis of the data collected. The process of theme identification included analysis of a response according to target, prompt, and vehicle leading to narrative indicated in the response (Figure 3.1).

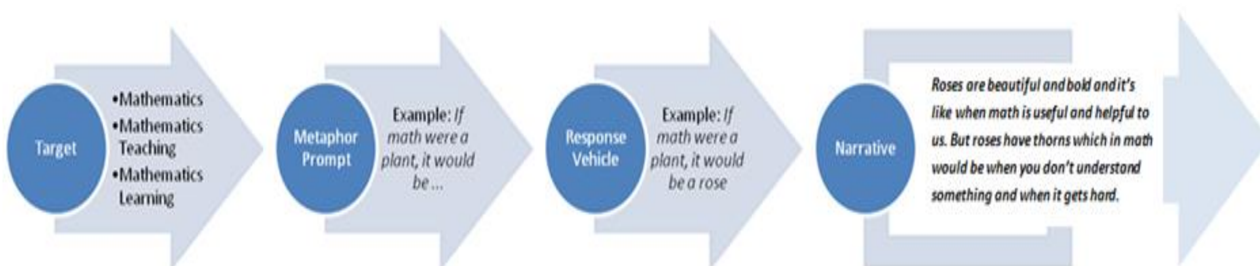

Figure 3.1: Metaphor Analysis & Theme Identification

Interpretation of themes, clusters, categories, or nodes guided by larger Social and Sociotransformative Constructivism, Positioning Theory, Complexity Theory, and discourse analysis frameworks provided basis to begin to address reform approach deficits (as described in Chapter One).

Teacher and Student Disposition

For purposes of this study, it was necessary to have operationally defined criteria for identification of teacher and student disposition (Chapter One and Glossary). These definitions guided rating of disposition characteristics on the continuum of highly productive to highly nonproductive, intensity and identification of target within the affective disposition construct.

Evaluation and acknowledgement of contextual variables was an important element of the coding and rating process that led to identification of highly productive to highly nonproductive disposition. Variables were not specifically components of the operational definitions, nevertheless were considered to evaluate influence and impact on dispositions and positioning.

Contextual, Intervening or Extraneous Variables

For the purposes of this study, contextual variables were considered as the affective disposition attributes the participant demonstrated in discourse (responses to metaphor prompts, interviews, classroom observations) that were related to self-positioning or positioning-by-others. Simultaneity and transphenomenality, as defined in Complexity Theory, guided identification of intervening and extraneous variables contributing to disposition and positioning. Positioning was defined as habitual inclination formed by teacher and/or student in response to and in order to navigate through academic content, settings, and interactions.

However, it is important to note that this study in no way attempted to identify causal relationships between variables, but took into account the effects of contextual, intervening or extraneous variables which may have contributed to or were reflected in self-positioning and positioning-by-others. Contextual, intervening or extraneous variables that were considered included: 1) demographics, such as ethnicity, gender; 2) social and cultural influences such as

parental influence; 3) grade level and content, such as teaching multiple contents; 5) state assessment scores; and/or 5) timing of data collection (example: before or after the state assessment). All variables were identified and evaluated within the implementation of the methodology of the research design based in Positioning and Complexity Theories (van Langenhove & Harré, 1999; Davis, 2005; 2006).

Overview of Methodology and Procedures

Marshall and Rossman (2006) indicated that "data collection and analysis typically go hand in hand to build coherent interpretation" (p.155). Citing Wolcott (1994), Marshall and Rossman further state that qualitative analysis is not a linear, neat process, but rather a bundling of "…description, analysis, and interpretation, three somewhat distinct activities, …into the generic term analysis" (p.154). Marshall and Rossman posit that the researcher's duty is to "…convince the reader that "thought and awareness have gone into planning the analysis phase of the study" (p.154). In an effort to substantiate the process of data analysis, the study followed what Creswell (2007) defined as rigor of data analysis including "multiple levels of data analysis, from narrow codes or themes to broader interrelated themes to more abstract dimensions" (p.460).

The study had a predominantly qualitative approach supported with and derived from quantitative data analysis. "Qualitative research can help develop quantitative measures, especially when there are no measures available or change is involved, because qualitative research is holistic (considers the particulars of each case)" (Mason, 2006). Hence, the research utilized a mixed methods approach.

Mixed Methods

The research design was a non-experimental, exploratory, single group QUAN-QUAL study driven by a mixed methods approach. Creswell, et al. (2006) state "…mixed methods research is both a methodology and a method, and it involves collecting, analyzing, and mixing qualitative and quantitative approaches in a single study or a series of studies" (p.1). Inherent in the survey instrument utilized, the semi-structured interview prompts, the Likert-type rating instrument, and classroom observation protocol were study data elements that were evaluated from both qualitative and quantitative perspectives.

Rationale

The rationale for utilizing a mixed methods approach was based in the intent of eliciting in-depth data that could be analyzed from a holistic approach which contributed to indicative reflections of participants' narratives or storylines. "Quantitative evidence can indicate relationships which may not be salient to the researcher. It also can keep researchers from being carried away by vivid, but false, impressions in qualitative data, and it can bolster findings when it corroborates those findings from qualitative evidence." (Eisenhardt, 2002, p.14). Furthermore, "Mixed quantitative and qualitative data sets have the capacity to broaden and enrich research questions using styles of synthesis, triangulation, and integration" (Grbich, 2007, p.203). Synthesis, triangulation and integration of data analysis were guided by Complexity Theory, specifically transphenomenality, and were facilitated through the integration of a nested research design.

Nested Research Design

As shown in Figure 3.2 below, the nested research design was composed of four major stages of data collection: an open-ended survey encompassing metaphorical prompts and open-ended question items, Likert-type ratings, individual case study semi-structured interviews, and classroom observations with field notes. Within each of these components were procedures and methods designed to elicit data about teacher self-positioning and positioning-by-others. The design of the survey elicited descriptions and insights into self-positioning and affective disposition characteristics through metaphor prompts and open-ended question items. Likert-type rating and interview protocol served as confirmatory data indicating self-positioning through self-reporting, as well as some indicators of positioning-by-others. Classroom observation and field notes provided the data source to identify positioning-by-others as indicative of transphenomenal simultaneity.

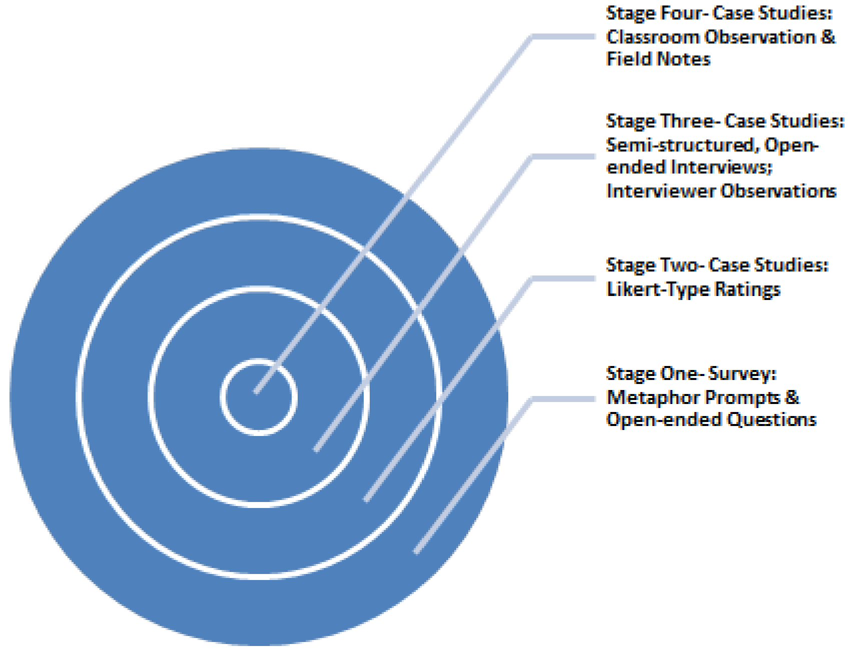

Figure 3.2: Nested Research Design

The purpose of the Likert-type rating and interview components was to confirm or deny self-positioning as teacher-engineer or teacher-technician. Classroom observation and field notes were used to identify any self-positioning movement over time, but more importantly positioning-by-others that contributed to a phenomenological conflict between teacher self-positioning and positioning-by-others. Interview, classroom observation and field notes data distinguished and established additional contextual or intervening variables and factors (Complexity Theory) contributing to positioning. For purposes of triangulation, comparative analysis of survey data, interview, classroom observation, and field notes data was done, in conjunction with coding, rating, and analyses of data.

Purposeful Sampling

Patton (1990, 2002) stated, "The logic and power of purposeful sampling lies in selecting *information-rich cases* for indepth study. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research, thus the term *purposeful* sampling" (p.169). The stratified purposefully chosen participant population had a focus on the study of middle school (grades 6-8) mathematics teachers and linked students and is further described.

Population and Sample Description

The population consisted of middle school mathematics teachers and linked students in a large (60,000 plus students) school district in a southwestern border region representing eight responding sites of seventeen targeted middle schools in the district. Stage One participating campuses were geographically dispersed in the city where the district is located. For Stages Two through Four, two teacher case studies were identified with criteria-based sampling of self-reported positioning as teacher-engineer and teacher-technician.

Teachers

The sample of Stage One teachers represented an approximate 60/40 split in declared ethnicity of the teachers in the district, that is, a greater number of teachers are Latino/a. There were approximately 161 middle school (grades 6-8) mathematics teachers in the school district chosen. Of the 161 teachers, 75 middle school mathematics teachers were approached to participate in the survey administration, based on the willingness of site administration to participate in the study. Of the 75 teachers provided with a survey, 32 teachers participated on a voluntary basis.

Case study teacher participants, Sage and Thyme (pseudonyms), demographically were eighth and sixth grade female mathematics teachers, Hispanic and Anglo, and possessed a bachelors and masters degree, respectively. Each teacher had accumulated in excess of twenty years of teaching experience. Sage self-reported as bi-lingual English-Spanish and Thyme self-reported as a mono-lingual English speaker.

Students

4000 student surveys were distributed to the 75 teachers of 10,873 middle school (grades 6-8) mathematics students. A sample of 1,429 students responded to the survey, including students of teachers not responding to the teacher survey. The district student population was approximately 83% Latino/a, (Texas Education Association (TEA), AEIS, & 2011 District Report) with a large percentage (70%) of students considered to be economically disadvantaged (TEA, AEIS, & 2011 District Report).

Case study student participants (e.g.: three linked students per teacher case study) were randomly chosen by indicated positive, neutral, or negative self-reported positioning toward mathematics, mathematics teaching and learning and willingness to participate in the interview stage. Of the six students, 50% were male and 50% were female, 17% were African American, 33% Hispanic, 50% Anglo, and two students reported as bi-lingual English-Spanish, while all others were mono-lingual English speakers.

Teachers and Linked Students

Surveys received from teachers and their linked students yielded a sample of 22 teacher surveys and approximately 890 corresponding student surveys. A random number generator was used to select no more than twenty-five linked student surveys per teacher or a total of 458

student surveys. Linked surveys were representative of seven of the eight participating middle schools in the target district. Case study participants represented 6^{th} and 8^{th} grade mathematics instructors and students. Demographics of the case study participants are included in Chapter Four, Findings, Tables 4.2 and 4.3.

Nested Sampling

As depicted in Figure 1.4, two teachers, from those responding, were selected to participate in Likert-type ratings, semi-structured interviews and classroom observations, as identified utilizing nested sampling. Teacher participants were selected based on self-positioning as teacher-engineer and teacher-technician in Stage One. Of the responding students linked to the two selected teachers, six students were selected to participate in semi-structured interviews, as identified utilizing nested sampling. Linked students were selected as representative of productive, neutral and nonproductive dispositions, based on analysis and rating of metaphor responses. The overall design of data collection and analyses stages is represented in Figure 3.3 below.

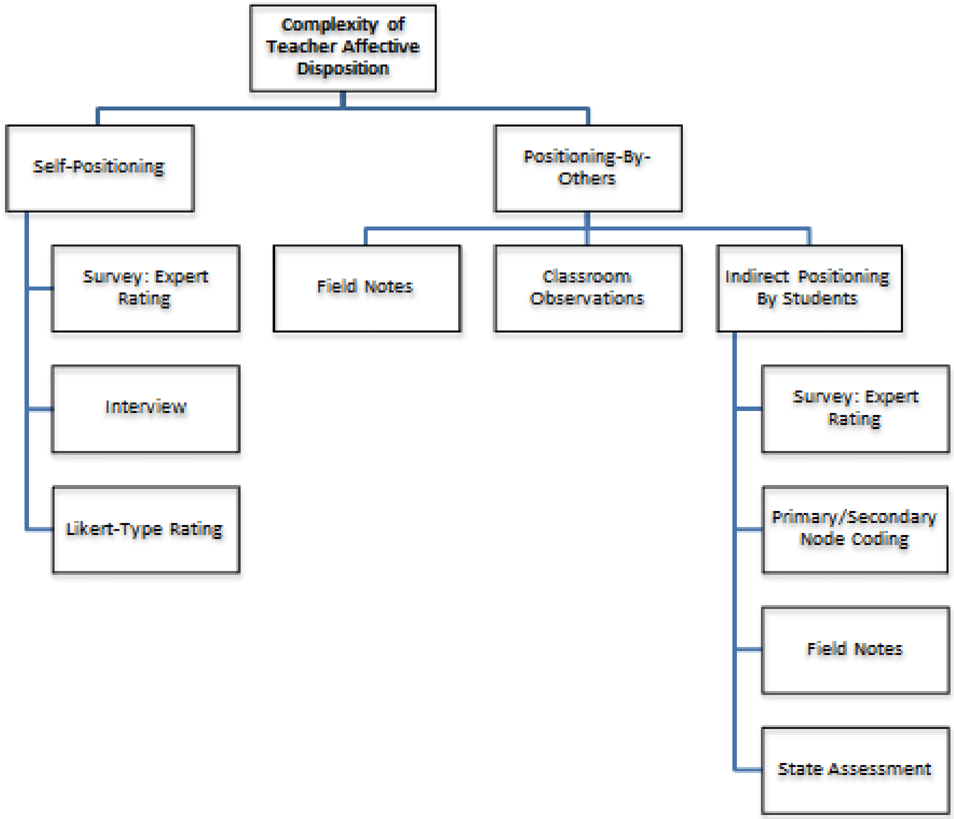

Figure 3.3: Stages of Data Collection & Analyses

Stages of the research design were developed to provide multiple sources or data and contribute to triangulation of collected data in the analyses phases, as well as, segregate data into categories of self-positioning and positioning-by-others.

Stage One: Survey Research

"A survey is an instrument to collect data that describes one or more characteristics of a specific population" (Gay, Mills, & Airasian, 2009, p. 175). Gay, et al. defined *survey research* as "…collecting data to test hypotheses or to answer questions about people's opinions on some topic or issue" (p.175). In the case of the survey instrument utilized in this research, data was collected to ascertain teacher and student affective disposition toward mathematics, mathematics

teaching and learning by means of meaning coding, linguistic and deconstruction analysis (Kvale & Brinkmann, 2009) using multiple raters.

Marshall and Rossman (2006) delineated survey research as a "distinctive style in the research process… allowing for the collection of a large amount of data from smaller samples that can be generalized to populations" (p.125). For purposes of this study, a survey instrument incorporating metaphor and open-ended question items was developed, guided by the disposition domains of cognitive, affective, and conative constructs with emphasis on affective disposition characteristics. Strategies for confirming findings included the use of multiple sources for triangulation of data: Triangulation is "finding the multiple perspectives for knowing the social world" (Marshall & Rossman, p.204). Triangulation of responses among the sections of the survey supported interpretation and analysis.

The benefits of utilizing a survey that incorporated metaphor and open-ended question items included the opportunity to gather large quantities of self-reported, descriptive information from a smaller sample. With application of a sequencing approach within the survey structure, that is, responses coupled with explanations tended to be more authentic and reflected deeper, critical thinking expressed descriptively. Moreover, through analysis of demographic questions included on the survey, it was possible to determine and describe the characteristics of the participants individually and as a group. Demographic descriptors were used to facilitate identification of themes and groupings of participants based on responses.

To triangulate the coding, analysis and rating of survey responses, to provide a basis for semi-structured interview prompts and identify disposition movement over time, a Likert-type rating instrument was used to evaluate case study responses to strategically chosen metaphor prompts.

Stage Two: Case Studies - Likert-Type Rating

Likert-type or frequency scales were used to evaluate and measure self-reported attitudes or components of affective disposition. Survey metaphor responses were rated using a five-point scale and as a component of the semi-structured interview/case study participants were asked to evaluate selected metaphor prompts on a Likert-type scale (Appendix B: Methods of Inquiry). The scale utilized consisted of a continuum from one to five with one representing o*ne of the worst* and five representing *one of the best* and included a request for explanation (narrative) of ratings chosen. The resulting Likert-type data was comparatively analyzed for reflections of survey ratings in addition to identification of convergent and divergent ratings. From the Likert-type responses a basis for the development of the semi-structured interview prompts was generated. The purpose was to confirm, disconfirm, or elaborate self-positioning as teacher-engineer or teacher-technician, and for student survey ratings, to select cases representative of productive, neutral and nonproductive dispositions.

Stage Three: Case Studies - Semi-Structured Interviews

Patton (1990 and 2002) suggested that the identification of confirming and disconfirming cases is appropriate when "…you are seeking further information or confirming some emerging issues which are not clear, seeking exceptions and testing variation" (p.178), and to further deepen your analysis or confirmatory fieldwork. As a mechanism for triangulation, semi-structured, open-ended interviews, or confirming/disconfirming case studies, provided the opportunity for the researcher to test coding, analysis and ratings of dispositions, along with identification of emerging patterns and potentially new data. Patton asserted, "Confirmatory cases are additional examples that fit already emergent patterns; these cases confirm and

elaborate the findings, adding richness, depth, and credibility" to interpretation of data and findings (p.178).

Supplementary support of the integration of case studies through the usage of semi-structured, open-ended interviews, is provided in the assertion of Miller and Glassner (2004),

> Those of us who aim to understand and document others' understandings choose qualitative interviewing because it provides us with a means for exploring the points of view of our research subjects, while granting these points of view the culturally honored status of reality (p.127).

Qualitative interviewing, as evidenced in the prior mentioned study of pre-service teachers, enhanced and enriched the authenticity of participant responses. Within a nested sampling design, intensity purposeful selected participants, or information-rich cases that manifested positioning intensely, but not extremely, were interviewed individually. Semi-structured interview prompts were developed based in reference to coding, analysis of rating of survey responses and Likert-type ratings/explanations of ratings. Prompts reflected demographic characteristics, such as grade level taught or in, to create connections to participant background facilitating analysis.

Stage Four: Case Studies - Classroom Observations and Field Notes

Dragon, et al., (2008) asserted, "An instructor who establishes emotional and social connections with a student in addition to cognitive understanding enhances the learning experience" (p.29). As a characteristic of teacher-engineer or teacher-technician, classroom observations provided the venue to identify teachers who make those connections and teachers who do not make connections with students. Dragon, et al. further stated, "Classroom observations are a useful exploratory strategy because human observers can intuitively discern high-level behaviors and make appropriate judgments on limited information" (p.30).

Consequently, to identify stable and changeable aspects (transphenomenality) of affective dispositional characteristics of teacher participants and to confirm self-reported data, Stage Four of data collection and analyses included teacher case study classroom observations and field notes. Linked students were not included in classroom observations due to a one year lapse in time between survey and observations, that is, students had moved to the next grade level mathematics course. However, interviewer observational field notes or narrative descriptions were meaning-coded and analyzed to confirm self-reported student data in Stage Four.

Classroom observation afforded the opportunity to collect descriptive data not comparatively analyzed with self-reported data, but provided consideration of what Davis (2006) refers to as the "transphenomenal character of educational 'objects'" or in this case fluid and dynamic disposition and positioning of the teacher in teaching practice (p.12). Greenwood, et. al (1994) asserted "…measurement with implications for improving teaching and learning must be sensitive to changes in teaching... Classroom observation protocols honor this assumption by recording one or more classroom processes, such as (a) the behavior of the student, (b) the behavior of the teacher, (c) the materials in use, and (d) the interactions between and among these variables" (pp. 197-198). Centering on the interaction between and among variables, elements of discourse measured in the classroom protocol (Appendix B: Methods of Inquiry) were categorically organized and linked to characteristics of teacher-engineer and teacher-technician positioning. Observers were asked to additionally take unstructured, descriptive field notes utilizing a time-line format to insure depiction of the entire class session activities and behaviors.

Using meaning-coding and analysis (Kvale & Brinkmann, 2009), a single classroom observation, field notes and interview observations were condensed or decontextualized (p.205)

according to affective disposition clusters and teacher-engineer/teacher-technician nodes. Kvale and Brinkmann identify this process as "…*autonomy of the text;* the text should be understood on the basis of its own frame of reference by explicating what the text itself states about a theme" (p.210). In order to build a chain of evidence, linguistic frequency utilizing *counting* was employed (p. 234) for eclectic multi-layered analysis.

Demographic Data Collection

Although the intent of the study was not to identify cause-effect relationships or generalize to the larger population of middle school (grades 6-8) math teachers and students, it was important to the research process to analyze demographic data pertinent to identification of themes, clusters or data unique to specific groupings of teachers and students. Wells, Hershberg, Lipton, and Oakes (2002) cited Bogdan and Biklen (1992) who suggested "…when proposing a study, researchers should address issues surrounding where the study is to be done, who the subjects are, how the subjects are determined…" (p.340) that is, setting boundaries of the participant sample. Demographic data was collected and analyzed in Stage One collectively and case study specifically in Stage Two.

Collection Methods and Data Collected

Demographic data was collected as a function of the survey instrument and Likert-type rating instrument (Appendix B: Methods of Inquiry), included as open-ended questions in the first section of the documents. Specific categories of information requested were selected based on review of multiple survey instruments, participant responses in prior studies, and consensus achieved utilizing the Delphi method.

Specifically, data gathered related to ethnicity, languages spoken, and primary language facilitated making interpretative connections in consideration of the border region of the study. Questions regarding gender facilitated analysis of the influence of stereotype threat in context of self-positioning toward mathematics. As relevant to teachers, delineation of levels of higher education attained and content of those degrees coupled with years spent as a classroom teacher provided a basis of analysis of pedagogical content knowledge (PCK) (Shulman, 1986), that is, content mastery specific to mathematics and positioning as a teacher-engineer or teacher-technician. Grade level(s) taught was utilized as a comparative point with state assessment data. Finally, identification of how many years spent in schools in the United States provided loosely attributable perspectives of dispositional differences as related to foreign and domestic school experiences and educational preparation.

Although not specifically asked as an open-ended response, location of schools was a function of the participant numbering system, allowing for initial trend analysis based on broad geographic areas, such as central, west, and northeast areas of the urban area in which the study was situated. The diversity of the population of the school district was in part due to the influences of geographic areas and socioeconomic status of the students in those areas. As such, location was an influential, intervening variable requiring analysis and acknowledgement in data analysis and interpretation components of the study.

State Assessment Data

Standardized tests (in compliance with the No Child Left Behind Act) are administered in mathematics to all students in grades 6, 7, and 8 in the state where the school district is located. These tests are typically administered in the spring during the months of March or April. Although several categories of state assessment data were collected, for purposes of the study

consideration of the overall percentage score achieved by students linked to the participating teacher during the academic year 2011- 2012 was used for triangulation purposes and considered an intervening variable (Findings, Chapter Four). Percentage scores are simply calculated based on number of responses correct out of total responses. Other designated state assessment measures used for accountability were not deemed to be reflective of mastery of content specific essential knowledge and skills due to scaling and standardization of scores. Testing data is available from records kept by the state education agency and are a matter of public record.

Analysis and Synthesis of Data

Analysis and synthesis of the data required qualitative and quantitative approaches to holistically reflect the authentic responses of the participants within the Positioning and Complexity Theory frameworks. “Data analysis is a reflective process and involves a sensitive attunement to opening up to the meaning of experience both as discourse and as text” (Ray, 1994, p.129). Self-reported and observed data were predominantly textual requiring deconstruction with critical attention to meaning-making in the responses in addition to rating. Likert-type data were quantitative by nature, conversely responses did include descriptions and explanations of responses requiring reflective analysis.

It is essential to note at this juncture that the study was an exploratory endeavor and it was not the intent to generalize the results to a larger population. “According to Guba (1981), application or transfer of knowledge can occur across settings when one knows a great deal about both the transferring contexts and the receiving contexts” (Johnson, 1997, p.197). The opinion was that findings and interpretations, through the utilization of vertical and horizontal comparative coding and analysis, resulted in thick descriptions that identified similarities (representativeness).

From a related perspective, it was the intent of the study to render findings that would address the research questions and sub-questions, as well as provoke further research. Descriptions of procedures are provided in the paragraphs that follow and illustrated in Figure 3.4.

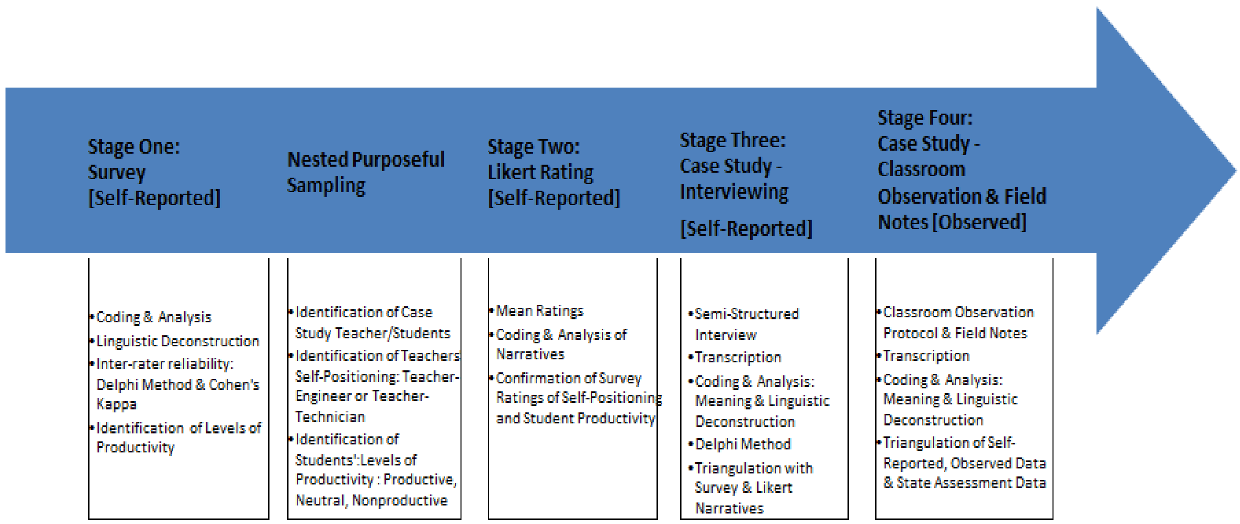

Figure 3.4: Research Procedures

Stage One: Open-Coding Framework - Linguistic and Deconstruction Analysis

In order to code, rank, and/or rate affective categories and levels of intensity of responses in the most authentic manner possible, linguistic analysis and deconstruction was used as a basis (Kvale and Brinkmann, 2009). It is the contention of Kvale and Brinkmann that “Meaning and language are intertwined” (p.196). Specifically, underlying connotation within the responses (deconstruction) and what terms, such as personal pronouns, were being used and meaning implied (linguistic analysis) was examined. Coding categories were developed based on the definitions of constructs of affective disposition (Appendix C; Table 2.1) and on prior mentioned study analyses. Affective domain categories examined included nature of mathematics,

usefulness, worthwhileness, attitude, anxiety, self-concept, and sensibleness of mathematics. Table 3.1 provides a matrix with examples of the coding framework being utilized.

Table 3.1: Productive & Nonproductive - Levels of Intensity

Level of Productive & Nonproductive Disposition	**Examples of Affective Domain Characteristics**	**Example of *Mathematics is like…***	
		High Intensity	**Low Intensity**
Highly Nonproductive:1	Nature of Math	*Mathematics is like a dule (dull- inserted) hair brush, because it makes me want to pull out my hair"*	*"Mathematics is like the unknown; not everyone knows math"*
Nonproductive:2	Self-Efficacy	*"Mathematics is like a foreign language. Just when I feel like I am grasping it, I am shown something different"*	*"Mathematics is like something you are just not born for. I believe that every person has gifts and defects. Some are born to dance, some can write poetry, and I just believe that even though I can do some math, I wasn't born to be great at it"*
Neutral:3	Usefulness	*"Mathematics is like an adventure, because it always takes your mind to exploring different possibilities!"*	*"Mathematics is like a daily routine. There is always problems to resolve and you have to resolve them using the best strategy that you know and have on your hands, you learn from it and use it in future problems."*
Productive:4	Self-Concept	*"Mathematics is like breathing. You do it every day, sometimes without even thinking."*	*"Mathematics is like second nature. I don't have as much of a difficult time, if I feel confident about it."*
Highly Productive:5	Worthwhileness	*"Mathematics is like air/oxygen. It's all around us and we can't seem to live without it."*	"*Mathematics is like the gateway to a better life. People who understand and do math well have more opportunities and better choices to make in life"*

A response illustration of high intensity and highly nonproductive disposition was "*Mathematics is like a dull hairbrush, because it makes me want to pull out my hair*" (Table 3.1 example). Terms such as *"dull", "me", "pull out"*, and *"my"* provided insights into an underlying

narrative(deconstruction) and the intensity of that narrative (linguistic analysis). This framework was utilized independently by multiple expert raters when assigning levels of productivity and intensity for survey responses.

Inter-Rater Coding

Teacher and student survey responses were rated and coded according to the guidelines (Table 3.1) by three independent expert raters for teacher surveys and two independent expert raters for student surveys. Each item response was coded individually by each of the five raters in terms of level of productivity and level of intensity of the response (Iteration One). Next an overall rating of productivity was established for each participant by each rater (Iteration Two). Utilizing the Delphi method of consensus for teacher ratings (Iteration Three) required each rater to review their ratings with knowledge of overall ratings given by other raters. Justifications for changes in ratings were noted for each response included in the overall rating. Iteration Four required the three raters to review their revisions and have an open discussion of any divergent ratings. In Iteration 4, raters came to consensus on an overall rating of productivity, or retained divergent ratings. Pearson's *r* was used at Iteration Two to determine inter-rater reliability of student survey ratings.

When levels of productivity and intensity were established, responses were reviewed taking into consideration the target, that is, mathematics, mathematics teaching, or mathematics learning to ascertain context or social force of disposition/positioning (depicted in the Figure 1.1).

Level of Intensity

In second-tier coding levels of intensity of metaphorical responses and open-ended question items were defined as low (level 1), medium (Level 2), and high (Level 3) on a rating continuum. Semantic analysis and deconstruction provided the basis for determining levels of intensity. Examples of low and high intensity responses are given in Table 3.1. Levels of intensity were assigned by each rater individually; however, post rating discussions (utilizing the Delphi method) among raters was a part of the analysis and process of determining inter-rater reliability.

Inter-Rater Reliability

Inter-rater reliability was of particular importance to the study due to coding and ratings by multiple expert raters of each component of the survey instrument. "A measure of objectivity is 'inter-coder reliability', whereby two coders use the same coding frame to code independently the same units. The amount of agreement between them is the estimation of the inter-coder reliability" (Liakopoulos, 2000, p.162). Ratings were considered correlated based on the degree of agreement between rating and the homogeneity of the ratings. The Delphi method of consensus and Cohen's Kappa were utilized to ascertain levels of inter-rater reliability.

Cohen's Kappa. Cohen's Kappa was used as a data analysis source to establish inter-rater reliability of teacher ratings. Similar to Pearson's *r* (used with student ratings), Cohen's Kappa establishes the correlation coefficient as a number between positive one and negative one, indicating the magnitude and directionality of the two ratings. If the correlation is near to zero, then there is no relationship between the ratings, while closer to negative one indicates a negative relationship and near to positive one indicates a positive relationship. An acceptable kappa value is considered generally to be *0.70.* Differing from other inter-rater statistical tests, Cohen's

Kappa takes into consideration agreement that occurs by chance. The basic structure of calculating Kappa involved establishing a proportion of actual agreement among raters adjusted by the proportion of chance agreement. Key to the process was independent ratings without consultation or influence.

Delphi Method. Cohen's Kappa was assessed in the prior studies described in this chapter, to establish inter-rater reliability of teacher ratings. Based on analysis of results, it was determined that the most versatile, encompassing, effective method of establishing inter-rater consensus for teacher ratings, as pertains to the nature of the study, was the Delphi method. The Delphi method was developed by Dalkey and Helmer in the 1950s and was used predominantly at the Rand Corporation (Hsu and Sandford, 2007). "The Delphi method is an iterative process used to collect and distill the judgments of experts…" (Skulmoski, Hartman, & Krahn, 2007, p.2) and provided for multiple iterations, controlled feedback, and considerations of ratings within the context of multiple raters. Hsu and Sandford, indicated that "The Delphi technique… is a widely used and accepted method for achieving convergence of opinion concerning real-world knowledge solicited from experts within certain topic areas. Predicated on the rationale that, "two heads are better than one, or...*n* heads are better than one" (Dalkey, 1972, p. 15)" (p. 1), multiple iterations of consensus were used throughout the stages of the study by multiple raters.

There exist many versions of the Delphi method dependent on the context of the research and the nature of the research question. Skulmoski, Hartman, and Krahn (2007) stated "One quickly concludes that there is no *typical* Delphi; rather that the method is modified to suit the circumstances and research question" (p.5). The Delphi method has been used predominantly in quantitative studies, however, Skulmoski, et al., further elaborated, "The Delphi method is well

suited to rigorously capture qualitative data. It may be seen as a structured process within which one uses qualitative, quantitative or mixed research methods. Such flexibility … affords the ability of the method to answer many research questions…" (p.9). Based on the mixed methods nature of the study, Delphi consensus was appropriate to establish inter-rater reliability.

Generally speaking, the structure of Delphi included descriptions of the characteristics to be possessed by the independent raters: "…Delphi participants should meet four "expertise" requirements: i) knowledge and experience with the issues under investigation; ii) capacity and willingness to participate; iii) sufficient time to participate in the Delphi; and, iv) effective communication skills (Adler & Ziglio, 1996)" (Skulmoski, et al., 2007, p.10). The number of iterations is determined in the research process. Skulmoski, et al. delineated that,

> The number of rounds again is variable and dependent upon the purpose of the research. Delbecq, Van de Ven and Gustafson (1975) suggest that a two or three iteration Delphi is sufficient for most research. If group consensus is desirable and the sample is heterogeneous, then three or more rounds may be required. However, if the goal is to understand nuances (a goal in qualitative research) and the sample is homogeneous, than fewer than three rounds may be sufficient to reach consensus, theoretical saturation, or uncover sufficient information. (p.11).

As applicable to this study, Figure 3.5 depicts the structure of the Delphi method utilized.

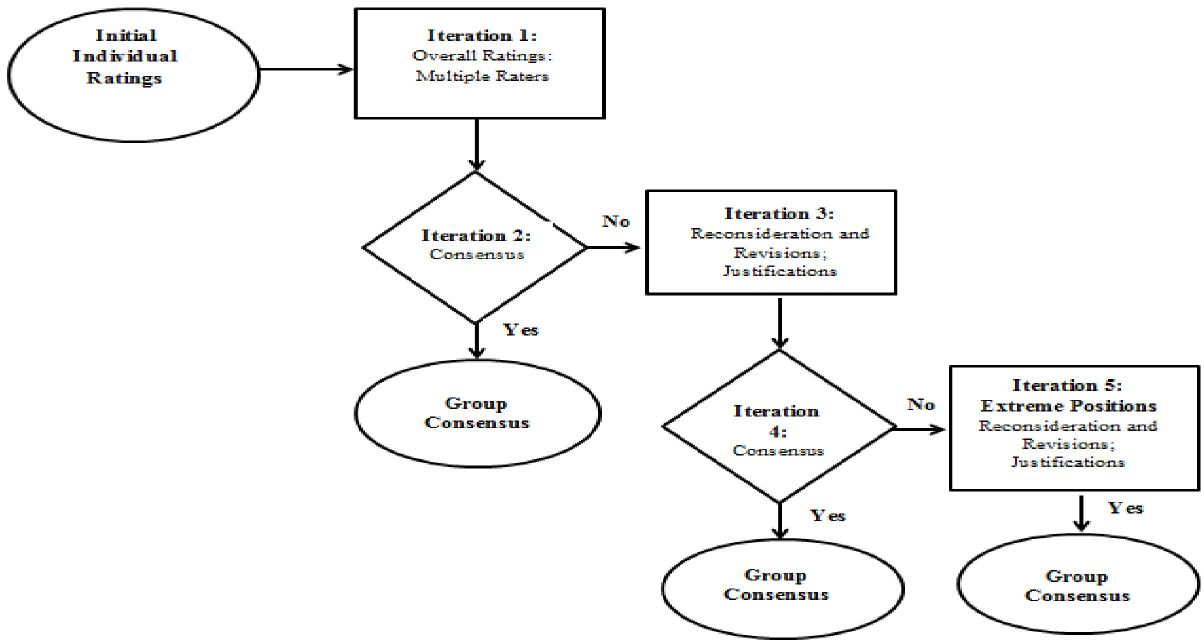

Figure 3.5: Delphi Method

Hsu and Sandford, citing Miller (2006) stated, "…consensus on a topic can be decided if a certain percentage of the votes falls within a prescribed range" (p. 4). Consensus, for purposes of this study, was not set at a level of complete agreement, but at a minimum of 80% agreement. Hsu and Sanford (2007) cautioned

> "…that subtle pressure to conform with group ratings was one of the major drawbacks in the Delphi technique (Witkin & Altschuld, 1995, p. 188). Delphi investigators need to be cognizant, exercise caution, and implement the proper safeguards in dealing with this issue" (p.5).

This limitation was considered in the process of iterations and confirmed through the use of Cohen's Kappa test of inter-rater reliability.

Identification of Affective Disposition/Positioning

Two scales were utilized in evaluation of affective disposition and positioning of participants. Initially, as a product of coding and analysis of survey responses and ratings,

participants were rated and coded as productive, neutral or nonproductive toward mathematics, mathematics teaching and learning. Teacher participants who self-reported as nonproductive or highly nonproductive were classified as teacher-technicians and participants rated as productive or highly productive were classified as teacher-engineers. From these ratings, two teachers and six linked students were purposefully chosen to voluntarily participate in Likert-type ratings, semi-structured interviews and classroom observations.

Criteria-Based Case Study Sampling

Two teacher case studies were identified with criteria-based sampling of self-reported positioning as teacher-engineer and teacher-technician and six students were purposefully selected as representative of productive, neutral and nonproductive dispositions, based on analysis of survey responses. Selected participants were asked to participate in open-ended interviews to further confirm self-positioning. Purposely sampled case studies represented the following links: Teacher-Engineer with linked Productive Student (Ps), Neutral Student (Ns), and Nonproductive Student (NP) and Teacher-Technician with linked Productive Student (Ps), Neutral Student (Ns), and Nonproductive Student (NPs). Once identified, participants were given a Likert-type rating instrument. The Likert-type ratings and explanations were used as prompts within the interview question framework.

Stage Two: Case Studies-Likert-Type Ratings

Affective disposition and positioning of participants was identified as productive, neutral or nonproductive toward mathematics, mathematics teaching and learning based initially on coding and analysis of survey responses. Based on those ratings, teachers were identified as self-positioning as teacher-engineer or teacher-technician. Likert-type ratings and explanatory

narratives were used to confirm initial productivity ratings and self-positioning. Delphi standard as compared to survey ratings with no more than a plus or minus one point deviation in divergent Likert-type overall ratings of productivity was used. The design of the Likert-type rating scale was applied consistently to meet a condition of using Cohen's Kappa.

For purposes of confirmation, self-reported Likert-type ratings were specifically compared to survey ratings for prompts three, four and five as depicted in Table 3.2. Likert-type ratings were compared with individual question ratings and overall survey ratings compared to mean Likert-type ratings. Additionally, narratives from the survey and Likert-type instrument were linguistically deconstructed and compared for uniformity of responses. Transphenomenality was noted in individual cases as indicated.

Table 3.2: Comparative Survey/Likert-Type Prompts

Survey Prompt	***Likert-Type Rating Item***
Students: *If you were a mathematics teacher, how would you teach math? Explain.* **Teachers:** *In an environment without restrictions, how would you teach math? Explain.*	*On a scale of 1-5, with 1 being 'one of the worst' and 5 being 'one of the best', how would you position yourself toward mathematics teaching? Explain Why.*
Describe a mathematics classroom where students are best able to learn. Explain and give details.	*On a scale of 1-5, with 1 being 'one of the worst' and 5 being 'one of the best', how would you position yourself toward mathematics learning? Explain Why.*
Mathematics is like ________. Explain why.	*On a scale of 1-5, with 1 being 'one of the worst' and 5 being 'one of the best', how would you position yourself toward mathematics? Explain Why.*

Stage Three: Case Studies - Semi-Structured Interview/Audio Transcriptions

Creswell (2007) identified six forms of data in case study: “documents, archival records, interviews, direct observation, participant observation, and physical artifacts” (p.132). Sommer and Sommer (1997) identify the main goal of unstructured interviewing “…to explore all alternatives in order to pick up information, to define areas of importance that might not have been thought of ahead of time, and to allow the respondent to take the lead to a greater extent” (p.108). The characteristics and protocol of the semi-structured interview did not include a structured interview guide but was grounded in open-ended questions. The process was similar to a conversation and was used to gain more personal information by using the respondent’s answers to delve more deeply into the underlying narrative in survey and Likert-type responses (Pawson, 1996). Each participant was interviewed on their home campus at a pre-arranged time which did not interrupt instructional time. Due to a potential conflict of interest, three outside interviewers (graduate students) were contracted and trained in the protocol and interviewing process, as needed. Interviewers were experienced in semi-structured interviewing techniques and required no training, other than review of the protocol. Interviews lasted between twenty minutes to one hour, with student interviews taking typically less time.

In order to preserve the integrity of the data and include verbatim responses as part of analysis, interviews were audio taped and transcribed. Open-ended interview prompts were developed from linguistic analysis of the survey responses and the Likert-type rating responses, primarily with the intent of confirmation and clarification. Elaboration on survey and Likert-type responses provided an avenue to explore affective disposition at a storied and personal level and provided the opportunity to ask further probing questions based on participants’ interview

responses. To further develop case studies and identify patterns and themes, extraneous variables and demographics were explored and analyzed within the complexity framework.

Stage Four Case Studies: Classroom Observations and Field Notes

Douglas (2009) posits, "… self-report is subject to error due to memory, comprehension, judgment and social desirability" (p. 519). Classroom observations and field notes were included in Stage Four of data collection to comprise observational data as confirming/disconfirming when examined in conjunction with self-reported data. Douglas, citing a study conducted by Pulardy and Rumberger, stated, "They find that teacher attitude and practices combined account for more variance in student learning than do teacher background qualifications" (p.518). For purposes of this study, it was asserted that teacher disposition and practices were critical to development of student mathematical disposition and that observational data confirmed the presence of transphenomenality.

Observational data collection conveyed with it inherent issues that required an experienced observer. Levine, et al., (1980) documenting how to teach observation methods indicated the role of the observer must be one of a "…disciplined, analytic, idea-generating observer" (p.43). One participating interviewer was contracted to complete classroom observations due to established rapport with the teachers and perception of neutrality. To facilitate participation, classroom observations were prescheduled with the teachers at a time chosen by them. Single observations were conducted using pre-determined categorical protocol and time-generated descriptive field notes. Observations lasted one class period or approximately forty-five minutes and did not include references to identify of specific students. Linked students were not present in the classroom due to lapse in time between survey and classroom observations.

Student interview observational notes written by interviewers were provided in a format categorized by teacher-engineer, teacher-technician and affective dispositional characteristics. Observational notes were products of neutral observations during the span of the interview and through listening to audio tapes of the interviews.

Categories, themes, clusters and nodes were developed through meaning-coding and condensation linked to constructs of teacher-engineer, teacher-technician and affective disposition. Clusters identified were *Nature of Math*, *Worthwhileness, Usefulness and Sensibleness, Self-Concept*, *Attitude* and *Anxiety.* Semantic reference and linguistic frequency counting was achieved within the clustering coding framework from observation protocol and field/observation notes.

Intervening Variables/Demographic Cross Comparisons

Intervening variables and demographics were considered for identification of sub-group trends, patterns, and themes, as well as potential influences that reflected in self-positioning, positioning-by-others and disposition. It was not the intent of the study to focus on intervening variables and demographics, but to acknowledge those factors. Grbich (2007) stated, "…cluster analysis of quantitative data" (p.200), such as demographic data provided additional criteria for selection of case study participants, which can be a factor in defining a more encompassing cross-section representation of the participant group.

Extended Triangulation: State Assessment Scores

For purposes of triangulation of multiple instrument findings, academic year 2011-2012 student state assessment data was reviewed for each case study. State assessment data was considered to be outcome data reflective of self-positioning and positioning-by-others. As an

extraneous variable used to triangulate data, state assessment scores were considered as adequate sources of supplemental data.

State assessment scores for case study teachers were comparatively analyzed with state assessment scores for the sample of 32 teacher participants. Scores were grouped in quartile distribution ranges. Quartile placement of case study teacher scores was considered to be a reflection of positioning-by-others.

Ethical Considerations

Ethical issues and considerations included confidentiality, protecting participants from harm, knowledge of possible benefits to participants, voluntary/informed participant consent, and Institutional Review Board (IRB) approval from the sponsoring and participating institutions.

Confidentiality

It was important to protect participants' anonymity and maintain all information and data collected in secure and confidential manners. It was also important to insure reliability of interpretations and findings. Strategies for validating findings included the use of multiple sources for triangulation of data. Data collection and inclusion of teacher and student specific data (quantitative and qualitative) were maintained in a locked location insuring confidentiality and accessible only to the researcher. All data were maintained in secured areas, including electronic data stored on flash drives, discs, etc. All participant documents were coded with pre-numbered identification prior to instrument administration to provide anonymity.

Protection of Participants from Harm

Gay, et al., (2009) state, "…the most pervasive ethical issues relate to informed consent and the researcher's ability to have closely aligned personal and professional ethical

perspectives" (p.114). The *Ethical Principles of Psychologists and Code of Conduct,* as well as *The National Research Act of 1974* were used as resources of guidelines for ethical considerations. Participants were informed of the purpose of the study, any possible benefits or harm, and that participation was completely voluntary. In the study, the process of obtaining informed consent and assent included provision of a description of the purpose of the study, the data that was collected, and all contact information, through written notice in English/Spanish and discussion/presentations in English and Spanish. All participants were reassured that participation was voluntary and that at any time their consent for participation may be withdrawn without repercussions or penalty.

There were no physical or financial risks known or anticipated in this study. There was not a loss of confidentiality of data posing no immediate ethical concerns. There was no evidence of participant stress or distress as a result of interview. There were no apparent psychological impacts that influenced the outcomes of the study. Finally, there was no cost or burden to the participant, other than time committed for interviewing and completing surveys.

IRB guidelines

Institutional Review Board (IRB) approval was obtained from the sponsoring university and representative independent school district for the study. All guidelines and established IRB procedures were adhered to, including study amendments and closure.

Issues of Trustworthiness

The Robert Wood Johnson Foundation (2008), as part of the qualitative research guidelines project and citing Lincoln and Guba (1985), provided the following definitional characteristics of trustworthiness:

> …*credibility* or “confidence in the 'truth' of the findings”, *transferability* or “showing that the findings have applicability in other contexts”, *dependability* or “showing that the findings are consistent and could be repeated”, and *confirmability* or “a degree of neutrality or the extent to which the findings of a study are shaped by the respondents and not researcher bias, motivation, or interest” (n.p.).

Each characteristic mentioned above was considered for the research study.

Credibility

Credibility of findings was supported through inter-rater reliability assessments and triangulation of data utilizing multiple sources of data and verification. Coding of responses was subjective, although based within an analytical linguistic deconstruction framework and utilizing operationally defined teacher-engineer, teacher-technician and affective dispositional construct characteristics and clusters.

Transferability

Cause-effect relationships was not identified or asserted; rather research reflections and conclusions were reported in the findings and analysis. The data were used to present suppositions and assertions addressing research questions; cause and effect was not established nor implied.

Dependability

Replication of the study was not intended, yet is possible. Specifically, intensity and stratified purposeful sampling utilized impacts the potential for replication. Indicative to an exploratory study, the intent was to report findings rather than generalization of results to the population of teachers and students in totality.

Confirmability

Identification of and accounting for biases in interpretation enhanced the credibility of the data collected and data analysis. Marshall and Rossman (2006) stated “The qualitative researcher’s challenge is to demonstrate that the personal interest – increasingly referred to as the researcher’s positionality – will not bias the study” (p.30). Multiple rater review, confirmation and triangulation of data functioned as the external auditor of the analysis; Marshall and Rossman (2006) identify these constructs as sources of “confirmability” (p.203).

Limitations

“A limitation is some aspect of the study that the researcher cannot control but believes may negatively affect the results of the study” (Gay, et al., 2009, p. 109). Limitations accounted for in the study included researcher bias, instrument validity, and reliability of participant responses.

Researcher Bias

The researcher acknowledged that there was a preconceived notion of the importance of identifying and understanding transphenomenal simultaneity as indicative of the complexity of education as identified in self-positioning and positioning-by-others. This notion was based in the researcher’s twenty-plus years of educational experience, particularly the years spent as a middle school mathematics teacher and instructional coach. Even though this was considered a limitation, the research design incorporating multiple raters, interviewers, observers and defined parameters accounted for researcher bias.

Instrument/Response Bias

There were three central limitations that arose due to the design of the survey instrument, Likert-type questions, and interview protocol: clarity of questions, honesty of participant responses, and response rates.

Within the design of the open-ended questions, metaphorical prompts and drawing parameters, there may have been issues of clarity of questions, that is, what the intent of each question or prompt was. However, the nature of open-endedness, the prior piloting of metaphorical prompts, and the inclusion of explanations (sequencing) addressed issues of clarity for both the respondents and raters. Further clarification was provided during the interview process as needed. Items that were identified in analysis to have been misconstrued by participants were omitted from analysis.

Design of the metaphorical prompts was intended to elicit authentic responses and allow for linguistic deconstruction of responses to account for honesty within participant responses. As indicated in the prior pre-service study, open-ended metaphorical prompts provided responses of greater depth and authenticity than pre-determined levels within Likert-type rating scales. Participant honesty in responses was accounted for with these design structures, yet continued to be a potential limitation that was considered. Self-reporting might have been impacted by self-esteem which was not measured or controlled for due to interconnectedness of affective disposition to emotion to self-esteem and vice-versa.

Lastly, survey response rates provided an adequate sample for the study in consideration of established levels of appropriate numbers of participants necessary for the particular study design. The quantity of completed surveys was tested to assure representation of the group of middle school math teachers and students.

Summary

Utilizing survey/case study research, middle school mathematics teachers' self-positioning is challenged by positioning-by-others (student) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition and was an area of study not yet fully investigated. The impetus for this study was the desire to identify metamorphoses between teacher-as-engineer and teacher-as-technician and resultant student disposition toward mathematics. As Todd (2011) has stated, "This enables construction of theories about what has been observed and is based upon reflections of particular experiences" (pp. 120-121).

Through the process of gathering and analyzing authentic data, findings provided insights into why some teachers position themselves as engineers and some as technicians. Further, identification of contributing factors, such as stereotype threat, led to inquiries and application of findings to address extraneous factors, and/or patterns of teaching practice. Lastly, the report of results and findings facilitated creation of an additional reform perspective or accounting for the *who* along with the *how* and *what* in recommendations for mathematics education reform.

In Chapter Four, findings, results and analysis for research Stages One through Four are presented with graphical representations and interpretations reflecting self-positioning and positioning-by-others as evidence of transphenomenal simultaneity. The intent was to provide a view of self-reported and observed middle school teacher and student experiences in mathematics, based on the analysis of affective dispositional characteristics within the context of its complexity.

Chapter 4: Findings, Results and Analysis

Introduction

This was a study about middle school mathematics teachers' self-positioning challenged through positioning-by-others (student) revealing simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition. Bishop (2012) reaffirmed the importance of student affective disposition by citing, "…the National Research Council recognized the affective component of learning mathematics saying 'Students' disposition toward mathematics is a major factor in determining their educational success' (2001, p. 131)" (p.35). As evidenced by this statement, affective dispositional characteristics within the context of its complexity are critical factors for study. Additionally, Beyers (2011) documents existence of a relationship between teacher and student disposition, but to what extent and encompassing what characteristics and factors has not been sufficiently substantiated.

The absence of prior exploration of the reflection of teacher disposition in student dispositions and the evolution of positioning of the teacher, in interaction with the student and content, in one of two ways: as teacher-engineer or as teacher-technician (Tchoshanov, 2011) were motivating factors for this research study.

Summary of Methods

Data collected from the survey instrument employed open-ended question items and metaphorical prompts (Stage One), Likert-type ratings (Stage Two), interview prompts (Stage Three), classroom observation protocol and field notes (Stage Four) and were the foci of coding and meaning analyses of self-reported and observed participant responses. Multi-stage mixed

methods approach produced a shift from quantitative methods in Stages One and Two to a heavily emphasized concentration of analysis grounded in and compelled by qualitative examination of data in Stages Three and Four. A nested intensity purposeful sampling process afforded movement from a larger stratified purposeful sample to case studies. State assessment and demographic data were also collected to provide additional quantitative confirming and disconfirming data for triangulation as described in the Chapter Three, Methodology.

Data coding and analyses were guided by and based in the concept of transphenomenality outlined in Complexity Theory (Davis 2005; 2006). Constructs and characteristics of affective disposition and Positioning Theory (van Langenhove & Harré, 1999; Harré, 2011; Harré & Moghaddam, 2003) provided structure for coding frameworks. Linguistic deconstruction, meaning-making, and discourse analysis were the main tools of coding (Kvale and Brinkmann, 2009). Independent expert raters determined levels and intensity of productive, neutral and nonproductive dispositional inclinations from survey responses. Inter-rater reliability was achieved through use of the Delphi Method of Consensus and Cohen's Kappa, accounting for multiple raters. Open coding of self-reported and observed data included frequency and meaning-coding according to operationally defined categories and clusters as well as, identification of themes or nodes.

Overview of Findings and Results

"Complexity theory proposes that any minute change in any dynamic system has a generative impact on a multiplicity of inter-related locations and relationships" (Fels, 2004, p.77). Stage One findings and results provided insight into disposition and self-positioning of teacher and student participants. The magnitude of examining, coding, and rating thirty-two teacher surveys (one teacher survey was eliminated based on incompleteness of responses) was

encompassing and was considered to be a representative sample of the seventy-five teacher surveys distributed. Coding and rating of teacher surveys was completed by three independent raters. Of the 1,429 student surveys received, 890 completed surveys were linked to teachers. Using a random number generator with a limit of twenty-five surveys per teacher, 458 student surveys were randomly selected from the 890 and linked to twenty-two teacher surveys.

Rating of the 458 linked student surveys was completed by two independent expert raters. The overarching finding in Stage One analysis of self-reported data, on a scale of one to five with one being highly nonproductive inclinations and five being highly productive inclinations, demonstrated generally an overall productively inclined affective disposition mean rating for twenty-two teachers (*3.54*) and a slightly lower overall mean rating of *3.24* for linked students (Appendix G). This finding indicated a contradiction to the literature review finding of prevalent nonproductive dispositions toward mathematics in studies such as Rock and Shaw (2000) and Picker and Berry (2000). Self-positioning of teachers and students in the sample was inflated and not substantiated when triangulated with district 2011-2012 academic year state assessment data that is, overall student percent scores (number of correct responses out of total responses) by grade level were not reflective of productive dispositions (Table 4.1).

Table 4.1: District 2011-2012 Academic School Year State Assessment Math Percent Scores By Grade Level

Grade Level	**Overall Percent Score**
6^{th} grade	60.15%
7^{th} grade	56.44%
8^{th} grade	50.54%
***** *Data Source: AEIS 2011-2012 Report*	

However, this finding was solely based on self-reported data and was further explored with observed data for identified case studies.

In overview of findings and results for Stages Two through Four, it was surmised that teacher and student core dispositions dynamically manifested in varied positioning stances. For example, a teacher rated as having a productively inclined disposition toward mathematics (Pt) demonstrated a neutral to nonproductive positioning-by-others toward mathematics teaching and learning. Of the three students linked to the productively inclined teacher, all three students experienced the same teaching and learning positioning demonstrated by the teacher; nonetheless students exhibited three distinct, unique core dispositional inclinations – productive (Ps), neutral (Ns), and nonproductive (NPs) – toward mathematics, mathematics teaching and learning. Core dispositional inclination or self-positioning was found to be less flexible while positioning-by-others was actively fluctuating (Figure 4.1).

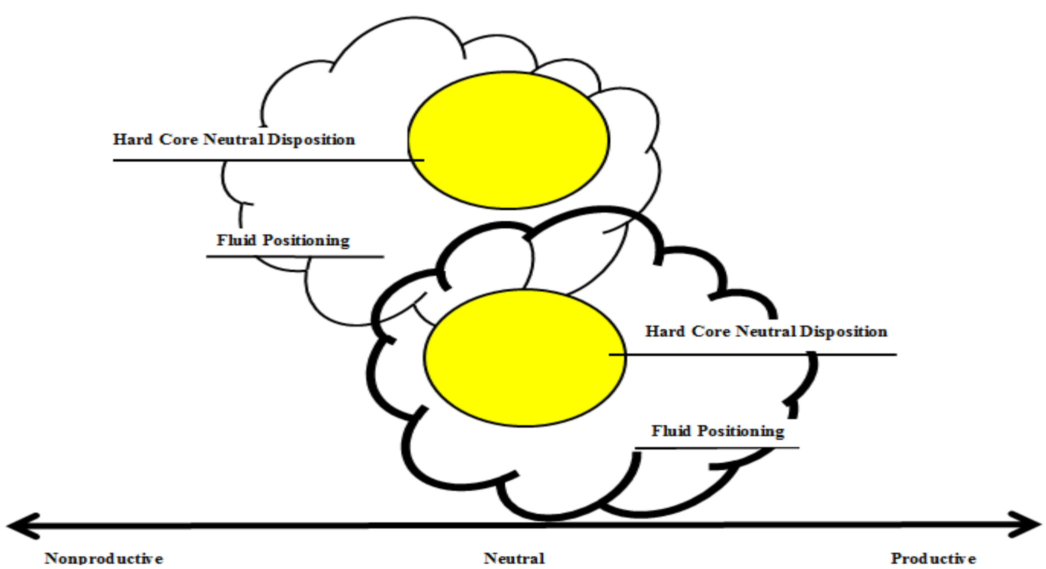

Figure 4.1: Transphenomenality & Simultaneity of Disposition & Positioning

Simultaneity of transphenomenality reflects "…events or phenomena that exist or operate at the same time" (Davis, 2005, p.14) and was recognizable in the dynamic and multifaceted nature and characteristics of disposition which contributed to emergent and shifting mathematical disposition. Fluidity in teacher self-positioning and positioning-by-others, measured by multiple instruments, was representative of metamorphoses between teacher-engineer and teacher-technician and resultant in student disposition toward mathematics. Manifestations of simultaneity of transphenomenality representative of phenomenological conflict are portrayed for each teacher case study participant, Sage and Thyme (pseudonyms), subsequently in this chapter.

Consequentially, findings were demonstrative of triangulation of multiple sources of data which provided a basis for identifying case studies. Each set of case study participants voluntarily participated in semi-structured interviews and teacher participants agreed to classroom observations. Interview field notes were taken for all case study participants and classroom observational field notes were taken in addition to protocol entries. Data were cross-analyzed and triangulated in Stages Two through Four of findings reporting and analysis. Findings and results are presented for each stage of data gathering and analyses guided by Complexity Theory. The research questions and sub-questions (stated in Chapter Three) were situated in the perspective for collection and presentation of data which is described for Stages One through Four.

Findings, Results and Analysis

Stage One: Sample Demographics

Table 4.2 presents the self-reported demographics of the thirty-two teachers initially coded and rated in Stage One and, as a point of comparison, demographics for district teachers in grades 6, 7, and 8.

Table 4.2: Stage One – Teacher Sample and District Comparative Teacher Demographics

Sample (Self-Reported)			**District (AEIS 2011-2012 Report)**		
Gender	Male	26%	Gender	Male	30.9%
	Female	74%		Female	69.1%
Ethnicity	White	40%	Ethnicity	White	30.5%
	Latino/a	56%		Latino/a	64.1%
	African American	4%		African American	2.4%
Grade(s) Taught	6	36%	Grade(s) Taught	6	33%
	7	31%		7	33%
	8	33%		8	33%
Years Teaching	Mean	10.7 years	Years Teaching	Mean	12.6 years
	Range	2 years to 34 years		Range	0 years to 20+ years
Languages Spoken	English	52%	Languages Spoken	English	ND
	English/Spanish	48%		English/Spanish	ND
Level of Degree Held	Bachelors	60%	Level of Degree Held	Bachelors	76%
	Masters	40%		Masters	23%
	Doctorate	0%		Doctorate	1%

The sample of *n* = 32 was fairly representative of the district demographics for teachers in grades 6, 7, and 8. Although the findings were not meant to be generalized to the district, the stratified purposeful sample displayed demographics illustrative of the larger population. Self-reported teacher demographics were symbolic of middle school demographics in most districts located in southwestern border region school districts.

Geographic area data were revealing in that ethnicity, language(s) spoken and mean years teaching were typical of the demographics of the district geographical areas as illustrated in Table 4.3.

Table 4.3: Stage One: Teacher Self- Reported Demographics by Geographical Areas

Geographical Area		***Central***	***West***	***NE***
Gender	Male	43%	17%	27%
	Female	57%	83%	73%
Ethnicity	White	14%	55%	40%
	Latino/a	86%	44%	50%
	African American	-	-	10%
Years Teaching	Mean	15.1 yrs.	10.1 yrs.	8.2 yrs.
	Range	8-27 yrs.	2-34 yrs.	2-27 yrs.
Languages Spoken	English	43%	67%	45%
	English/Spanish	57%	33%	55%
Level of Degree Held	Bachelors	57%	73%	45%
	Masters	43%	27%	55%

(n = 32)

The central area of the district, represented in the study, has traditionally been predominantly Latino/a, English/Spanish speakers and having a lower socioeconomic status label. Teacher self-reported data for the central area, as depicted in Table 4.3, indicated predominantly Latino/a, reasonably split between male/female and with the highest mean years of teaching experience for all geographic areas. The northeast area of the district serves a large number of students from military families and has a higher percentage of African American population than the other two geographical areas. Ethnicity of teachers in the northeast area mirrored the ethnic distribution of the northeast population. Mean years of teaching experience was the lowest of the three areas, possibly reflecting the transient nature of the northeast military population. The west area of the school district represented in the study is typically considered a more affluent area with multiple ethnicities and languages represented. The majority of teachers in this geographic area reported

being mono-lingual English, principally possessing bachelors' degrees and predominantly female.

Table 4.4 presents the self-reported demographics of the linked 458 students initially coded and rated in Stage One and district student demographic data for grades 6, 7, and 8.

Table 4.4: Stage One – Student Sample and District Comparative Student Demographics

Sample (Self-Reported)			**District (AEIS 2011-2012 Report)**		
Gender	Male	51%	Gender	Male	51%
	Female	49%		Female	49%
Ethnicity	White	20%	Ethnicity	White	10.9%
	Latino/a	63%		Latino/a	82.6%
	African American	8%		African American	4.1%
	Asian	4%		Asian	1.1%
	Other	4%		Other	1.3%
Grade(s)	6	54%	Grade(s)	6	33.5%
	7	12%		7	33.1%
	8	34%		8	33.4%
Languages Spoken	English	38%	Languages Spoken	Limited English Prof.	25.3%
	English/Spanish	53%			
	English/Other	9%			

Ethnic distribution and grade distributions were within a range of representativeness and were generally reflective of district demographics. The slight differences were not considered to impact findings and results, but were considered as extraneous variables. Gender representations were closely matched supporting analysis by gender.

Stage One: Survey Research Findings, Results and Analysis

Survey instruments allow for collection of self-reported responses to a variety of prompts. Employment of survey research in the study allowed for a conceptualization of reality utilizing a dialogical approach to data collection (Bakhtin, 1981) encompassing the context and meaning of participant responses. The application of open-ended question items and

metaphorical prompts afforded an opportunity for authenticity of responses. Khan (2012), referencing Rocoeur's work (2004), stated "…metaphors *(inserted)* engage us in interpreting and understanding complex abstract concepts and the meaning of life" (p.55). Open-ended question items and metaphorical responses were linguistically deconstructed to facilitate two phases of coding and rating: (1) rating of affective dispositional inclinations on a continuum of one to five within operationally defined categories of productive to nonproductive disposition; and (2) meaning-making of participant responses as narrative or story-line utilizing two nodes of response, teacher-engineer and teacher-technician.

Stage One: Open-Ended Question Items

The intent of the open-ended question items was to obtain perspectives into participants' overall disposition toward mathematics, mathematics teaching and learning and self-positioning as teacher-engineer or teacher-technician. Each open-ended prompt was designed to elicit data related to one single target area i.e. mathematics, mathematics teaching or mathematics learning, including narrative description. Prompts were purposefully phrased for either the teacher or student participant respectively. Four open-ended questions items were posed as the introductory elements in the teacher survey:

(1) Would you consider yourself a mathematician? Why or why not?;

(2) Do your fellow math teachers use your ideas in their teaching practice? Explain

(3) In an environment without restrictions, how would you teach math? Explain; and

(4) Describe a mathematics classroom where students are best able to learn. Explain and give details.

Four open-ended questions items were posed as the introductory elements in the student survey:

(1) Would you consider yourself a mathematician? Why or why not?;

(2) *Does your math teacher use your work as examples for the class? Explain;*

(3) *If you were a mathematics teacher, how would you teach math? Explain.; and*

(4) *Describe a mathematics classroom where students are best able to learn and give details.*

Each of the open-ended prompts was examined and analyzed without reference to the other open-ended prompts.

Open-Ended Question One: Findings, Results and Analysis

Question One, *"Would you consider yourself a mathematician? Why or why not?"*, was primarily analyzed looking at gender distribution. There is a general perception that males are more inclined to pursue careers in mathematics, enjoy mathematics, or be pre-disposed to mathematics than females (Spencer, Steele, and Quinn, 1996; Osborne, 2006). Utilizing Chi Square, it was found that no statistically significant relationship between gender and consideration of oneself as a mathematician for students existed ($X^2 = .785$, $df = 2$, N = 458, $p = .675$). As illustrated in Figure 4.2, students who responded with *yes, no, or neutrally* were consistently distributed across gender, based on the participant array of males and females.

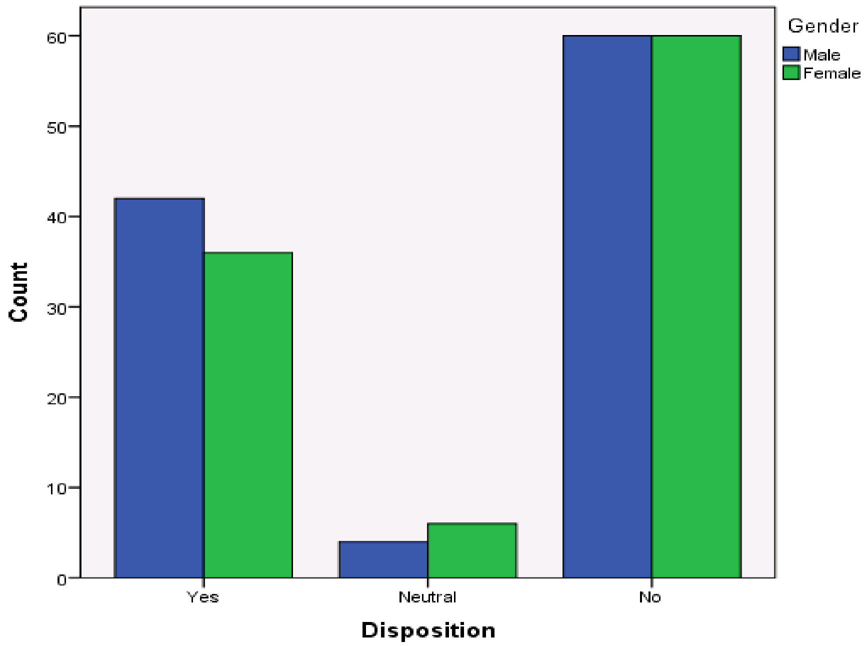

Figure 4.2: Distribution of Student Responses by Gender to the Question -Would you consider yourself a mathematician?

The finding of no statistically significant gender differences is important to identify as a shift in affective disposition toward mathematics from prior studies in stereotype (Chee, 1997; Fein & Spencer, 1997; Osborne, 2006; Rydell, Rydell & Boucher, 2010; Singletary, Ruggs, Hebl, & Davies, 2009; Spencer, Steele & Quinn, 1999; Steele, 1997).

Students who responded in the affirmative supported their responses with leading statements about high mathematics grades (assessment and classroom), appropriate levels of content understanding, and problem solving skills. A sample student response was "*Yes I would. I do because I enjoy doing math and I am very good at it. I think I am a mathematician also, because I get good grades in math. I can't avoid math so I may as well use it"*; grades were indicative of designation as a mathematician or not. Principally negative student responses indicated they did not feel they were that advanced, lacked understanding, didn't make good

grades, or that they were just "*average*". This excerpt is representative of a negative student response: "*I don't think so because I don't understand some stuff about math. I'm not good at everything. I'm only good at it when I understand it".* The perception of not being "*good*" at mathematics represented the affective characteristic of self-concept contributing to disposition toward mathematics.

Data in response to question one, *"Would you consider yourself a mathematician"?,* indicated a shifting in affective disposition toward mathematics from a gender perspective. Hyde and Mertz (2009), citing their study of gender differences in mathematics performance, found "U.S. girls now perform as well as boys on standardized mathematics tests at all grade levels" (p.8806). Although this particular study focused on mathematical performance as opposed to the affective characteristic of self-concept, there is some evidence supporting a narrowing of the gender gap. Else-Quest, et al., (2010) supported the conclusions of Hyde and Mertz, however with a caveat: "This meta-analysis provides further evidence that, on average, males and females differ very little in mathematics achievement, despite more positive math attitudes and affect among males" (p.125). To address the concern surrounding "Stereotypes that girls and women lack mathematical ability persist, despite mounting evidence of gender similarities in math achievement" (Else-Quest, et al., 2010, p.103), further investigations of gender differences in terms of disposition domains are warranted to determine overall impact of this shifting.

Additionally, the data were reflective of draw a mathematician studies (Rock & Shaw, 2000; Picker & Berry, 2000) demonstrating the perception that mathematicians are perceived as "*genius*" or "*above average*". Of the teachers responding who considered themselves mathematicians, the primary rationales given were that they were educated, had problem solving skills and content skill set mastery as illustrated in this response: "*Of course. A mathematician is*

a person who is actively involved in mathematical problem solving". Teachers responding in the negative prevalently justified the response by stating that although they had some mathematical content mastery, they were not at the level of expert, genius, or discoverer of mathematical concepts. One teacher responded "*No, I don't consider myself a mathematician. I think someone who is a genius at math and sees patterns beyond what is given is a mathematician".* As an extension, data from question one suggests evidence of the contention that there is a reflective nature of teacher affective disposition and positioning in student affective disposition manifesting in positioning-by-others.

Open-Ended Question Two: Findings, Results and Analysis

The intent of the research question two was to elicit self-reported assessment of peer and teacher value of the participant's work with determination of factors that contributed to self-positioning or positioning-by-others. The prompts posed were "*Do your fellow math teachers use your ideas in their teaching practice? Explain"* (teacher survey) and "*Does your math teacher use your work as examples for the class? Explain"* (student survey).

Due to the presence of a professional learning community model (PLC) in the district, the overwhelming teacher response to this question was "*Yes*" indicating strong collaboration among teachers; however responses provided little or no insight into self-positioning or positioning-by-others. A single teacher reported "*No*" to question two, stating she felt "*left out*". As will be detailed and supported in Stage Three analysis of case study interviews, Thyme self-positioned herself as a teacher-technician and was identified as an example of a teacher with a non-productive affective dispositional inclination.

Student response to the question, "*Does your math teacher use your work as examples for the class? Explain"* was misconstrued by largely all of the student participants in the linked

sample as a question about usage of examples by the teacher – not usage of student work. Predominantly, those that responded as the question was intended, were responses in the negative as given in these examples: "*No, my math teacher doesn't use my work for examples. My work is not that neat compared to others. Also some questions might not be correct"*; or "*No, because she doesn't like it? Or it's just not as good as the other ones I guess…☹";* or "*No because I'm bad at math and I probably got all the answers wrong".* Equally, a "*Yes*" response had a negative narrative as shown here: "*Yes, we look at one and she tells us our mistakes and what we did wrong".* Consequently, data from question two was not beneficial in answering the question of self-positioning or positioning-by-others and thus was not considered as contributing to overall analysis. Individual responses were considered in the case study analyses, however.

Open-Ended Question Three: Findings, Results and Analysis

In an effort to ascertain characteristics of a productive affective disposition toward mathematics teaching, question three posed the following prompts to the teachers and students: "*In an environment without restrictions, how would you teach math? Explain"* and *"If you were a mathematics teacher, how would you teach math? Explain".* Word frequency analysis was facilitated with the use of NVivo software; word clouds pictorially displayed the most frequent terms found in single or multiple data sets. The most frequent twenty-five terminology responses from teachers and students to the mathematics teaching prompt presented significantly different teacher-student perspectives as revealed in Figure 4.3 word clouds.

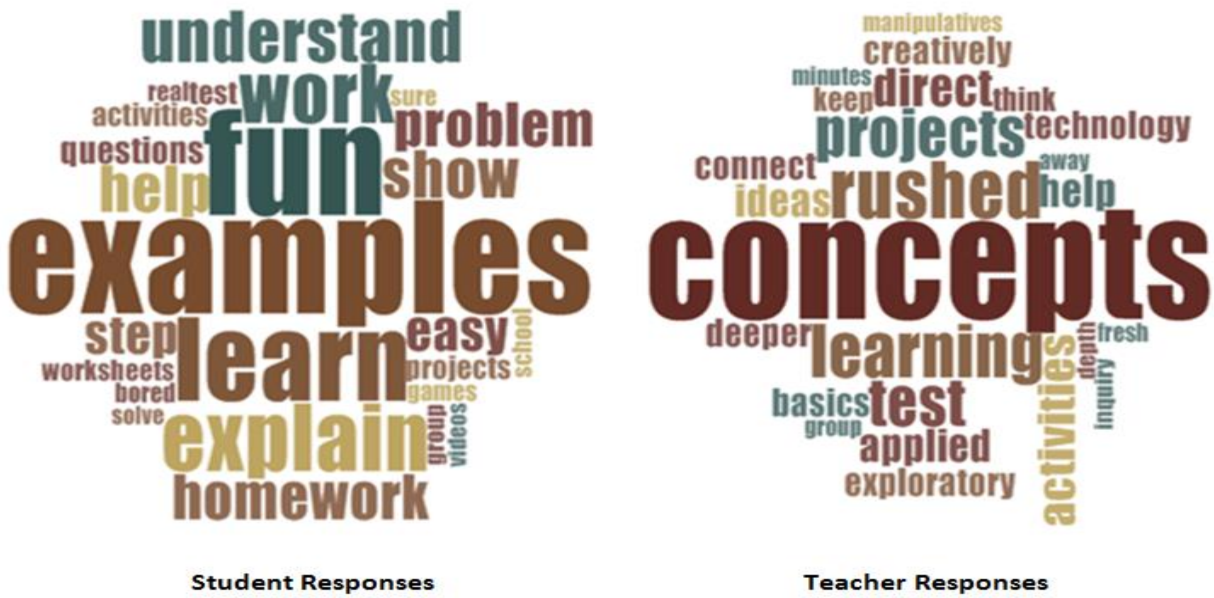

Figure 4.3: Teacher – Student Word Cloud Comparison of Disposition Toward Mathematics Teaching Approaches

Whereas teacher responses were focused on the element of having enough time, mathematical concepts and learning, students most frequently stated teaching with examples and explanation, in a "*fun*" approach as most important to teaching mathematics. Conjecture might lead us to believe that the feeling of being "*rushed*" expressed by teachers led to less explanation and provision of examples as expressively needed by the students. This in turn was reflective in affective disposition toward mathematics teaching as a product of teaching practices (positioned-by-others) as opposed to self-positioning. Case study analysis provided at a later point substantiated this assumption.

Open-Ended Question Four: Findings, Results and Analysis

Question four open-ended prompt was designed to ascertain what attributes and characteristics are necessary, from the teacher and student perspectives, to facilitate mathematics learning and contribute to productive affective disposition. In response to, "*Describe a*

mathematics classroom where students are best able to learn and give detail", students and teachers seem to be of the same mindset. One student stated, "*The best classroom to best be able to learn is where there is group work, inspirational posters and hands-on problems";* in agreement a teacher specified, "*Centers – class discussion with directions and new ideas brought forth. Then students will break into small groups and hands-on experiences. A lot of self-discovery"*. Both statements indicate a desire for movement away from direct instruction (teacher-technician) to more indirect instruction (teacher-engineer), facilitated with visuals, kinesthetic activities and collaborative learning, as opposed to lecture. Figure 4.4 illuminates characteristics reported as important to learning.

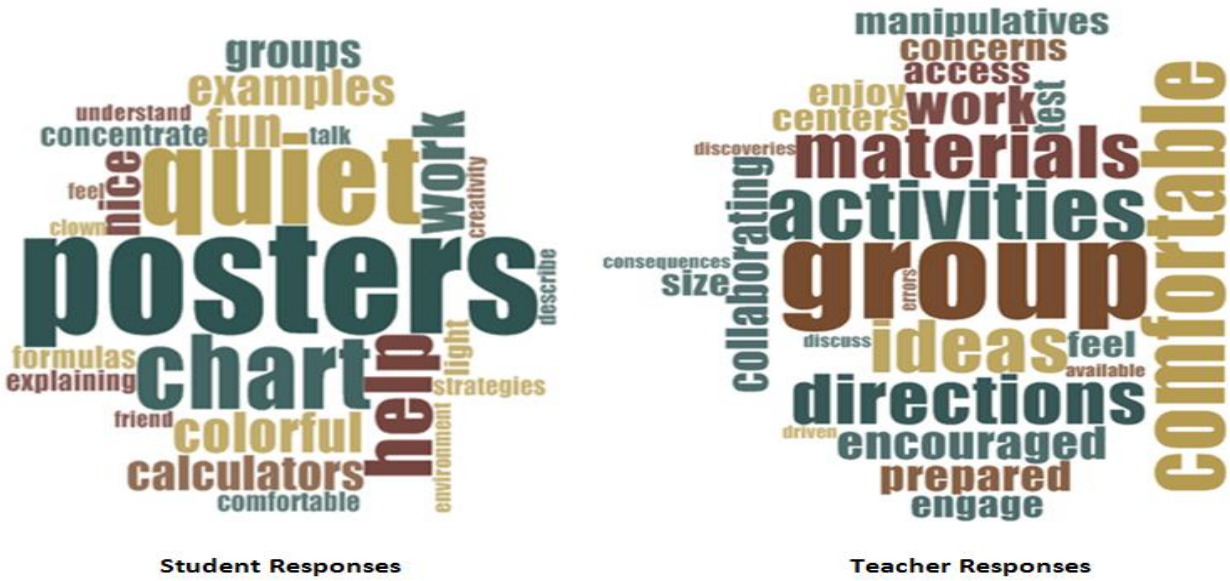

Figure 4.4: Teacher – Student Perspectives Depicted by Word Clouds on Mathematics Learning

Word frequency analysis produced a surprising student response of "*quiet*" as a characteristic contributing to learning. Particularly surprising for a middle school student response, "*quiet*" was mentioned for a total of thirty-two instances. Additionally, students continued to express

"*examples"* and "*explaining"* as necessary components of teaching and learning, a consistent theme in open-ended questions three and four.

Stage One: Metaphorical Responses

Presentation of the five metaphorical prompts (question five utilized simile as an instantiation of metaphor) was the nucleus of the survey to elicit authentic narratives, or external representations of storylines, leading to self-positioning as teacher-engineer or teacher-technician and ratings of affective disposition as productive, neutral or nonproductive toward mathematics, mathematics teaching and learning. As stated in Chapter Three, with application of a sequencing approach within the survey structure, that is responses coupled with explanations, responses tended to be more authentic and included deeper, critical thinking expressed descriptively.

Coding and Inter-Rater Reliability

Utilizing coding categories defined as constructs of affective disposition (Appendix C), three independent expert raters for teachers and two independent expert raters for students used linguistic analysis and deconstruction or meaning-making (Kvale and Brinkmann, 2009) to rate participants on each metaphor response. Ratings, one to five with one as highly nonproductive and five as highly productive, were assigned for each metaphor response; individual ratings were used to determine an overall rating for each participant. Of the thirty-two teacher participants, two surveys were eliminated from ratings due to insufficient prompt response. Inter-rater reliability for teacher surveys (n = 30) was approached using Delphi method of consensus (methodology described in Chapter Three). Resulting iterations arrived at consensus on ratings for twenty-eight of the thirty participants, or a 93% inter-rater agreement, exceeding the minimum 80% established rate of consensus for this study. Additionally, Cohen's Kappa was

noted at $k = .875$ (within the range of 'almost perfect agreement). Inter-rater reliability for student surveys ($n = 458$) was established using Pearson's $r = .691$, $p < .001$.

Overall mean rating for teacher coding of self-reported data (self-positioning) was *3.38*; no teacher was rated overall as highly unproductive (rating *1*) or highly productive (rating *5*). Seven percent of teachers were rated as nonproductive, 40% were rated as neutral (rating *3*), and 53% were rated as productive (rating *4*). Teacher ratings in isolation are not particularly indicative of dispositional attributes or self-positioning, but rather as an indicator of the overall middle school math teacher sample self-positioned as more productive than not. However, when linked overall teacher and student ratings, coupled with state assessment average percentage scores are viewed side-by-side (Table 4.5) a simultaneous pattern of self-positioning coupled with positioning-by-others emerges. This pattern suggested the existence of simultaneous transphenomenality (Complexity Theory) and indicated greater scrutiny was needed to establish characteristics of self-positioning and positioning-by-others; case study research method was appropriate to further explore results and findings. Data for case studies, Sage and Thyme, are highlighted in Table 4.5.

Table 4.5: Linked Teacher & Student Overall Mean Ratings with State Assessment Scores

Teacher	**Teacher Overall Mean Rating (*n* = 21)**	**Overall Mean Student Rating (*n* = 458)**	**State Assessment Average Percentage Score***
045-045	3.33	2.80	71.81%
045-046	3.33	3.28	61.28%
045-047	3.00	3.43	53.33%
045-048	3.33	2.65	52.70%
045-049	4.00	2.75	55.27%
045-052	4.00	3.85	50.63%
045-053	3.67	3.45	49.80%
047-035	3.67	3.30	55.14%
048-099	4.33	2.82	64.41%
048-175	3.33	3.06	59.70%
052-001	3.67	3.40	56.53%
052-004	3.67	3.36	52.53%
052-006	3.33	3.30	83.47%
053-140	3.00	3.65	82.65%
053-142	4.00	3.13	63.81%
053-145	3.67	4.00	74.80%
053-144	**2.67**	**2.58**	**66.50%**
053-149	**3.33**	**3.19**	**52.18%**
053-148	3.67	2.83	64.07%
053-146	3.67	3.25	58.94%
056-022	3.67	3.42	57.09%
***2012 Data used reflective of timeframe of survey completion;* *Source: TEA State Assessment Reports* *Does not reflect pass/fail: scores are scaled for passing rate determination*			

Thyme self-positioned at a nonproductively inclined level (*2.67*) with students self-positioned at a nonproductively inclined level (*2.58*). The concept of transphenomenality was demonstrated by reported student assessment scores (66.50%) in the top quartile of reported scores for all teachers in the sample. Conversely, Sage self-reported as productively inclined (*3.33*), as well as a productive student rating of *3.19*, yet assessment scores reported (52.18%) were in the lowest quartile for the sample. These examples bore out the assertion that simultaneously one can be self-positioned nonproductively or productively, yet be positioned-by-others (observed) on the opposite end of the continuum.

Level of intensity coding was facilitated through linguistic deconstruction of narratives or storylines given in response to the metaphorical prompts. Intensity as a coding element was used secondarily in determination of overall coding levels. Additionally, linguistic deconstruction guided identification of target or disposition toward mathematics, mathematics teaching and learning. Coding levels for intensity were not aggregated, but were used solely in meaning-coding-by-meaning-coding situations. To illustrate the impact of intensity, below are sample narratives from some teacher and student surveys (Figure 4.5).

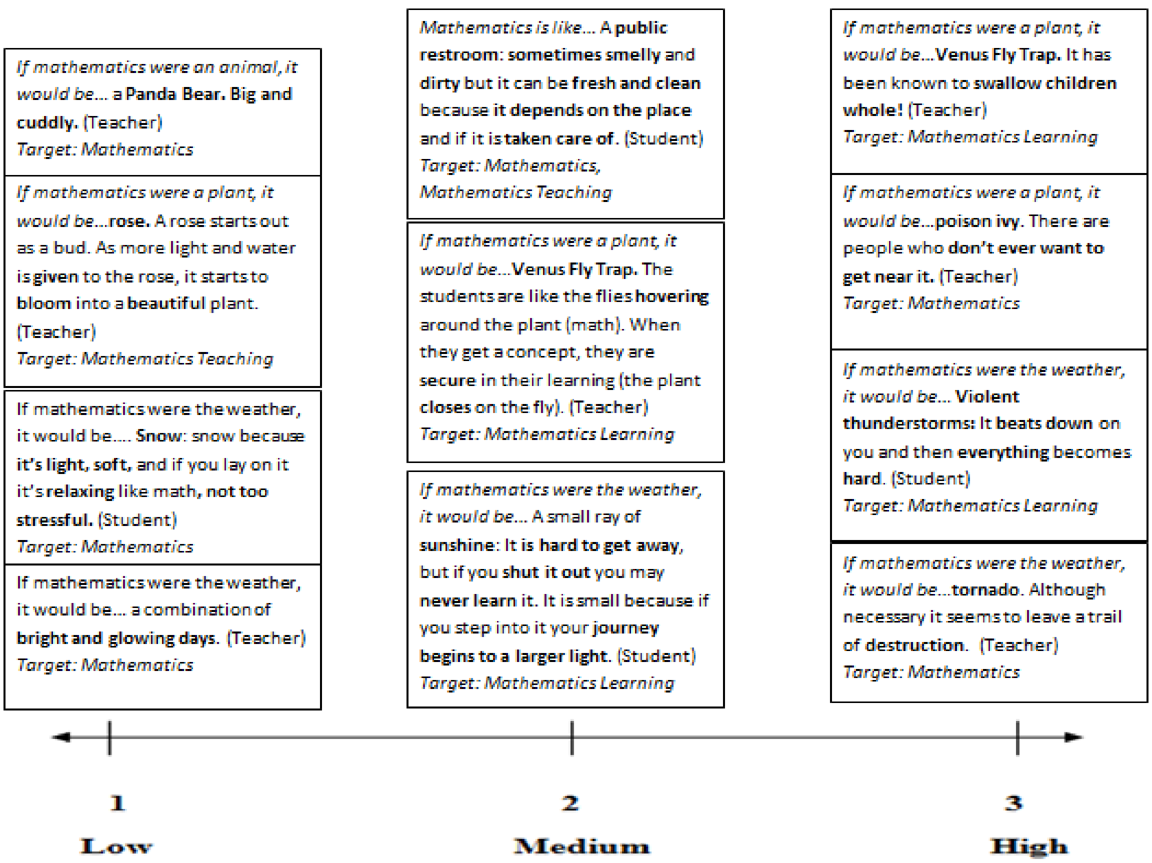

Figure 4.5: Teacher – Levels of Intensity Illustration

Intensity level ratings for the majority of metaphor prompts had mean ratings in the *medium* range (Table 4.6), with the exception of question seven, "*If mathematics were a plant, it would*

be…”; the mean intensity rating for students was *2.736* or in the range of “*medium to high”*. Typically, high intensity ratings were coupled with nonproductive ratings, indicating nonproductively inclined narratives were much more intense than productively inclined narratives.

Table 4.6: Mean Intensity Level Ratings by Metaphorical Prompt

	Question 5	Question 6	Question 7	Question 8	Question 9
Student	1.973	1.892	2.736	1.716	1.786
Teacher	2.133	2.400	2.548	2.167	2.269

(Pearson's $r = 0.779$)

The most frequent metaphorical vehicles for question seven for teachers and students were “*cactus, rose, Venus fly trap,* and *tree”*. The most frequent target identified in question seven was disposition toward mathematics learning. Intensity analysis indicated that teacher narratives tended to generally be more intense than student narratives overall, which may be attributable to written expressive language development of middle school students as opposed to teachers, and thus is not considered to be indicative of any particular trend.

Analysis of teacher and student mean ratings by metaphorical prompt (Table 4.7) provided evidence of inflation and deflation in self-reported narrative responses.

Table: 4.7: Mean Ratings by Metaphorical Prompt

	Question 5	Question 6	Question 7	Question 8	Question 9
	Math is like…	*Weather*	*Plant*	*Question*	*Animal*
Student	3.581	3.091	3.301	3.200	3.079
Teacher	3.033	2.767	2.806	2.700	3.000

(Pearson's $r = 0.442$)

The greater the teacher self-positioned as having a productive disposition (affective characteristic of self-concept), the greater positioning-by-others (students) was reflective of transphenomenal conflict. Utilizing triangulation, word frequency analysis represented in word clouds (Figures 4.3

and 4.4) was demonstrative of the same transphenomenal simultaneity in self-positioning and positioning-by others.

Meaning Interpretation

Kvale and Brinkmann (2009) structure meaning-interpretation as "…focus on small segments of interaction…" such as narrative responses to metaphorical prompts (p.201). Meaning-interpretation in this study involved identification of key words that were coded according to clusters, categories or nodes, such as self-positioning/positioning-by-others, teacher-engineer/teacher-technician characteristics, productive or nonproductive attributes, levels of intensity, targets, or affective characteristics of disposition. Meaning-interpretation and analyses extended within and across stages of the research. Metaphorical responses were analyzed individually and overall.

Metaphor Prompt Five: Results, Findings and Analyses

Metaphor prompt five, "*mathematics is like…*", utilized simile as an instantiation of metaphor. As was anticipated from the overall productive rating (previously reported), teacher responses were generally productive (90% of references), closely split between disposition targets of mathematics and mathematics learning. Teacher narratives revealed a focus on knowledge, problem solving, and math as solution finding similar to puzzles or disposition toward the nature of mathematics. Productively, a teacher stated "*A puzzle: because you have to come up with a strategy and think how you will complete the puzzle*"; conversely, one teacher described math as "*Anxiety: sometimes you don't understand*", however, this type of narrative was in the minority of responses. Hence, the majority of teachers self-positioned as teacher-engineers in response to this metaphor prompt.

Student responses were productive in 70% of references and, similar to teachers, were distributed closely between the targets of disposition toward mathematics and mathematics learning targets. However, linguistic deconstruction of student narratives displayed a greater focus on difficulty of mathematics (hard or easy) and the process of learning (boring or fun). Many students distinguished difficulty as both ends of the spectrum – a description rather than judgment – as revealed in this example, Mathematics is like… "*A video game: well in a video game the more levels you pass the harder it gets just like math. It's easy in the beginning and gets harder and harder*". Responses of "*boring*" or "*fun*" were rooted in student self-positioning toward mathematics and mathematics learning as expressed in the following narratives: "*Bubble wrap: bubble wrap is fun and kids enjoy and math is the same way*" and "*A boring thing nobody wants to do*". Semantic references to "*kids*" and "*nobody*" provided indication of personal responses or self-positioning.

Summarily, response to *mathematics is like…* provided indicators of self-positioning as having productive affective disposition toward mathematics and mathematics learning targets. Most narratives in response to this prompt were less intense and were more neutral. Teachers, self-positioned as teacher-engineers, espoused discovery and knowledge acquisition as key components of mathematics and mathematics learning. Frequently, students self-positioned dichotomously ("*boring*" or "*fun*") demonstrating simultaneous transphenomenality or transphenomenal conflict in affective disposition. Responses to metaphor prompt five provided indications of inflation in teacher self-positioning and initial indications of positioning-by-others in student responses.

Metaphor Prompt Six: Results, Findings and Analyses

Establishing weather as the metaphorical vehicle in prompt six produced an interesting fusion of responses, fairly evenly split between productive (49%) and nonproductive (49%) descriptors and mathematics (54%) and mathematics learning (44%) targets (neutral responses accounted for variances in percentages). As depicted in teacher and student word clouds (Figure 4.6), "*rain*" and "*sunny*" were the two most frequent types of weather vehicles chosen by both teachers and students.

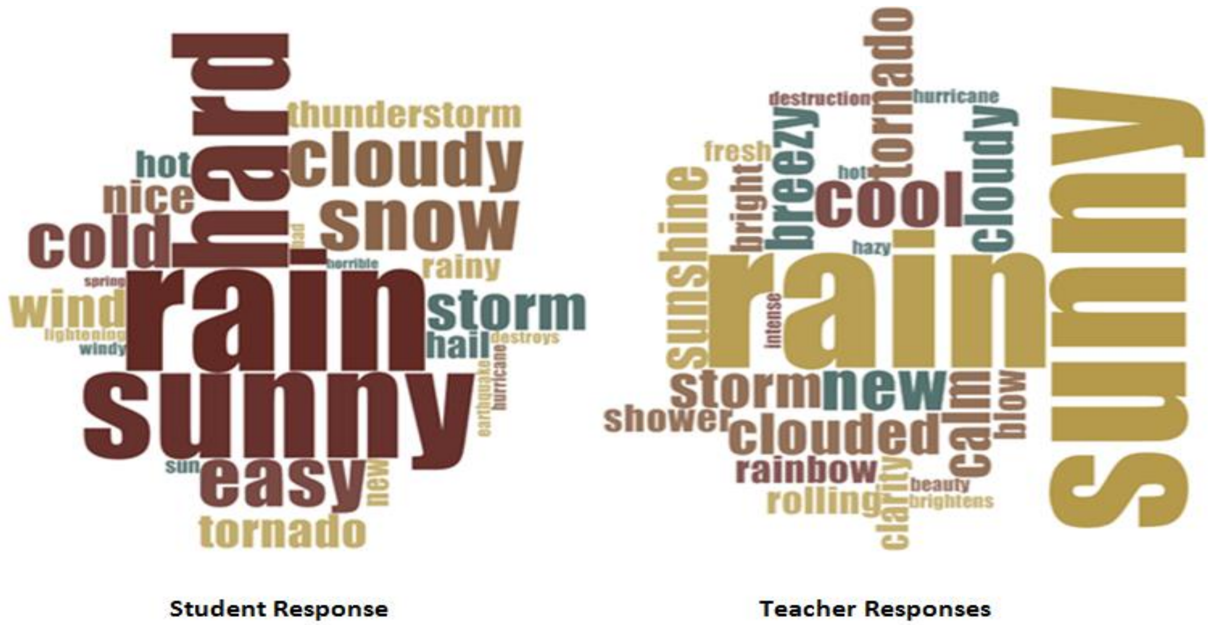

Figure 4.6: Metaphor Prompt Six Vehicle "If mathematics were the weather" – Frequency Word Cloud

However, the same vehicle was used in productive and nonproductive depictions as illustrated in these student narrative responses: "*Like a rain storm: because math usually gives me a hard time just like rain when I'm trying to get somewhere it gives me a hard time*" or "*A light rain: since math helps make the world be an easier better world, it nurtures it, like how rain nurtures life*".

Hence, linguistic deconstruction and meaning-interpretation of narratives was critical to metaphor response analyses to establish levels of productivity and self-positioning or positioning-by-others.

The intensity of student responses was observed to be higher in nonproductive responses than productive responses and, through meaning-coding, levels of intensity were magnified. Table 4.8 displays narrative excerpts with bolded sections which facilitated identification of intensity levels.

Table 4.8: Sample Student Narrative-Weather Prompt

Narrative	Level of Productivity	Intensity
Violent thunderstorms: It **beats down** on you and then **everything** becomes **hard**	Nonproductive	High
A storm: because **I don't like** math a lot. A storm is like a **disaster**. That's what **I** think of math.	Nonproductive	High
Bad weather: because it is **stressing** and **you** feel **your** mind will **explode** seeing a lot of numbers	Nonproductive	High
Partly cloudy: math is like a **double-edged sword** to **me** because there are things **you** really **excel in** and some things **you don't excel in**	Productive	Medium
A thunderstorm: it's **really hard** at times and sometimes is **kinda easy**	Productive	Medium
All different types of weather: because sometimes math can be **easy** and sometimes it could be **hard** learning something new	Productive	Medium
Sunny and breezy: because math is **fun to me** and that is **good** weather	Productive	Low
The sunshine: because the more **you** practice the **easier** it is to **see** how to solve it	Productive	Low
A light rain: since math **helps** make the world an **easier better** world, it **nurtures** it, like how rain **nurtures** life	Productive	Low

Nonproductive student storylines within narrative responses to *"If mathematics were the weather, it would be…"* were demonstrative of intensity of affective disposition and positioning, more so than was in evidence in productive student storylines. Rarely, were teacher narratives as intense, even when the narrative was described from a nonproductive stance (the majority of narratives were overall productive). In the teacher excerpt, "*A tornado: although* ***necessary*** *it*

*seems to leave a trail of **destruction***", there was nevertheless the caveat of necessity justifying the destruction – destruction was an intense term, but less intense when it was described as necessary.

Meaning-coding and interpretation of student narratives given for metaphor prompt six and analysis of intensity levels established affective domain characteristics of self-concept, attitude, and anxiety in student storylines and were understood through authentic, nonproductive narratives and coded as identifiers of student self-positioning. Teacher narratives described the affective characteristics of nature of mathematics, worthwhileness, usefulness, and sensibleness and demonstrated teacher self-positioning as teacher-engineers predominantly.

Metaphor Prompt Seven: Results, Findings and Analyses

Although responses to metaphor prompt six were directed primarily toward the targets of mathematics and mathematics learning, metaphor prompt seven, "*If mathematics were a plant, it would be…*", predominantly directed toward mathematics learning, elicited an increase in responses that reflected the target mathematics teaching. Many conjectures arose to justify this shift in target of response, yet none were substantiated with linguistic deconstruction. Suffice it to say that there was a more pronounced presence of characteristics of disposition toward mathematics teaching than was in evidence in previous prompts. Narratives of students and teachers were predominantly productively inclined with a mere 34% of responses reflective of nonproductive characteristics.

The five plant vehicles most frequently chosen by teachers and students consistently were *tree, flower/bloom, rose, Venus Fly Trap,* and *cactus*. *Trees* and *flowers* were consistently portrayed as givers of knowledge, beauty, and strength, as provided in mathematics teaching as the target. Narratives for *rose* and *cactus* suggested dichotomous perspectives

(transphenomenality) as related to mathematics content. Narratives typically acknowledged complexity of mathematics content in the learning process, that is simple to difficult, and the impact on the learner as represented by terms such as *beauty* and *useful* as opposed to *thorns* and *spines* that *hurt*. The following student excerpt exhibited the dual perspective of a rose and by extension mathematics: "*It would be a rose because roses are beautiful and bold and it's like when math is useful and helpful to us. But roses have thorns which in math would be when you don't understand something and when it gets hard*." Similarly, a teacher response stated, "*Math is sometimes pretty like a rose but it also has thorns when it is a difficult concept to teach or learn*". Transphenomenal responses where dual perspectives exist, such as these, required extension of research to case studies to further substantiate existence of transphenomenal conflict reflected in self-positioning and positioning-by-others.

Surprising to the researcher was the frequency *Venus Fly Trap w*as the vehicle of choice for the plant metaphor prompt not only by students, but also by teachers portraying productive disposition characteristics. According to the Botanical Society of America (2013), a Venus Fly Trap is a carnivorous plant and is an example of plant morphology and environmental adaptation. Unlike the cactus, this is not a plant indigenous to the southwest, rather is native to select boggy areas in North and South Carolina. However, Venus Fly Traps can be grown anywhere with appropriate cultivation and feeding.

Metaphorically, mathematics may have been perceived as adaptable and able to flourish with appropriate instruction: "*Venus fly trap: the students are like the flies hovering around the plant (math). When they get a concept they are secure in their learning (the plant closes on the fly)*" or "*A Venus fly trap: once you understand math and are good at it you tend to get other people to enjoy it*". It was important to note the exception or the manner in which one teacher's

narrative demonstrated positioning-by-others in clearly a nonproductive stance as evident in this excerpt: "*Venus Fly Trap: It has been known to swallow small children whole!*". Still, common teacher usage of Venus Fly Trap as a metaphorical vehicle was representative of productive disposition characteristics.

Similarly, student narratives utilizing Venus Fly Trap as the metaphorical vehicle were descriptive of the "*complexity"* and "*brilliance"* of the plant and largely used to portray productive disposition characteristics: "*Venus Fly trap: because it's complex, yet brilliant*", and "*Venus Fly traps catch flies like your brain catches new facts you learn in math; the brain eats it by processing it into your mind*". It would be remiss not to provide an example of student usage from a nonproductive perspective: "*A Venus fly trap: you think that it might be a good day in math and that it might be easy but once you go in the classroom BAM IT'S A TRAP!*" Clearly this student displayed an apprehension of attending mathematics class or was self-positioned with nonproductive affective disposition characteristics, such as anxiety. Overview of student usage of Venus Fly Trap as a metaphorical vehicle for plant was in the same vein as tree and flower narratives – productively inclined. Meaning-coding and interpretation of narratives was absolutely critical for this prompt, as well as the other prompts, to avoid assumptions based on metaphor vehicle choice.

Metaphor Prompt Nine: Results, Findings and Analyses

In prompt seven, "*rose"* and "*cactus"* as metaphor vehicles with corresponding narratives were used to demonstrate dichotomous perspectives or simultaneous transphenomenality in positioning. Student and teacher narratives for prompt nine, "*If mathematics were an animal, it would be…*" continued to reveal a dual perspective of mathematics. The primary metaphor vehicle, "*dog*", was used to illustrate diversity and

complexity of mathematics, as well as, the necessity to "*care for*" the animal or mathematics. Each of the following excerpts provided a window to view dual perspectives: "*Dogs are tame yet we don't know everything about them*" portrayed mathematics as diverse and a large body of knowledge; "*A dog: because the dogs are also good and sometimes hard*" and "*A dog: because sometimes it frustrates you but sometimes it amuses you*" indicated a continuum of complexity evident in mathematics; and "*a dog can help you your whole life, and can be good or bad depending on how you treat it*" emphasized the need to give attention to mathematics or "c*are*". Perceptions of mathematics from multiple viewpoints simultaneously contributed to transphenomenal conflict impacting self-positioning and positioning-by-others manifested in characteristics of affective disposition.

Multiple additional vehicles were used in response to metaphor prompt nine across a wide spectrum of animals limiting identification of commonality in vehicles utilized. Meaning-coding according to categories of affective disposition characteristics provided structure to meaning-interpretation and analysis. Categories of affective disposition characteristics included nature of mathematics, worthwhileness, usefulness, sensibleness, self-concept, attitude and anxiety. Narratives in response to metaphor prompt nine predominantly denoted *nature of mathematics, attitude and self-concept* as major contributors to affective disposition and positioning. Transphenomenality, as described in prompt seven analysis, was evident in each of the aforementioned characteristics. Ironically, in response to this particular prompt, worthwhileness, usefulness and sensibleness were coded less than 10% of the time. Anxiety was most prevalent among students, but not at a significant frequency in comparison to nature of mathematics, attitude and self-concept.

Stage One: Summary

In response to the research question "*What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics?",* teacher and student participant responses to the open-ended question, *"Would you consider yourself a mathematician? Why or why not?"*, showed no significant relationship to gender and nature of response. There was roughly equivalent numbers of females responding "*yes*" and "*no*" as males. From a limited data source, this evidence suggests a shifting and narrowing of the stereotypical gender disparity, but is stated with the caveat that additional research is needed to substantiate this finding.

Within the component of survey research utilizing open-ended question items and metaphorical prompts, expert rating, meaning-coding and interpretation, analyses resulted in identification of affective characteristics which contributed to teacher self-positioning and some indication of positioning-by-others. Primarily teachers self-positioned as teacher-engineers and students self-positioned as having productive dispositions rooted in nature of mathematics, attitude and self-concept characteristics. Disposition toward mathematics and mathematics learning dominated as narrative targets. Evidence of transphenomenal conflict was present, but not fully evident nor supported in quantitative analysis.

Hence the question, "*Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self-positioning and positioning-by-others?"* and the research question, "*How and to what extent is transphenomenal simultaneity in teacher positioning reflected by student positioning?"* were not answered sufficiently in Stage One analysis compelling collection of additional confirming/disconfirming data. The transphenomenal, complex nature of data in

Stage One challenged the linear, straightforward approach of quantitative analysis leading to embracement of disorder or simultaneous multiplicity of transphenomenal characteristics of affective disposition necessitating movement to more holistic, qualitative methodology of case study research.

Stage Two: Case Studies

Two teacher case studies were identified, with criteria-based sampling of self-reported positioning as teacher-engineer and teacher-technician based on expert ratings of survey responses and initial evidence of transphenomenal conflict in participant responses. Three linked students per teacher were randomly chosen by indicated productive, neutral, or nonproductive ratings determined through self-reported positioning toward mathematics, mathematics teaching and learning and willingness to participate. Although other teacher participants displayed transphenomenal characteristics, linked student participants at the campus where the selected case study teachers taught had included indication of identification (sample of convenience) facilitating contact. All case study participants voluntarily participated and signed secondary informed consents for subsequent stages of research; campus administration gave approval for continued research efforts.

Demographically, the two teacher case studies, Sage and Thyme (pseudonyms) were eighth and sixth grade female mathematics teachers, Hispanic and Anglo, and possessed a bachelors and master's degree, respectively. Each teacher had accumulated in excess of twenty years of teaching experience. Of the six student participants, 50% were male and 50% were female, 17% were African American, 33% Hispanic, 50% Anglo, and two students reported as bi-lingual English-Spanish, while all others were mono-lingual English speakers.

Stage Two: Case Studies – Likert-Type Ratings, Results, Findings and Analyses

In Stage Two, Likert-type ratings were numerically ranked and narratives analyzed through linguistic deconstruction (Kvale & Brinkmann, 2009) as well as, parallel analysis with Stage One results for case study participants. Stage Two results of the Likert-type ratings for Sage and Thyme continued to reflect inflated (teacher-engineer) and deflated (teacher-technician) self-reporting of disposition toward mathematics, mathematics teaching and learning. Student ratings and narratives were indicative of positioning-by-others.

Sage self-rated in all areas as "*above average*": "*I share my knowledge with students. I leave it mostly to them to learn from my experience*". This self-rating was consistent with the expert survey rating in Stage One of *3.33* or productive. Sage's linked students self-rated disposition from *below average* to *above average*, each with unique narratives: "*Average because I'm not outstanding but I get how it works; below average because I'm not very good at explaining*", "*I'm a fast learner when it comes to math, but not the best*", and "*Sometimes I struggle when they're explaining to me at first, then I get focus and I understand it*". Self-rated Likert-type student ratings were also consistent with expert survey ratings ranging from *1.5* to *3.4*.

Thyme rated herself as "*average to above average*" but in narrative expressed doubt of her content mastery: "*I am not afraid to learn alongside with my students and this encourages and facilitates a positive learning environment*". Although her Likert-type rating was higher than the overall expert survey rating of *2.67*, meaning-coding and interpretation of the narratives was consistent with the expert survey rating as evidenced in the above narrative excerpt. Her students self-rated as "*average*" to "*above average*" and included revealing narratives of positioning-by-others: "*Average because my teacher doesn't explain stuff very well*", "*Above Average, my*

teacher hasn't done anything wrong" and "*Average, if my teacher explains things to me, I understand it better*". Student Likert-type ratings were reflective of Thyme's divergent self-rating in comparison with expert survey ratings. For example, the student identified as having a nonproductive disposition (Thyme-NPs) or an expert rating of *1.88,* self-rated on the Likert-type rating as "*average*". However, as illustrated in the following excerpts, narrative meaning-coding and interpretation supported the expert survey rating: "*Because I'm not good with everything in math*" and "*Because I really don't like math*". Although the student self-rated as "average" in her positioning toward mathematics, mathematics teaching and learning based on a pre-determined rating scale, narrative responses provided evidence of self-positioning in a nonproductive stance.

Stage Two: Summary

Stage Two self-reported rating of disposition via Likert-type scale provided a limited, yet structured rating of disposition toward mathematics, mathematics learning and teaching. Pre-determined rating scales provided clear and understandable intervals from which to choose a response. However, an odd number of choices allowed participants to gravitate to the center without having to make a clear, cut choice. The middle option of "*average*" in adolescence was most appealing; rarely would a middle school student want to be more or less than "*average*"! Narrative responses provided a source of individual confirming or disconfirming data, yet meaning-interpretation of narratives provided no additional evidence in contradiction to the observation of inflation and deflation in self-positioning and indications of positioning-by-others found in Stage One.

Constructively and as a confirmatory instrument supporting Stage One findings, narrative responses included with Likert-type ratings provided direction for development of semi-structured interview prompts to facilitate meaning-interpretation at deeper levels. As in Stage

One, Stage Two findings were solely based on self-reported data in response to a pre-defined rating scale, albeit with narrative explanation, and required further exploration through additional data collection to ascertain affective characteristics that influence disposition and positioning.

Stage Three: Case Studies – Semi-Structured Interviews

In Stage Three, interviews for teachers and students were first transcribed individually. Subsequently, data was analyzed using thematic coding, episodic summaries (stages of data collection), and cluster comparisons (Kvale & Brinkman, 2009) of all sources of data to identify characteristics of affective disposition, self-positioning, positioning-by-others, and evidence of transphenomenality within targets of mathematics, mathematics teaching and learning. As a result, analyses of teacher data were combined for Stages Three and Four and will be reported in Stage Four. Student data collection did not include classroom observation and, as such, interview data was analyzed in Stage Three comparatively with survey and Likert-type data, as well as, interviewer observation field notes.

Stage Three: Case Studies – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

In Stage Three, through meaning interpretation, it was found that trajectory of student disposition, as reflection of teacher disposition, is dependent on multiple factors within the learning environment and is unique to each individual. Although students may simultaneously be exposed to the same teaching method and materials, they may have very different trajectories or outcomes in their positioning. Purposefully, student case studies were chosen based on criteria and as representative of students who were rated as productive, neutral and nonproductive to demonstrate varying trajectories.

Stage Three: Productive Student (Sage-Ps) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Thematic, episodic and cluster coding for Sage's students demonstrated three distinct trajectories. Productive Student (Sage-Ps) reflected Sage's self-positioning as identified in common phraseology such as "*teach basics*", "*step-by-step instruction*" and mathematics as a "*puzzle*". Within the target of mathematics learning, Sage-Ps self-positioned as a "*fast learner*" and "*automatically knowing*" how to solve mathematics problems, similar to Sage's self-positioning as teacher-engineer. Observationally, Sage-Ps demonstrated a "flat affect" showing little or "*no excitement or enthusiasm*" during the interview. Positioning-by-others tended to be toward a neutral, nonproductive disposition mirroring Sage's observed teacher-technician characteristics. This was substantiated with a reported academic year 2011-2012 state assessment score of 61%.

Transphenomenal conflict was noted in dominance of positioning-by-others as opposed to self-positioning, yet with simultaneous occurrence contributed to a conflictive state. Beyers (2011) identified two key impacts of disposition on learning: (1) "…teachers play an essential role in shaping students dispositions with respect to mathematics", and (2) "students dispositions with respect to mathematics affect student learning by means of opportunities to learn" (p. 70). Sage-Ps self-positions mirroring Sage's self-reported positioning, yet due to positioning-by-others or the habitual inclination formed by Sage and Sage-Ps in response to and in order to navigate through academic content, settings, and interactions demonstrated nonproductive tendencies. Sage-Ps, also, positioned Sage in the teacher-technician mode in response to Sage-Ps' demonstrated affective characteristics of self-concept and attitude. The complex inter-

relationship between Sage-Ps and Sage is demonstrative of Sage's metamorphoses from teacher-engineer to teacher-technician and resultant student disposition toward mathematics.

Stage Three: Neutral Student (Sage-Ns) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Neutral Student (Sage-Ns) displayed dichotomous self-positioning as exemplified in survey and interview statements such as Mathematics is "*hard and thinking work, because you have to understand all the problems and solve it*", "*…sometimes I struggle understanding*" versus "*I really enjoy math and I really give a lot of effort on it*". Contributing to this phenomenal conflict were examples of positioning-by-others.

Sage-Ns self-reported a need for "*explanation*", "*examples*", and the ability to "*see*" problem solving processes. As elaborated upon in Stage Four, Sage was positioned-by-others as a teacher-technician and was observed not exhibiting mathematics teaching characteristics desired by Sage-Ns, thus positioning him in a state of transphenomenal simultaneity. Similarly, extraneous positioning-by-others was noted in Sage-Ns' statement, "*I don't know – it's because my Dad, he is an engineer, so I don't know. He may, may like it more*" in explanation of his Likert-type ratings of mathematics. Introduction of parental influence (Dad Factor) was likewise considered as positioning-by-others, yet more as a characteristic of affective disposition leading to conative disposition or perseverance, "*I practice it*"; an extension of dispositional research is required to substantiate this finding.

Triangulation of data from multiple sources introduced another unexpected outcome for consideration when academic year 2011-2012 state assessment datum was examined for Sage-Ns, as pertained to self-positioning as neutrally inclined. Of the three student case studies linked to Sage, Sage-Ns achieved the highest state assessment score, or a score of 84% indicative of

positioning-by-others, that is, having a productive disposition. Conjecture identifying factors contributing to this outcome were not made, although it was suspected that the extraneous "*Dad Factor*" was a contributor.

Ultimately, positioning-by-others was seen as a primary contributor to transphenomenal conflict for Sage-Ns. Unique student trajectory for Sage-Ns, as identified in parallel data analysis, was indicative of fluidity of positioning and core disposition stability. Affective characteristics of self-concept and attitude presented in the data contributed to a conflictive state of self-positioning and positioning-by-others. As evidenced in state assessment datum comparative to expert neutral self-positioning rating, the storyline for Sage-Ns is one of successfully navigating a "space of emergence" (Osberg, 2005) impacted by the framework of Sociotransformative Constructivism or power (agency) relationships and institutional codes (institutional, historical, and social) and locations (social, ideological and academic) manifested as positioning-by-others.

Stage Three: Nonproductive Student (Sage-NPs) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Sage-NPs (nonproductive student) presented during the interview process as having a high level of anxiety, not only toward the interview process, but also toward predominantly mathematics teaching. As background to the reporting of findings, Sage-NPs was not inclined initially to participate because she was "*afraid she would not pass*" the interview. Once, it was clarified that the interview was not pass-fail, her concern shifted to confidentiality of her responses. Observationally, the interviewer reported, "*Prior to the beginning of the interview, the student asked if any teachers would listen to the recording because she had a bad experience with one of her teachers*". The affective characteristic of anxiety was clearly a major contributor

to self-positioning and positioning-by-others for Sage-NPs, as was reflected in subsequent analyses.

The affective characteristics of self-concept, attitude, and anxiety were the most prevalent in parallel data analysis for Sage-NPs. The interview transcription revealed positioning-by-others within the target of mathematics teaching: "*…it was harder for me to understand because my teacher wasn't one-on-one explaining it*"; "*when you're just doing work all day you just feel like I want to stop this and I want to go home*"; "*Because you don't feel like you're forced to be quiet and forced to do it…*"; or " *… because I know how it feels to be bored to death by work*". The same intensity, exhibited in terms such as "*death*", "*forced*", was noted in survey and Likert-type responses, as well as, interviewer observation field notes. Interviewer observational field notes stated body language conveyed an intense "*lack of confidence*" and "*When talking about her math abilities, she shrugged her shoulders and made facial expressions*". Survey narratives were reflective of intense nonproductive characteristics including "*Mathematics is like a spider bite…*" or underlining three times the words "*nice teacher*" when describing a mathematics classroom where students are best able to learn. Self-positioning had become a manifestation of positioning-by-others, or self-fulfilling prophecy, and was substantiated by a 2011-2012 state assessment score of 32%. The importance of consideration of the *who* in addition to the *what* and *how* of the reform puzzle is conveyed in this particular case study.

The question of extent of impact on self-positioning by positioning-by-others for this particular case study prompted review of academic year 2012-2013 state assessment data, potentially reflective of student experience with another teacher. Sage-NPs' percentage score increased to 41% and was considered "satisfactory performance" as opposed to the prior year's score, which was considered "unsatisfactory performance". A distinct relationship between state

assessment scores and positioning cannot be established, but does indicate longitudinal research may provide greater insight into implications of this particular source of data.

Stage Three: Productive Student (Thyme-Ps) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Thyme-Ps revealed disposition toward mathematics teaching and learning, although mathematics learning was the dominant target for Thyme-Ps, as identified in parallel data analysis. Thyme-Ps indicated in interview responses enthusiasm about mathematics learning and showed an appreciation of challenges as confirmed in the following excerpt: "*I was pretty excited about it*. *I kind of liked solving it because you know it was a little harder than what I was used to…*". Thyme-Ps self-positioned productively as illustrated in statements such as "…*it was pretty easy once I got the hang of it*" and "*Math comes pretty easy to me but not most kids*".

Productive disposition continued to be substantiated in interview responses which reflected positioning-by-others: "*My teacher explains it well to me*" and "*My teachers teach me better than I would teach somebody else*". Alluding to teacher-engineer characteristics observed in Thyme's practice, Thyme-Ps speaks to a teaching practice that "*persuades the kids that Math is fun*". Concepts such as persuasion, justification, and discovery were considered linguistic markers and characteristics of teacher-engineer.

Transphenomenality in Thyme's self-positioning as teacher-technician and positioning-by-others as teacher-engineer is reflected in Thyme-Ps' meaning-interpretation and parallel data analysis. "Complexity theory proposes that any minute change in any dynamic system has a generative impact on a multiplicity of inter-related locations and relationships" (Fels, 2004, p.77). Thyme was positioned-by-others as a teacher-engineer which then is translated to the positioning-by-others of Thyme-Ps. The inter-connectedness between Thyme and Thyme-Ps is

representative of student core dispositions dynamically manifested in varied self-positioning stances and subsequent positioning-by-others from diametrically opposed perspectives. As an outcome of teacher-engineer practice, 2011-2012 state assessment score of 88% for Thyme-Ps substantiates Thyme's positioning-by-others as teacher-engineer.

Stage Three: Neutral Student (Thyme-Ns) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Neutral student, Thyme-Ns, self-reported that, although his learning preferences had moved from mathematics to other interests, "*Maybe I'm not interested in math as I used to be, maybe??*", his self-positioning as a mathematics learner was "*confident… almost cocky*" as reported in interviewer observational field notes. "*Well, you know I get high grades in that class… I don't really struggle with it*" was coupled with the caveat "*Once you tell me, I learn things pretty quickly*" exhibiting a positioning-by-others element and indications of the presence of transphenomenal conflict impacting affective disposition. Thyme-Ns demonstrated a complex relationship between his self-positioning as a "*knower*" and a need for explanatory mathematics teaching that covers "*…basic things first and the more complex things later on*" or positioned-by-others as a "*learner*".

As with Sage-Ns, 2011-2012 state assessment percent score of 98% was the highest for Thyme-Ns of all of Thyme's linked students. Thyme-Ns was positioned-by-others in a more productive stance from a neutrally inclined self-positioning as exemplified in an acknowledgment of a usefulness affective characteristic of mathematics as related across content areas: "*I think math has helped out with band*". Another semantic indicator of teacher-engineer characteristics identified was the ability to provide connections for students to anchor learning. Thyme-Ns disposition was reflective of Thyme's positioning-by-others as teacher-engineer,

rather than Thyme's deflated self-positioning as teacher-technician, as demonstrated in Thyme-Ns' ability to make connections between mathematics and other content areas.

Stage Three: Nonproductive Student (Thyme-NPs) Case Study – Student Interview Ratings and Parallel Data, Results, Findings and Analyses

Attitude, as an affective characteristic, was prevalent in Thyme-NPs' interview responses and clearly indicated a nonproductive self-positioning: "*I really don't like math – like I hate math*" and "*I really don't pay attention in math*". Interviewer observational field notes stated that Thyme-NPs "*…seems very indifferent and emotionless when talking about memories of math*" and notes that Thyme-NPs "*…did not appear to show signs of anxiety and was confident in answers*". Anxiety, as an affective characteristic, did not impact self-positioning for Thyme-NPs.

However, as Thyme-NPs' responses are cross-analyzed across data sources it became apparent transphenomenal conflict or "events or phenomena that exist or operate at the same time" (Davis, 2005, p.14) existed in her positioning and was shown in the self-concept characteristic of affective disposition. Thyme-NPs' own description of herself as "*..an inbetweener. Learning math is fun sometimes and sometimes it can be really, really boring*", demonstrated a dichotomous nature to her positioning. Explanation in a manner in which she understood was very important to her: "*I was better at it 'cuz my teacher taught me like she explained it to me more*". Positioning-by-others is evident in Thyme's response to student need for differentiation of instruction – characteristic of teacher-engineer.

2011-2012 state assessment data for Thyme-NPs, 31%, was reflective of nonproductive disposition. However, fluidity in positioning as evidenced in the following excerpt exemplified the complexity of affective disposition: "*Mathematics is like fries…because some of them can be moist and old. And some of them are hot and salty. Mathematics can be sometimes like boring*

and sad and dull and then sometimes math can be like it can be fun!" For Thyme-NPs, self-positioning is represented in mathematics as "*boring and sad and dull*", while positioning-by-others occurred when math was "*fun*". Bogdan and Biklen (2010) suggested understanding phenomena or "…the meaning of events and interactions to ordinary people in particular situations" (p.33) is a basis of social constructivism. Mathematical disposition and positioning are then reflections of the fluidity and dynamic nature of interaction among phenomena and individuals. Thyme-NPs self-positions diametrically opposed to positioning-by-others which opens the door to the potential of learning when coupled with a teacher-engineer or Thyme. The research question, *How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning*? was answered in part by Thyme-NPs fluid self-positioning as nonproductive gravitating to neutral disposition as a reflection of and in response to Thyme's positioning-by-others as a teacher-engineer.

Stage Three: Case Studies – Summary

Utilization of qualitative methods of meaning-coding, interpretation and analysis according to themes, categories, and clusters provided deeper narrative analyses of affective dispositional characteristics within the context of its complexity. To conduct educational research from a limited narrow perspective without regard for transphenomenal simultaneity or the connections between the *knower, knowledge* and *learner* is not accounting for "how discourses intersect, overlap, and interlace" with the phenomena (Davis & Phelps, 2005, p.3).

In each student case study synopsis of analysis, connections between *knower, knowledge* and *learner* were established identifying elements of self-positioning and positioning-by-others. Because each student case study possessed a uniqueness of its own, it was impossible to quantify student positioning experiences. Each student case study did exemplify the transphenomenal

quality of positioning, particularly fluidity in movement from self-positioning to positioning-by-others. Succinctly, imparting knowledge as a teacher-technician had different student outcomes than the storylines developed when exposed to a teacher-engineer.

The complexity of education is rooted in the nature of discourse, multiplicity, and simultaneity. As each student self-positioned, teachers were then positioned-by-others (students). Osberg (2005) suggests that the process of education is dynamic, with intertwined variables and teachers and students participate in the educational process "…from a position of extreme flexibility and responsiveness to the moment or space we are in" (p.82). Meaning-making of events and interactions related to disposition led to analyses of self-positioning and positioning-by-others, and thus opened the door to view student disposition within the affective domain (Moghaddam, 1999) as a reflection of teacher disposition.

Stage Four: Case Studies - Classroom Observations and Field Notes

The positioning of a teacher may evolve in one of two ways: as teacher-engineer or as teacher-technician (Tchoshanov, 2011). Critical to this study were the variances in teacher self-reported positioning and positioning-by-others as evidence of transphenomenal simultaneity. Primary attention was given to the interconnectedness between teacher and student affective dispositions and how the self-positioning of teachers was challenged due to positioning-by-others (students). Classroom observation provided a venue to identify characteristics of affective disposition present in teaching practices, the interactive nature of self-positioning and positioning-by-others and the presence of simultaneous transphenomenality, according to defined data collection protocol (Appendix B – Method of Inquiry). The framework of clusters was created from episodic summary and thematic coding, and was essential to facilitating recognition of the presence of transphenomenal conflict in data analyses.

Clusters, delineated to facilitate meaning-coding and interpretation during Stage Four, (Appendix D), were designated as Nature of Mathematics (Procedural, Direct, Conceptual and Indirect), WUS (Worthwhileness, Usefulness and Sensibleness), Self-Concept Teacher (Engineer or Technician), Self-Concept Student (Success, Failure, and Irresolute), Attitude (Effective Criticism, Acknowledgement, Negative Criticism and Sage), and Anxiety (Insecurity, Threatened, and Degradation). Each cluster addressed perspectives of self-positioning and positioning-by-others. For each case study participant, all sources of data were meaning-coded according to clusters and interpreted holistically within the context of Complexity and Positioning Theories.

Stage Four: Case Studies - Classroom Observations and Field Notes Overview

During comparative cluster analyses, it was surmised that Sage was positioned-by-others as a teacher-technician and Thyme was positioned-by-others as a teacher-engineer in conflict with their self-positioning. "Whenever somebody positions him/herself, this discursive act always implies a positioning of the one to whom it is addressed" (van Langenhove and Harré, 1999, p. 22). Consequently, students self-positioned in response to teachers' self-positioning which in turn instigated positioning-by-others of teachers, as a fluid and dynamic process.

Stage Four: Case Study of Sage – Cluster Analyses

The area line graph below (Figure 4.7) represents meaning-coding of data from Sage within the cluster framework for all sources of data. As represented in the posterior portion of the graph, Sage self-positioned as a teacher-engineer (Nature of Math-E) and demonstrated significant affective characteristics of attitude. Affective characteristics of attitude indicated a self-positioning as an authority as illustrated in the following statements: "*I know I'm not*

average. Um, a lot of the other math teachers come to me to help them" or "*I have lots of math knowledge in particularly the 8th grade*". Nature of Mathematics affective characteristics included self-positioning in indirect, exploratory teaching practices: *"...when I share the knowledge they're not just taking it there, they're taking it more beyond that*" and "*I give them problems in the homework that are marked higher thinking level problems*". Meaning-coding and interpretation of classroom observation protocol and field notes produced a shift in Sage's dual positioning to teacher-technician (illustrated in the anterior portion of the graph).

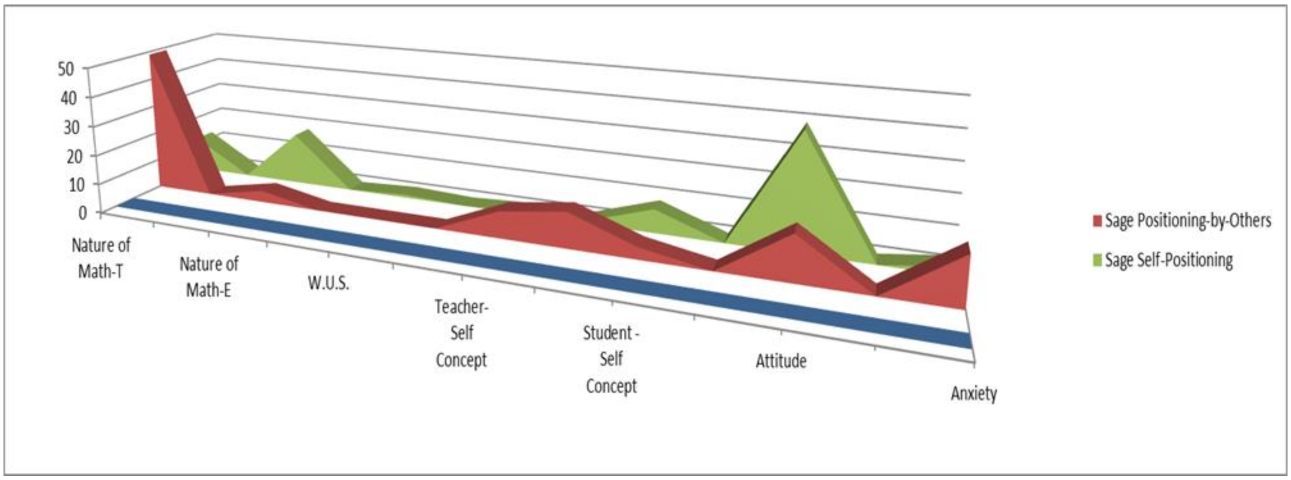

Figure 4.7: Cluster Comparison of Self-Positioning and Positioning-by-Others

Case-Study Sage

Nature of Math–T increased from self-positioning and is reflected in excerpts from classroom observation and field notes such as, "*...directed instruction on step-by-step procedures for solving problems*" and "*Turn to page 23 and copy what I have here"; "Turn to page 12 of your STAAR interactive notebooks. Page 17, my bad." Goes through True/False answers. Continues reading answers. "Now Lesson 15, 1-10*". Characteristics of attitude were still present in positioning-by-others, however from a position of power rather than authority: "*I better see you for detention tomorrow morning at 7" then corrects herself after third time – "tutoring not*

detention". Visually, the existence of transphenomenal simultaneity was corroborated in the graphs of self-positioning and positioning-by-others.

Identification of elements of student positioning that contributed to the shift or positioning-by-others was the next logical phase of analyses. In Figure 4.8 below, identification of student positioning was compared to Sage's positioning-by-others.

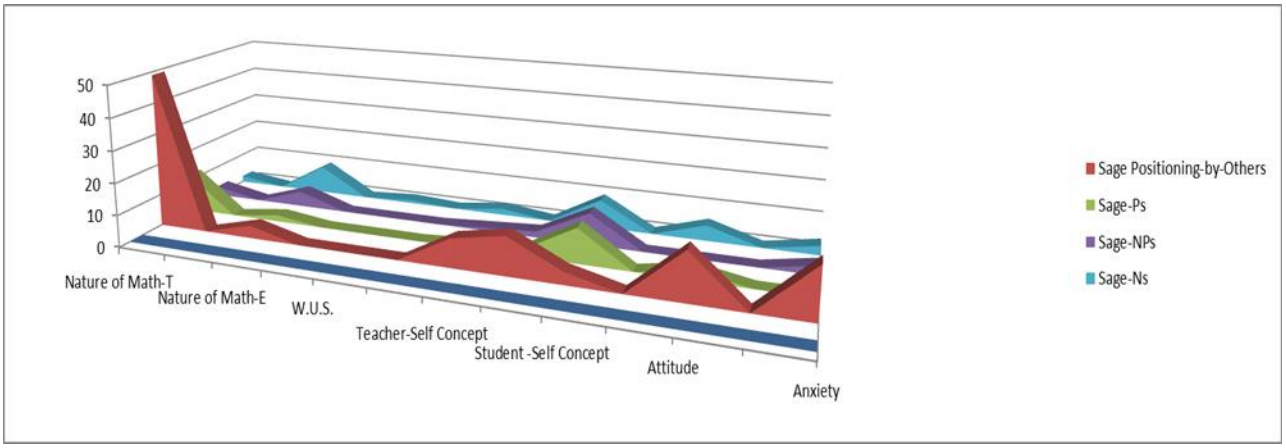

Figure 4.8: Cluster Comparison of Student Self-Positioning and Positioning-by-Others

Case-Study Sage

As illustrated in the graph, Sage was positioned-by-others (students) reflective of student positioning. Nature of Math-T and Math-E had fairly similar data patterns, as well as the affective characteristic of self-concept. Noted in frequency counting of Nature of Math cluster elements, Sage's students referenced "*procedural approach*", "*direct instruction*" and "*structured*" twenty-one times, conversely referencing "*indirect instruction*", "*differentiation*" and "*higher order thinking skills*" sixteen times. Nature of Mathematics frequency counting of Sage's data revealed a similar distribution of answers or seventy technician-type responses to forty-five engineer-type responses. Within the discursive practices of the classroom setting,

Sage's self-positioning was transformed to be reflective of student self-positioning as manifested in a positioning-by-others move to teacher-technician from teacher-engineer.

Anecdotal examples from classroom observation protocol and field notes established positioning-by-others as teacher-technician as evidenced by teaching approaches utilized: "*Protocol: Enriched by conjecture, investigation or analysis. Observation: NO*. "*You now have 6 minutes to come up with a sample space*". Further evidence of lack of enrichment was provided in field notes, "*1 minute boys and girls" asks students to put response on white boards, but needs to reveal answer choices. Teacher is at the computer for 3 minutes. "Pick the one that looks closest to yours" All boards go up. "D is the answer - pass 'em up, pass 'em up". Warm-up sheets are stored in the classroom*." As a polar opposite, Sage self-positioned as teacher-engineer stating in the interview "*There are always different ways to solve problems*", yet in the positioning-by-others example above "*D is the answer*" with no further extension of learning. Transphenomenal conflict is clearly present in the teacher-engineer and teacher-technician examples given above.

Meaning-coding and interpretation produced multiple anecdotal examples as evidence of self-positioning as teacher-engineer, positioning-by-others as teacher-technician and the existence of transphenomenality. Affective characteristics which contributed to a phenomenological conflict between teacher self-positioning and positioning-by-others in the case study of Sage were nature of mathematics, self-concept, and attitude as measured by meaning-coding and interpretation utilizing cluster analyses.

The extent transphenomenal simultaneity identified in Sage's positioning was reflected by her students' positioning and was exemplified in Sage-NPs' statements, "*...because I know how it feels to be bored to death by work*" and conversely, "*I might be like more interested in*

what to actually do it and what to understand it more than being bored and not understanding it". Illustrating van Langenhove and Harré's (1999) assertion, "Clearly, persons are constantly engaged in positioning themselves and others. The concrete forms such positioning will take differ according to the situations in which they occur" (p.30). Sage's self-positioning was challenged by positioning-by-others (student) and revealed simultaneous transphenomenality as a manifestation of complexity of the main construct of the study – teacher affective disposition.

Stage Four: Case Study of Thyme – Background

The ability to consider multiple forms of positioning within the context of affective disposition was guided by the supposition that "…persons are constantly engaged in positioning themselves and others" (van Langenhove & Harré, 1999, p.30). Referencing the adapted positioning triad (Figure 4.9), the interrelationship of self-positioning, positioning-by-others and situational positioning is dynamic and fluid reflecting disposition toward mathematics, mathematics teaching and learning.

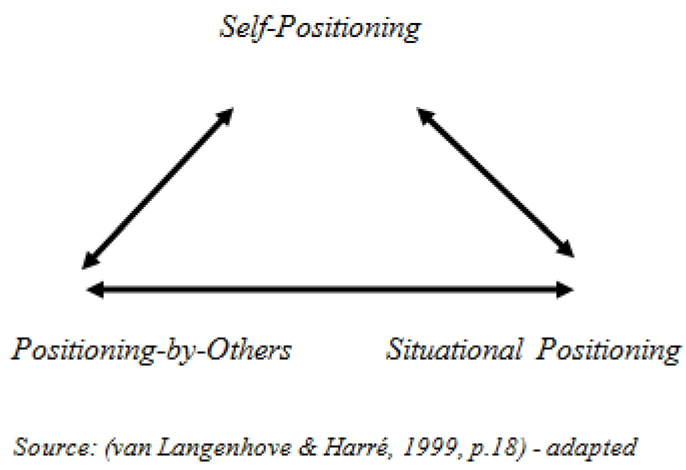

Figure 4.9: Dis/Position Transphenomenality Triad

The case study of Thyme personified the dynamics involved in self-positioning and resulting transphenomenal conflict in positional shifting. Thyme in Stages Three and Four of the study self-positioned herself as a teacher-technician. However, observationally, and as supported by state assessment data (overall student percent score was in the top quartile of teachers included in the study), she was positioned-by-others (students) as a teacher-engineer. Illustrated in the adapted positioning triad, "The concrete forms such positioning will take differ according to the situations in which they occur. One individual can thus undertake several varieties of positioning" (van Langenhove and Harré, 1999, p.30). Situational factors were distinct contributors to Thyme's disposition toward mathematics, mathematics teaching and mathematics learning.

Thyme, unlike Sage, was predominantly an English Language Arts teacher who also taught mathematics. Extraneous factors contributing to Thyme's self-positioning as a teacher-technician was her perception of her relationship with her mathematics peers. In response to open-ended question item "*Do your fellow math teachers use your ideas in their teaching practice? Explain*", Thyme answered, "*Since I only teach 1 class of math and 4 classes of English, I frequently feel "left out" in the development process. I'm given the lesson plans to follow*". Although Thyme possessed all the credentials necessary to teach mathematics and held a masters degree with more than twenty years of teaching experience, her response to positioning-by-others (peers) was to self-position as teacher-technician based in self-concept affective disposition characteristic. van Langenhove and Harré (1999) describe self-concept to be located in "…what an individual believes about themselves…and what they are able in the circumstances to display as personas" (p. 9). As will be shown, Thyme was simultaneously

positioned-by-others (students) as a teacher-engineer, which in all probability represented her core disposition toward teaching in general.

Stage Four: Case Study of Thyme – Cluster Analyses

Meaning-coding of data for Thyme, within the cluster framework for all sources of data, is displayed in Figure 4.10 indicating self-positioning as teacher-technician in the background of the graph and positioning-by-others in the foreground of the graph.

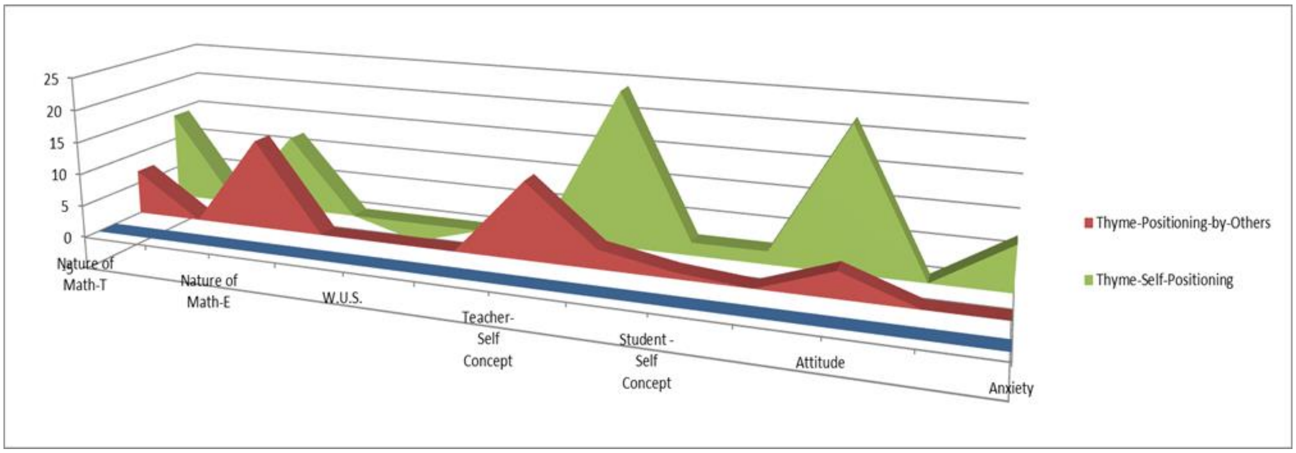

Figure 4.10: Cluster Comparison of Self-Positioning and Positioning-by-Others

Case-Study Thyme

Within the dichotomous positioning shown, there was a distinct shifting in attitude and self-concept clusters from self-positioning to positioning-by-others. Self-concept affective characteristics were designated as perceptions of engineer or technician. Thyme had twenty-four references to technician as opposed to three references to engineer when self-positioning; Frequency of references in positioning-by-others shifted to three references to technician and twelve references to engineer. Thyme in response to the situation, was displaying a distinctly different persona (self-concept) when positioned-by-others.

Attitude, as an affective characteristic shifted, yet to almost no indication of the characteristic. During the interview stage, Thyme stated "*I'm a struggling learner so I don't take things for granted*" and "*I didn't understand the problems. But, it was beautifully intimidating… I love math*". Simultaneous conflict existed in Thyme's self-positioning attitude toward mathematics and mathematics learning. However, in meaning-coding of positioning-by-others data there were minimally four references to attitude. The focus of positioning-by-others was positioning toward mathematics teaching rather than attitude toward mathematics and mathematics learning.

Demonstrative of core disposition as teacher-engineer was the presence of reasonably similar frequency counts between self-positioning and positioning-by-others, distinguishable in the graphical representations of Nature of Mathematics-E. However, distinct shifting in Nature of Mathematics-T was observed in positioning-by-others. Thyme was observed to be thoughtful and more individualized in her teaching practice exhibiting teacher-engineer characteristics. Field notes stated "*Students interacted around the topic. Learning was enriched by conjecture, investigation and analysis. Instruction was related to something relevant to the students. She asked for explanations and justifications*", clearly characteristics of a conceptual approach to instruction.

Identification of student positioning was compared to Thyme's positioning-by-others to further extend analyses (Figure 4.11) of self-positioning and positioning-by-others. The cluster of attitude was an inconclusive designation as reflection in positioning-by-others for Thyme and her students. As identifiable in the graph, Thyme-Ps and Thyme-NPs have very dominant affective characteristics in the attitude cluster that were not a reflection of Thyme's positioning-by-others attitudinal characteristics, yet were reflective of Thyme's self-positioning.

Transphenomenal conflict as related to attitude was particularly pronounced for Thyme and her students within and across the multiple types of positioning.

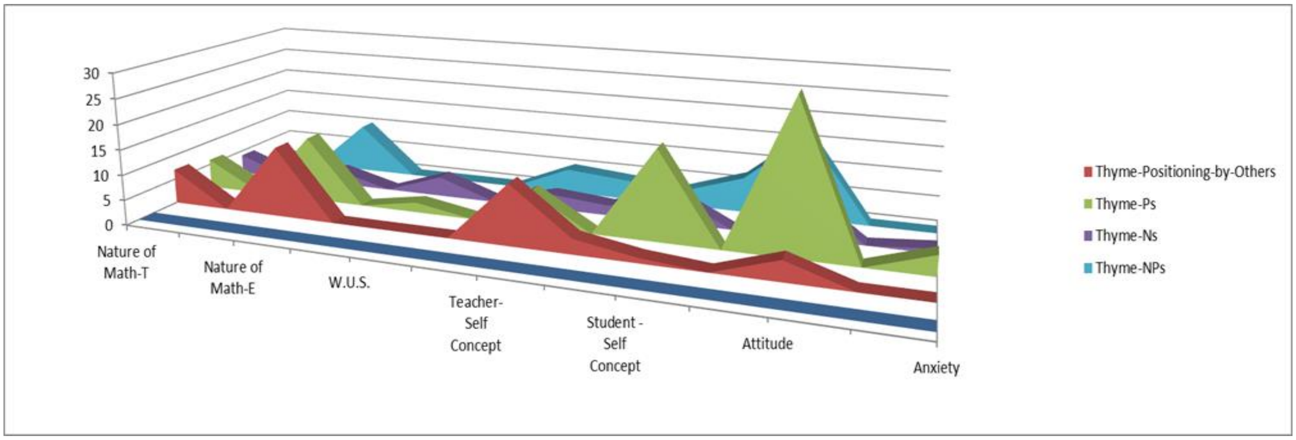

Figure 4.11: Cluster Comparison of Student Self-Positioning and Positioning-by-Others Case-Study Thyme

In support of the assertion of student reflection of teacher positioning-by-others are the clusters of Nature of Math-T and Nature of Math-E: Thyme's students' positioning mirrors Thyme's teacher-engineer positioning for these two clusters. As examples, students responded to the question about mathematics teaching "*…if I was a math teacher I do want to make sure that the math is fun so that they will enjoy learning it and they'll take it in, they will learn it. It will go off the top of their head like Oh WOW that's the answer*" and "*If I was a mathematics teacher, I would teach students the basic things first and the more complex things later on. You have to start with little things first before you move to the big things*". Thyme similarly responded "*They need to be hearing it, seeing it, feeling it and then it becomes internal… visualize in their mind… processes they're going to remember it. And they're going to be able to apply it to different aspects of their life*". Facilitating learning connections to background knowledge was apparent in

classroom observation (as noted in protocol), "*...relates instruction to something relevant to students*"; this too is a form of positioning through discourse, as well as, a characteristic of a teacher-engineer.

In the case study of Thyme, meaning-coding and interpretation uncovered anecdotal data examples of self-positioning as teacher-technician, positioning-by-others as teacher-engineer and the existence of transphenomenality present in positioning. Reflective characteristics of positioning were present in the case study of Thyme, but not to the extent noted in the case study of Sage. This finding took into consideration the extraneous factor of Thyme as a teacher of multiple content areas.

Of note, following the academic year 2011-2012, Thyme chose to no longer teach mathematics and teach only English Language Arts. Thyme's positioning toward mathematics versus positioning toward English Language Arts was generalized to be very distinct and different following the experiences described in this study. However based on classroom observational data, positioning as a teacher-engineer transcended content and was representative of Thyme's overall positioning toward teaching practice in general. In essence, Thyme displayed distinct affective dispositional characteristics toward mathematics from her affective disposition toward mathematics teaching and learning and was yet able to demonstrate teacher-engineer positioning.

Stage Four: Case Studies - Summary

The process of positioning self and others was the origin of simultaneous transphenomenality or "…events or phenomena that exist or operate at the same time" (Davis, 2005, p.14) functioning as a major contributor to complexity of affective disposition. The multiple sources of data afforded holistic comparative analyses in response to the research

questions, *What are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self- positioning and positioning-by-others?;* and *How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning?*, and presented differing situations to view student and teacher positioning.

Specifically, in Stage Four, affective characteristics identified as contributing to phenomenological conflict manifested in self-positioning and positioning-by-others were predominantly *nature of mathematics, self-concept, and attitude* as exemplified in the case studies. This finding is important in respect of narrowing the focus of research to identify contributing elements of those characteristics and to bring more awareness of transphenomenal simultaneity in teaching practices.

The reflection of teacher positioning in student positioning was substantiated in the identification of self-positioning and positioning-by-others. The presence of transphenomenal simultaneity in student positioning reflection of teacher positioning was affirmed, although the extent of reflection was clearly unique to each student case study.

Chapter Four: Findings, Results and Analyses – Overall Summary

Overall, teachers and students in the study demonstrated levels of productive disposition toward mathematics, mathematics teaching and learning. Further, evidence of self-positioning and positioning-by-others was shown to be manifested in simultaneous transphenomenality resulting in dichotomous conflict. In all four stages of analyses, complexity of the construct and characteristics of affective disposition were exemplified primarily in qualitative analysis utilizing meaning-coding and interpretation according to themes and clusters. Although quantitative analyses produced a generally productive rating, qualitative analyses and triangulation of all data sources resulted in identification of hidden, descriptive findings of teachers positioned as

engineers and/or as technicians. The profoundness of these findings was three-fold: 1) evidence of the existence of transphenomenal simultaneity in teacher positioning contributing to conflict and complexity impacting teaching practices; 2) evidence of reflection of teacher positioning in student positioning with the potential of impacting student learning outcomes, further supporting Beyers' (2011) assertion of relationships between teacher and student disposition: and 3) a shifting or narrowing of the gap in gender positioning toward mathematics was unexpected based on previous research. However, additional research is needed to substantiate this finding.

Chapter 5: Conclusions and Recommendations

"Becoming a teacher is a curricular adventure, a generative framework of possibility that invites stops, interruptions, hesitations, elated moments of recognition, loss, and recovery; a unique journey shared by educator and students across an emerging landscape that unfolds with each footstep."
– Lynn Fels

Introduction

The purpose of this exploratory study was to ascertain if there was a pattern of transphenomenal simultaneity between teacher and student disposition that contributed to the phenomenological conflict of teacher self-positioning and positioning-by-others toward mathematics, mathematics teaching and learning. The intent was to provide a view of self-reported and observed middle school teacher and student experiences in mathematics, based on the analysis of affective dispositional characteristics within the context of its complexity. This dissertation argued that understanding affective disposition of teachers and students, and the reflection of teacher positioning in student positioning, must be examined with respect to the dynamic, transphenomenal (Complexity Theory) nature of the concept of core disposition interrelated with multi-positioning stances. Core affective disposition does fluctuate, but is of a more stable 'habit of mind' than positioning. Positioning occurs at multiple levels of perspective and productivity, simultaneously accounting for and as an interaction/reaction with extraneous variables. Self-positioning and positioning-by-others were critical to identification of teachers-as-engineers or teachers-as-technicians.

Fluidity or transphenomenality in teacher positioning, measured by multiple instruments, (survey employing metaphorical prompts and open-ended question items, Likert-type rating, interview, classroom observation and field notes) was representative of continuous

metamorphoses between teacher-as-engineer and teacher-as-technician and reflective student disposition toward mathematics. The targets as social forces (mathematics, mathematics learning and teaching) were used to establish parameters for analysis (Weston et al., 2001) leading to a cluster technique of coding. “A complex system is characterized by emergent behavior resulting from the interaction among its parts…” or for purposes of this study, emergent teacher positioning resulted from “…dynamics of interaction” (Ferreira, 2001, p.1) as illustrated in interconnectedness of dis/position, storyline and social force (Figure 2.1, Adapted Positioning Triad). Each episode of behavior was coded using analysis by word or phrase, recognizing internal and external cues. Thematic coding was seen not as a precursor to analysis, but as a unit of analysis and the “best representation of …thinking about the phenomenon at a particular time” (Weston, et al., 2001, p. 391). Not all text was pertinent and focus was given to analyses which demonstrated positioning, the characteristics of affective disposition, and transphenomenal conflict as representative of the complexity of the construct of affective disposition. Stages of data collection, coding and analysis afforded a scaffold conducive to sequentially and holistically construct meaning-coding and interpretation of data leading to key conclusions for each stage.

Key Conclusions

From Stage One data collection, coding and analysis, two key conclusions were distinguished. First, within the framework of Complexity Theory, inflated/deflated self-reported narrative of disposition and positioning encouraged embracing “…disorders (Alhadeff-Jones, 2012b) rather than systematically looking for order.” (Alhadeff-Jones, 2013, p.42). Subsequent quantitative analysis, as anticipated, demonstrated non-significant correlations between teacher and student overall expert rating of disposition, between teacher expert ratings and assessment data, and student expert ratings and assessment data. The transphenomenal, complex nature of

data in Stage One challenged the linear, straightforward approach of quantitative analysis leading to embracement of disorder or simultaneous multiplicity of transphenomenal characteristics of affective disposition necessitating movement to a more holistic, qualitative methodology.

Secondly, in response to the survey question, *Would you consider yourself a mathematician?,* the research finding of no statistically significant gender differences was important as identification of a shift in affective disposition toward mathematics from prior studies of stereotype. Yet, stereotype threat, as an extraneous variable contributing to the development of disposition or positioning, was not readily apparent in positioning or levels of dispositional productivity overall in this particular study. Rooted in the perception that positioning is situationally based on narratives and storylines, this finding is in agreement with Steele's (1997) assertion that "Different groups experience different forms and degrees of stereotype threat because the stereotypes about them differ in content, in scope, and in the *situations (emphasis added)* to which they apply" (pp. 617- 618). However, further investigation of gender differences in terms of cognitive and conative disposition may be warranted to determine overall impact of this shifting and if there is recent research confirming or disconfirming this finding.

Stage Two data collection, coding and analysis of self-reported rating of disposition via Likert-type scale provided a prescribed, limited and structured rating of disposition toward mathematics, mathematics learning and teaching. Even with interpretation of narrative, the Likert-rating provided little additional evidence in contradiction to the observation of inflation and deflation of levels of productivity and self-positioning as either teacher-engineer or teacher-technician. Case study participants rated themselves on the Likert-type scale similarly to self-reported ratings identified in the survey research component. These findings further support that

due to influence of personal characteristics, such as self-esteem, self-reported storylines or narratives of affective disposition cannot be compartmentalized into pre-determined levels or rankings.

Through meaning-interpretation employed in Stage Three, it was found that experiential backgrounds (significant prior and/or current events or turning points) played a role of contributors to the formation of self-positioning, both negatively and positively. Trajectory of student positioning, as reflection of teacher positioning, was dependent on multiple factors within the learning environment and was unique to each individual. Although students were simultaneously exposed to the same teaching methods and materials, they had very different trajectories or outcomes in their positioning. The extent of reflection of teacher positioning in student positioning was variable and dynamic, yet always present as students "…coordinate their actions to position themselves in relation to the other…" (Miller, 2013, p. 79). Further supporting the finding of reflection of teacher positioning in student positioning, Davis (2006) asserted that "Discourses always function in relation or in opposition to other discourses" or transphenomenality (p. 11). Within the complexity of affective disposition, transphenomenal conflict was situationally adaptive and constantly evolving based on self-positioning and positioning-by-others. The significance of this finding is buried in the lack of realization of positional "level-hopping" (Davis, 2006, p.8) on the parts of teachers or students and the potential impact on affective disposition toward mathematics, mathematics teaching and learning.

Stage Four focus on the two case studies, Sage and Thyme (pseudonyms), and their self-positioning and positioning-by-others provided evidence of the simultaneity of transphenomenal affective characteristics of disposition. As polar opposites, Sage self-reported inflated

characteristics of a teacher-engineer and Thyme self-reported deflated characteristics of a teacher-technician. In analysis of classroom observation protocol and field notes for teachers and students, the phenomenon of student reflection of teacher practice in their positioning demonstrated converse positioning of both teachers – Sage as a teacher-technician and Thyme as a teacher-engineer. Similar to Davis' (2006) research, "…the teacher-participants did not seem to be aware that they were jumping among different levels of phenomena…" (p.8), or specific to this study, teacher were not aware of multiple conflicting positions as teacher-engineer and teacher-technician. This was not to say that self-reported disposition was 'false', but rather due to "…the multitude of diverse and often conflicting 'voices' that are speaking in a text, deconstruction…is attentive to the inevitable interdiscursive character of any knowledge claim" (Davis, 2006, pp. 14-15). Due to the complexity of the construct and the influence of extraneous factors, action spoke louder than words and was considered to be the authentic depiction of teacher disposition toward mathematics, mathematics teaching and learning.

Research Questions Responses

Responding to the first research question, *Within the complexity framework, what are teacher and student affective disposition characteristics which contribute to a phenomenological conflict between teacher self-positioning and positioning-by-others?*, affective characteristics that most frequently contributed to conflictive positioning were *nature of mathematics*, that is, teacher-engineer and teacher-technician, *attitude* and *self-concept*. *Anxiety* did present in individual descriptions of positioning, but was not a prevalent characteristic across the data collected. *Worthwhileness*, *usefulness*, and *sensibleness* (WUS) were mentioned in the data very minimally and were not considered to be affective characteristics that contributed to transphenomenal self-positioning and positioning-by-others. Identification of affective

characteristics was, nevertheless, not considered in terms of linear delineation of characteristics contributing to affective disposition, but as identification of primary contributors to positioning that gave rise to simultaneous transphenomenality reflecting conflict and complexity in the construct of affective disposition.

How, and to what extent, is transphenomenal simultaneity in teacher positioning reflected by student positioning? was exemplified in side-by-side graphical representation of cluster coding of affective characteristics. It was found that student positioning was generally reflective of teacher positioning, and in fact, teacher positioning-by-others was in response to student positioning. Davis (2006) found "…the relevant phenomena evolve at radically different paces…" resulting in "…unconscious but fluid level-hopping…" (p.8), or metamorphoses of positioning. The lack of awareness of self-positioning and positioning-by-others contributed to the complexity of navigation in the educational setting by not only the *knower*, but the *learner* and the methods of knowledge delivery and understanding reflective of positioning stances as illustrated in data excerpts.

In an effort to evaluate the influence of gender stereotypes as extraneous contributors to disposition and positioning, the following research question was posed: *What evidence is present in support of or in contradiction to shifting and closing the gap of stereotypical gender disparity in disposition toward mathematics?* Minimal evidence of a shift and closing of the gap in gender distribution of those that consider themselves as mathematicians and those that do not was presented in the data. Statistically, there was no relationship between gender distribution in responses to the question posed implying that females, as often as males, consider themselves or don't consider themselves mathematicians. Confirmatory research is needed to lend credence to this finding.

Recommendations

Critical to educational reform efforts is the acknowledgement of transphenomenal conflict integral to self-positioning and positioning-by-others (the *who* of the reform puzzle). Teacher recognition of the fluidity of self-positioning and positioning-by-others may result in teaching practice transformation, or, at a minimum, conscious positioning alignment and alteration impacting student affective disposition toward mathematics, mathematics teaching and learning. However, acknowledgement must not be in simplistic, linear terms ignoring the transphenomenal nature of self-positioning and positioning-by-others. "To understand consciousness, one must be willing and able to think in transphenomenal terms and engage in transdisciplinary ways" (Davis, 2006, p.20). Education seen through the viewpoint of Complexity and Positioning Theories, expands "…the space of human possibility by exploring the space of the existing possible" (Davis, 2006, p.22) and increases the understanding of the affective domain of disposition.

As pertinent to extraneous factors contributing to the development of disposition, it is recommended that research of gender stereotype be extended to inclusion of the interplay between all three domains of disposition or the conative, cognitive and affective domains. It is conjectured that there *is* a narrowing of the gender gap in disposition toward mathematics and that within the intersection of conative, cognitive and affective domains are the defining characteristics contributing to productive positioning, thus narrowing the gap between males and females.

It is conjectured that self-positioning and positioning-by-others is significantly impacted by simultaneous transphenomenality occurring in the overlapping of cognitive, conative, and affective disposition constructs and in points of construct intersection. Further investigation of all

three domains of disposition interacting with the dynamics of positioning is called for, based in the findings and results of this exploratory study. It is surmised that further evidence of complexity, presented as transphenomenal simultaneity, in teacher positioning and as reflected in student positioning will be substantiated.

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Appendix A: Glossary of Terms

Affective Domain:	A student's internal belief system (Fennema, 1989). The affective domain includes students' "beliefs about themselves and their capacity to learn mathematics; their self-esteem and their perceived status as learners; their beliefs about the nature of mathematical understanding; and their potential to succeed in the subject" (Tanner & Jones, 2003, p. 277)" (p. 507).
Attitude:	An (un)favorable state of mind/view and/or a positive/negative feeling influencing an emotional (re)action toward a (dis)investment in mathematics (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
Authentic Activity:	"… spaces in which students explore how the subject under study is socially relevant and connected to their everyday lives" (Rodríguez, 2005, p.20).
Coding:	"Breaking a text into manageable segments and attaching one or more keywords to a text segment in order to permit later retrieval of the segment." (Kvale & Brinkmann, 2009, p.323).
Cognitive Domain:	Involves thinking about thinking, understanding, knowing, and being able to make connections in knowledge; the ability or tendency to make connections and be able to express argumentation.
Conative Domain:	Perseverance, initiative, drive, desire, or inclination to attempt and complete tasks and develop knowledge; emphasis on striving, acting, impulse, desire, and volition; each element contributing to what educators frequently term "effort".
Confirming and Disconfirming Cases:	"…involves testing ideas, confirming the importance and meaning of possible patterns, and checking out the viability of emergent findings with new data and additional cases" (Patton, 1990, p.178).
Criterion Purposeful Sample	Meeting an identified criterion/a (Patton, 1990)
Discourse Analysis:	"Analysis of the interaction within discourses, on how the talk is constructed, and on what the power effects are of different discursive presentations of a topic within a broad context" (Kvale & Brinkmann, 2009, p.324).
Disposition:	A point (fluid and dynamic) on a continuum of feelings, thoughts and behaviors (cognitive, affective and conative interactions) toward mathematics education and mathematicians.
Economically Disadvantaged:	Coding classification of students who are eligible for free or reduced cost of lunch as defined under the National Lunch & Nutrition Program, in No Child Left Behind Act, and Department of Education Title programs. It is not the intent of the researcher to include a term that is not generally accepted outside the educational arena, but simply to identify categories of students based on established coding classifications.
Focus Group Interview:	"A small number of people, normally six to eight, meeting to discuss an issue of common concern led by a moderator, and often followed by one or two observers" (Bauer & Gaskell, 2000, p. 356).
Intensity:	For purposes of second tier coding, intensity of response will be categorized on a scale of one to three as low (1), Neutral (2), or High (3).
Inter-coder Reliability:	"A measure of objectivity is 'inter-coder reliability', whereby two coders use the same coding frame to code independently the same units. The amount of agreement between them is the estimation of the inter-coder reliability" (Liakopoulos, 2000, p.162)

Interpersonal Positioning:	Positioning of oneself in discursive practice with another person; self-positioning.
Interpretive Analysis:	"a hermeneutic (and non-algorithmic) process by which a human interpreter tries to find meaning (Verstechen) in qualitative data" (Bauer & Gaskell, 2000, p.358).
Intensity Purposeful Sample	Information-rich cases that manifest the phenomenon intensely, but not extremely (Patton, 1990)
Positioning:	*Positioning of oneself in discursive practice with multiple persons.*
Intrapersonal Positioning:	Positioning of oneself in discursive practice with oneself.
Linguistic Analysis:	"Analysis that addresses the characteristic uses of language in a speech or text segment, such as the application of grammatical and linguistic forms, the implied speaker and listener positions, and the use of metaphors" (Kvale & Brinkmann, 2009, p.325)
Linguistic Deconstruction:	"The destruction of one understanding of a text and opening for reconstruction of other understandings" (Kvale & Brinkmann, 2009, p.324).
Math Anxiety:	Experiencing an unpleasant/threatening/stressful/apprehensive psychological/physiological reaction resulting from engagement in mathematics (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
Meaning Interpretation:	"Interpretation that goes beyond a structuring of the manifest meanings of what is said to deeper and critical interpretations of the text" (Kvale & Brinkmann, 2009, p.325)
Metacognition:	A sense of consciousness, agency or habits of mind.
Metaphor:	"a figure of rhetoric. An implied comparison between two things of unlike nature that yet have something in common" (Bauer & Gaskell, 2000, p.359).
Mixed Methods:	"…mixed methods research is both a methodology and a method, and it involves collecting, analyzing, and mixing qualitative and quantitative approaches in a single study or a series of studies (Creswell & Plano Clark, in press)" (Creswell et al., 2006, p.1).
Narrative Analysis:	Analysis focusing on the meaning and the linguistic form of texts; it works out plots of interview stories and temporal and social structures" (Kvale & Brinkmann, 2009, p.326).
Nature of Mathematics:	A belief about mathematics being procedural/conceptual, logical/irrational, precise/chaotic, beautiful/dull, intellectually challenging/boring, creative/mundane, concrete/abstract, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of applications (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
Nonproductive Disposition:	Dispositions and positioning that impede facilitation of success and achievement.
Parallel Positioning:	Occupying more than one level of positioning at a time; transphenomenality; level-hopping (Davis, 2005)
Pedagogical Content Knowledge (PCK):	"a teacher's integrated understanding of four components, namely, pedagogy, subject matter content, student characteristics, and the environmental context of learning' (Cochran, et al., 1993, p. 266).

Position:	roles assumed and identities formed by teachers and students in response to, and in order to navigate, academic content, settings, and interactions. Positioning [response] is driven by disposition [location]; position and disposition are fluid and dynamic, dependent on the knowledge construction intertwined in dialogic conversations and codes – cultural, historical and institutional (sTc). Harré (2011) - "…a cluster of rights and duties recognized in a certain social milieu…" (p. ix).; The process (also fluid and dynamic) of situating responses to mathematics discourses and cultures in reaction to, and in order to navigate academic content, settings, and interactions. A person may be positioned or position themselves within a context.
Positioning:	habitual inclination formed by teacher and student in response to and in order to navigate through academic content, settings, and interactions
Productive Disposition:	"The NRC defines a productive disposition toward mathematics as a "habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own efficacy" (p.116)" (Beyers, 2011, p.75).
Purposeful Sampling:	"…selecting in formation-rich cases for study in depth" (Patton, 1990, p.169)
Reflective Theory Didactics:	Considered as a theory of instruction and education, helping "to structure and understand pedagogical practice", or the influence of teacher positioning on the "learners intentional activity" i.e. student's positioning toward mathematics and mathematics learning (Uljens, 1997, p.51-52).
Reform:	"…planned efforts to change schools in order to correct perceived social and educational problems" (Tyack & Cuban, 1995, p.4).
Self-Concept:	One's subjective feelings, ideas, and/or self-perception as a confident/insecure learner/user/knower of mathematics, as well as the ease/difficulty or (dis)comfort that one experiences with mathematics. (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
Semi-structured Interview:	"individual depth interview with a single respondent…" (Bauer & Gaskell, 2000, p.357).
Sensibleness:	A belief that mathematics is (un)reasonable, understandable/confusing, meaningful/meaningless, (dis)connected, etc. (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
State Assessment:	overall percentage score achieved by students linked to the participating teacher during the academic year 2011- 2012academic State assessment data was considered to be outcome data reflective of self-positioning and positioning-by-others.
Stereotype Threat:	The negative stereotype of mathematics is formed through a process of belief systems that are generalized in a limited set of experiences resulting in stereotyping and non-productive positioning towards mathematics and mathematicians (Picker & Berry, 2000, p.87).
Stratified Purposeful Sample	Illustrates characteristics of particular subgroups of interests and facilitates comparison (Patton, 1990)
Survey Research:	"…involves collecting data to test hypotheses or to answer questions about people's opinions on some topic or issue" (Gay, Mills, & Airasian, 2009, p. 175).

Target :	For purposes of third-tier coding, responses will be assigned one of three targets – disposition toward mathematics, disposition toward mathematics teaching, disposition toward mathematics learning.
Teacher-Engineer:	a teacher, who analyses, designs and constructs outcome-based teaching products to provide effective learning environments and experiences for student success (Tchoshanov, 2011); demonstrates pedagogical content knowledge (PCK).
Teacher-Technician:	a teacher who may or may not have content mastery; does not demonstrate integration of pedagogical content knowledge (PCK) into teaching practice including development of effective learning environments which encourage student learning experiences beyond direct instruction.
Thematizing:	"Explicit formulation of the researcher's conceptualization of the subject matter and the purpose of an investigation" (Kvale & Brinkmann, 2009, p.327).
Transform:	Restructuring of educational practice to include consideration of the who, what, and how of educational practice.
Transphenomenality:	pertaining to a process, nature, or realm which cannot be directly experienced using linear approach (Tchoshanov, 2013)
Simultaneity of Transphenomenality:	"…events or phenomena that exist or operate at the same time" (Davis, 2005, p.14)
Usefulness:	A belief about the contribution/detraction of mathematics for meeting current or future need, performance, success, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of practical/impractical applications (Tchoshanov, McDermott, Lynch-Arroyo, 2012).
Worthwhileness:	A value judgment that the time and/or effort spent engaging in mathematics has an intrinsic/extrinsic payoff/penalty leading to increased/decreased interest in mathematics (Tchoshanov, McDermott, Lynch-Arroyo, 2012).

Appendix B – Method of Inquiry

Instructor Version Do *not* put your name on these forms.

Demographic Information

Check one of the following or write response in the space provided:

Gender: Male _____ Female _____Ethnicity: ____

Grade Level(s) Taught: ________Languages Spoken:____

What do you consider your primary language? ____

How many years did you attend school in the United States? _________________________________

How many years have you been teaching?________________ Are you ACP Certified?____________

What is the highest degree you have earned? ___________ Major:___________ Minor:__________

Section I: Questions

Please answer the following questions in the space provided:

1. Would you consider yourself a mathematician?
   Why or why not?
2. Do your fellow math teachers use your ideas in their teaching practice? Explain.
3. In an environment without restrictions, how would you teach math? Explain.
4. Describe a mathematics classroom where students are best able to learn. Explain and give details.

Section II: Metaphor

Please complete the following statements in the space provided:

5. *Mathematics is like….*
   Explain why.
6. *If mathematics were the weather, it would be……*
   Explain why.
7. *If a mathematics classroom were a plant, it would be……*
   Explain why.
8. *If mathematics were a question, it would be……*
   Explain why.
9. *If mathematics were an animal, it would be……*
   Explain why.

Section III: Drawing

Please complete the following drawing and write an explanation in the space provided:

10. Draw your mathematics classroom.
11. Describe what you included in your drawing of your mathematics classroom. Explain.

Thank you for your participation in this survey.

Student Version Do *not* put your name on these forms.

Demographic Information

Check one of the following or write response in the space provided:

Gender: Male _____ Female _____Ethnicity: ____

Grade Level: ________Languages Spoken:____

What do you consider your primary language? ____

Students: How many years have you attended school in the United States? ____________________

Section I: Questions

Please answer the following questions in the space provided:

1. Would you consider yourself a mathematician?
   Why or why not?
2. Students: Does your math teacher use your work as examples for the class? Explain.
3. Students: If you were a mathematics teacher, how would you teach math? Explain.
4. Describe a mathematics classroom where students are best able to learn. Explain and give details.

Section II: Metaphor

Please complete the following statements in the space provided:

5. *Mathematics is like…*
   Explain Why.
6. *If mathematics were the weather, it would be……*
   Explain why.
7. *If a mathematics classroom were a plant, it would be……*
   Explain why.
8. *If mathematics were a question, it would be……*
   Explain why.
9. *If mathematics were an animal, it would be……*
   Explain why.

Section III: Drawing

Please complete the following drawing and write an explanation in the space provided:

10. Draw your mathematics classroom.

11. Describe what you included in your drawing of your mathematics classroom. Explain.

Thank you for your participation in this survey.

Likert-Type Survey Do *not* put your name on these forms.

Demographic Information

Check one of the following or write response in the space provided:

Gender: Male _____ Female _____Ethnicity: ____

Grade Level: ________Languages Spoken:____

What do you consider your primary language?____

Students: How many years have you attended school in the United States? ____________________

On a scale of 1-5, with 1 being "one of the worst" and 5 being "one of the best", how would you position yourself toward *mathematics*?

One of the Worst	Below Average	Average	Above Average	One of the Best
1	**2**	**3**	**4**	**5**

Explain Why:

On a scale of 1-5, with 1 being "one of the worst" and 5 being "one of the best", how would you position yourself toward *mathematics learning*?

One of the Worst	Below Average	Average	Above Average	One of the Best
1	**2**	**3**	**4**	**5**

Explain Why:

On a scale of 1-5, with 1 being "one of the worst" and 5 being "one of the best", how would you position yourself toward *mathematics teaching*?

One of the Worst	Below Average	Average	Above Average	One of the Best
1	**2**	**3**	**4**	**5**

Explain Why:

Semi-Structured Sample Interview Prompts

Thank you for agreeing to be interviewed as part of the survey you completed in the math methods class. I want to reassure you that your responses and identity will be maintained confidentially and will be anonymous to the researchers.

Are you alright with the interview being recorded? Once the tape is transcribed, it will be destroyed.

Interview Questions:

I'm going to show you your response to a question from the first survey and your response to a similar question from the second survey. [Question 5 & question 1]

Do you notice any differences between the two responses? If yes, what do you think contributed to those differences?

Now I'm going to show you another set of questions. Do you notice any differences? If yes, what do you think contributed to those responses? [Question 4 and question 2]

In your response mentioned that *"read quote".* Why do you think inquiry and room to make mistakes are important elements for best learning?

Now I'm going to show you a last set of questions. Do you notice any differences? If yes, what do you think contributed to those responses? [Question 3 and question 3]

In your response mentioned that *"read quote"*. Why is incorporating "real-life scenarios" important to your mathematics teaching?

With respect toward mathematics teaching, you position yourself as above average. Please explain why.

In a paragraph or two, describe the lesson you observed.

Classroom Observation Protocol

Number of Students		Grade level	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE: No value judgment of the teacher is intended.
Modes of Instruction	**Whole class instruction** **Affective Category: Nature of Mathematics**	Discusses topic/concept/principle; not introduction to an activity unless a discussion about what they already know and their experiences	
	Hands-on activities **Affective Category: Nature of Mathematics and Sensibleness**	Using manipulatives to explore, observe, collect data , arrive at solutions	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Modes of Instruction	**Lecture or recitation** **Affective Category: Attitude and Usefulness**	Teacher talks, students listen and may take notes and students answer specific questions teacher asks that usually have one right answer	
	Drill and practice **Affective Category: Attitude and Usefulness**	Similar to recitation but could be seat work where students answer questions on paper; is still drill and practice if students work in groups	
	Reading textbook **Affective Category: Attitude and Usefulness**	Printed material is used to teach mathematics concepts.	
	Teacher demonstration **Affective Category: Self-Concept, Usefulness, and Sensibleness**	Teacher uses manipulatives or technology to demonstrate a concept/principle.	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Modes of Instruction	**Small group discussion** **Affective Category: Nature of Mathematics, Attitude, Worthwhileness and Self-Concept**	Students interact around some topic; may fill in worksheet or data sheet	
	Cooperative group work **Affective Category: Nature of Mathematics, Attitude, and Self-Concept**	Students have specific tasks they do to collaborate with one another in completing an activity/project, etc. ; may involve solving a problem.	
	Math was portrayed as a dynamic body of knowledge **Affective Category:**	enriched by conjecture, investigation analysis, and/or proof/justification	

	Worthwhileness and Sensibleness		
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Modes of Instruction	**degree of "sense-making" of math content** **Affective Category: Nature of Mathematics, Attitude, Sensibleness, and Self-Concept**	appropriate for the developmental levels/needs of the students and the purposes of the lesson; students are making connections between new and existing content knowledge; students are able to reflect on new knowledge	
Assessment	**Uses ongoing embedded assessment** **Affective Category: Nature of Mathematics, Sensibleness, and Usefulness**	Teacher uses methods that provide information to make decisions about next steps in helping students understand; high expectations communicated	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Assessment	**Emphasizes relations to real life** **Affective Category: Usefulness, Worthwhileness, and Attitude**	Teacher relates instruction to something relevant to students or something that exists in the real world of mathematics	
	Circulates among students/student groups asking questions **Affective Category: Nature of Mathematics, Sensibleness, Self-Concept, and Attitude**	Teacher goes from group to group facilitating learning by asking questions, moving their thinking; does not include merely go around the room to "check progress"	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Assessment	**Assesses prior knowledge** **Affective Category: Nature of Mathematics, and Attitude**	Asks students what they already know and understand about the lesson or activity's topic; also adjust lesson if needed	
Effective Questioning	**Knowledge, Comprehension** **Affective Category: Nature of Mathematics, Sensibleness, and Attitude**	Low level questions in Bloom's taxonomy; includes non-instructional procedural and rhetorical (e.g., "Does everyone understand what they are supposed to do?") and input (recall, recognition, factual)	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Effective Questioning	**Application, Synthesis, Analysis, Evaluation**	High level questions in Bloom's taxonomy; includes process questions	

	Affective Category: Nature of Mathematics, Sensibleness, Worthwhileness, and Attitude	(compare contrast, associate – why) and output (evaluate, apply, expand, consider - what if)	
	Inquiry Based Affective Category: Nature of Mathematics, Self-Concept, and Attitude	closed-open ended questions; evidence supported claims teacher talks or student talks; students to students talking; student to teacher talking	
Instructional Strategies	attention to issues of access, equity, and diversity for students Affective Category: Attitude and Usefulness	language-appropriate, "wait time", identified prior conceptions and misconceptions, checking for understanding, re-teaching occurs	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Classroom Climate/Description	Respectful Affective Category: Attitude and Self-Concept	acknowledgment of students' ideas, questions, and contributions; or Teacher as "Sage on the Stage"	
	Discourse: collegial working relationships Affective Category: Attitude and Self-Concept	Student – Student; Teacher-Student; Students are interacting around the lesson or topic. Tolerance of differing points of view.	
	Discourse: procedural working relationships Affective Category: Attitude and Self-Concept	Students asking one another such things as, "What did he say?" or, "Do we answer questions 5 and 6 or just 6?"	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Classroom Climate/Description	Discourse: Active Intellectual Participation Affective Category: Attitude, Self-Concept, and Math Anxiety	Encouraged; valued; 1.students actively and enthusiastically participate in the discussion/activity = during a discussion, students are probably calling out answers and/or engaging one another in some point of discussion such as arguing with one another around an issue; or 2. students are hesitant to enter into the discussion/activity = students do not actively engage in discussion or engage in an activity and are likely only to answer direct questions posed by the teacher. You may see body language that corroborates their reluctance.	
	On Task Behaviors Affective Category: Attitude and Self-Concept	90 - 100% of students are on task for the entire class period	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Classroom Climate/Description	Seating Arrangements Affective Category: Nature of	Describe	

	Mathematics and Attitude		
	Materials Used **Affective Category: Nature of Mathematics, Attitude, Usefulness, and Worthwhileness**	technology; hands-on; textbook; handouts; bulletin boards; special materials or equipment; projector; smartboard; whiteboard;	
Likely Effect of Teacher's Efforts	Student Understanding of Math **Affective Category: Nature of Mathematics, Attitude, Usefulness, Worthwhileness, and Math Anxiety**	application; reasoning; generalization; procedural approach; conceptual approach; rote or comprehension; algorithms or heuristics	
DOMAIN	OBSERVABLE DIMENSION/EVENT	DESCRIPTION/INDICATORS	OBSERVER FIELD NOTES/EVIDENCE
Likely Effect of Teacher's Efforts	Student Self-Confidence **Affective Category: Attitude, Usefulness, Worthwhileness, and Math Anxiety**	demonstrated confidence in "doing" math; active participation with content	
	Student Interest **Affective Category: Attitude, Usefulness, Worthwhileness, and Math Anxiety**	demonstrated enthusiasm, appreciation for math; students are extrinsically and intrinsically motivated to learn mathematics	
Non-Instructional Events Observed	List Events **Affective Category: Attitude**	Impact on Instruction	

Post-Observation Interview Questions	
Did this lesson turn out different from what you planned? If so, in what ways?	
How typical was this lesson for the students?	
What do you think the students learned from this lesson, and what they still need to learn?	
What challenges did you confront in encouraging students to engage in the mathematical discourse?	
What do you plan to do in the next lesson with these students?	

Appendix C – Affective Domain Characteristics

Characteristic	Definition	Examples of Semantic Expressions

Nature of Mathematics	A belief about mathematics being procedural/conceptual, logical/irrational, precise/chaotic, beautiful/dull, intellectually challenging/boring, creative/mundane, concrete/abstract, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of applications.	procedural/conceptual, logical/irrational, precise/chaotic, beautiful/dull, intellectually challenging/boring, creative/mundane, concrete/abstract, computational, algorithmic, rule-based, etc.
Worthwhileness	A value judgment that the time and/or effort spent engaging in mathematics has an intrinsic/extrinsic payoff/penalty leading to increased/decreased interest in mathematics.	Worthwhile, payoff, worthless, etc.
Usefulness	A belief about the contribution/detraction of mathematics for meeting current or future need, performance, success, etc. It also could include the acknowledgement that mathematics plays/does not play a central role in modern culture with its broad/narrow range of practical/impractical applications.	Utility, useful, advantage, serviceable, practical, purposeful, etc.
Sensibleness	A belief that mathematics is (un)reasonable, understandable/confusing, meaningful/meaningless, (dis)connected, etc.	Un/reasonable, ir/rational, un/wise, im/prudent, in/coherent, un/realistic, un/sound, il/logical, etc.
Self-Concept	One's subjective feelings, ideas, and/or self-perception as a confident/insecure learner/user/knower of mathematics, as well as the ease/difficulty or (dis)comfort that one experiences with mathematics.	Confidence, insecurity, comfort, discomfort, easy, hard, difficult, etc.
Attitude	An (un)favorable state of mind/view and/or a positive/negative feeling influencing an emotional (re)action toward a (dis)investment in mathematics.	Like, hate, don't like, love, favorite, least favorite, dis/tasteful, etc.
Anxiety	Experiencing an unpleasant/threatening/stressful/apprehensive psychological/physiological reaction resulting from engagement in mathematics.	Fear, threat, danger, conflict, nervous, apprehension, stress, distress scared, lack of safety, frustration, worry, angst, suffering, agony, misery, grief, anguish, etc.

Appendix D – Cluster Framework

THEMES or CLUSTERS: Affective Disposition Characteristic	**SUB-THEME**	**DEFINITIONS OR LINGUISTIC EXAMPLES**

THEMES or CLUSTERS: Affective Disposition Characteristic	SUB-THEME	DEFINITIONS OR LINGUISTIC EXAMPLES
Nature of Math	Procedural Approach	Basics, step-by-step, in order, sequential, page-by-page, worksheets, textbook, low-level tasks, no hands-on/manipulatives, practice, 'drill and kill'
	Direct Instruction	Reading, giving answers, low-level or closed-ended questions, emphasis on correct answers, minimal explanations, copying, note-taking, memorization, formulaic, rote learning, does not assess prior knowledge, efficient, easy
	Indirect Instruction	Assessing and connecting to prior knowledge, open-ended questions, encourages solution finding, students as teachers/sharing, challenging
	Differentiated Instruction	Group work, cooperative learning, individual attention, multiple methods of explanation, hands-on or manipulatives [kinesthetic], examples, visualization, posters [visual], technology integration, 'fun', processing time
	Teach to the middle	Middle level skills addressed, No real-life connections, no enrichment, no individual attention, little or no technology integration
	Higher Order Thinking Skills	Extension, enrichment, Real-life Connections, high-level or open-ended questions, collaboration, high-level tasks, 'hard and thinking', self-assessment
	Democratic	Tutoring Available, Open discussion
	Structured	Timed, Work Shown, Structured discussion, Everyone Working, Accountability
	Dictatorial	Detention, No Discussion
Worthwhileness	Life Relevance [positive/negative]	High Stakes Testing, Success, Failure, Real-world Connections, enthusiasm, appreciation for math, effort 'counts'
Usefulness	Infinite Learning	Undefined parameters of learning, applicable to other applications, assists
	Finite Learning	Defined parameters of learning, not applicable to other applications, not helpful
Sensibleness	Facilitated Understanding	Error Analysis, Exploration, Discovery
Self-Concept: Teacher	Engineer	Facilitator, Shares knowledge, encourages collaboration, indirect instruction, higher levels of content mastery, resource for other teachers [as requested], enthusiastic, inspires, shows pride
	Technician	Regurgitates information, relies on supports, high

THEMES or CLUSTERS: Affective Disposition Characteristic	SUB-THEME	DEFINITIONS OR LINGUISTIC EXAMPLES
		level of structure required, lower levels of content mastery, not a resource for other teachers [vacuum]
	Novice	Knows little, regurgitates or recites information, indirect instruction, low levels of content mastery, intimidating, Lacks Confidence
Self-Concept: Student	Success	Confident, Good grades, good at math, has skills, fast learner, experts
	Failure	Tentative, Lacks confidence, ‘flunk’, ‘not a math person’, does not have skills, difficult, hard
	Irresolute	Not the best, can’t be perfect, struggle, bored
Attitude	Effective Criticism	Praise, reassurance, help, reinforcement, support, encouragement, approval, compliment, celebrate/applaud, problem solver, love, desire to learn/pay attention, ‘do your best’, enjoy, enthusiastic, gives advice, sense of humor, persuasion
	Sage	Knows all, master of all, gives knowledge, direct instruction, higher levels of content mastery, resource for other teachers [without prompting or request], ‘allows’
	Acknowledgement	Recognition, appreciation, reply, response, recommendation, respect, identification of issues
	Negative Criticism	Flip, disapproval, disparagement, reproach, disgust, faultfinder, reprimand, rebuke, admonish, chide, scold, excuses, hate, anger, no desire to learn/pay attention
Anxiety [examples of provokers or results]	Insecurity	Pressured, sense of fairness questioned, disappointment, pauses, hesitant, little or no elaboration, short answers, nervous
	Threatened	Fear, blame, pressured [self-imposed or externally imposed], “better do”,
	Degradation	Uninspired, discouragement, negative experience, belief that math aptitude is innate

THEMES or CLUSTERS: Affective Disposition Characteristic	SUB-THEME	DEFINITIONS OR LINGUISTIC EXAMPLES
Nature of Math	Procedural Approach	Basics, step-by-step, in order, sequential, page-by-page, worksheets, textbook, low-level tasks

THEMES or CLUSTERS: Affective Disposition Characteristic	**SUB-THEME**	**DEFINITIONS OR LINGUISTIC EXAMPLES**
	Direct Instruction	**Reading, giving answers, low-level or closed-ended questions, emphasis on correct answers, explanations, copying, note-taking, memorization, formulaic**
	Indirect Instruction	**Assessing and connecting to prior knowledge, open-ended questions**
	Differentiated Instruction	**Group work, individual attention, hands-on or manipulatives [kinesthetic], examples, visualization, posters [visual], technology integration**
	Teach to the middle	**Middle level skills addressed**
	Higher Order Thinking Skills	**Extension, enrichment, Real-life Connections, high-level or open-ended questions, collaboration, high-level tasks**
	Democratic	**Tutoring, Open discussion**
	Structured	**Timed, Work Shown, Structured discussion**
	Dictatorial	**Detention, No Discussion**
Worthwhileness	**Life Applications**	**High Stakes Testing, Success, Failure, Real-world Connections, enthusiasm**
Usefulness	**Infinite Learning**	**Undefined parameters of learning**
	Finite Learning	**Defined parameters of learning**
Sensibleness	**Facilitated Understanding**	**Error Analysis; Logical; connections**
Self-Concept: Teacher	**Engineer**	**Facilitator, Shares knowledge, encourages collaboration, indirect instruction, higher levels of content mastery, resource for other teachers [as requested], enthusiastic**
	Technician	**Regurgitates information, relies on supports, high level of structure required, lower levels of content mastery, not a resource for other teachers [vacuum]**
	Novice	**Knows little, regurgitates or recites information, indirect instruction, low levels of content mastery**
Self-Concept: Student	**Success**	**Confident, Good grades, good at math, has skills**
	Failure	**Tentative, Lacks confidence, 'flunk', 'not a math person', does not have skills**
Attitude	**Effective Criticism**	**Praise, reassurance, help, reinforcement, support,**

THEMES or CLUSTERS: Affective Disposition Characteristic	SUB-THEME	DEFINITIONS OR LINGUISTIC EXAMPLES
		encouragement, approval, compliment, celebrate/applaud, problem solver, love
	Sage	**Knows all, master of all, gives knowledge, direct instruction, higher levels of content mastery, resource for other teachers [without prompting or request]**
	Acknowledgement	**Recognition, appreciation, reply, response, recommendation, respect, identification of issues**
	Negative Criticism	**Flip, disapproval, disparagement, reproach, disgust, faultfinder, reprimand, rebuke, admonish, chide, scold, excuses, hate, anger**
Anxiety [examples of provokers or results]	**Insecurity**	**Pressured, sense of fairness questioned, disappointment,**
	Threatened	**Fear, blame, pressured [self-imposed or externally imposed], "better do",**
	Degradation	**Uninspired, discouragement, negative experience, innate [have to be born with math skills]**

Appendix E – Sample Cluster Coding

THEMES or Clusters: Affective Disposition Characteristic	SUB-THEME	FREQUENCY of SEMANTIC REFERENCES [all data sources]			
		Productive Teacher	Productive Student	Neutral Student	Non-Productive Student
Nature of Math	Procedural Approach	33	6	2	2
	Direct Instruction	20	6	0	1
	Indirect Instruction	0	0	1	0
	Differentiated Instruction	17	2	6	5
	Teach to the middle	28	0	0	0
	Higher Order Thinking Skills	0	0	2	0
	Democratic	0	0	0	1
	Structured	9	0	2	0
	Dictatorial	8	0	0	2
Worthwhileness	Life Relevance [positive/negative]	1 – 2 = -1 + 1 = 0 – 3 = -3	0	1	0
Usefulness	Infinite Learning	0	0	0	0
	Finite Learning	1	0	0	0
Sensibleness	Facilitated Understanding	0	0	0	0
Self-Concept: Teacher	Engineer	3	1	No references	No references
	Technician	4	2	No references	No references
	Novice	0	No references	No references	No references
Self-Concept: Student	Success	1	9	3	2
	Failure	1	1	1	8
	Irresolute	0	2	3	0
Attitude	Effective Criticism	0	1	5	0
	Sage	16	No references	No references	No references
	Acknowledgement	8	1	0	0
	Negative Criticism	5	0	0	5
Anxiety [examples of provokers or results]	Insecurity	0	0	3	1
	Threatened	8	0	0	1
	Degradation	2	0	0	1

Appendix F - Sample Linguistic Deconstruction

	Mathematics		Mathematics Teaching		Mathematics Learning	
Themes: Affective Disposition Characteristics	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**
Nature of Mathematics	**S:** Mathematics is like… a circle - Never ending but basic in nature **I:** I loved starting from one point and having nothing to fall upon except my brains and wits and paper and coming to a conclusion at the end.		**I:** what I do every day in the classroom. Again its collaboration and life experience. **S:** I would teach math in a small group setting with a much lower teacher to student ratio. I would not teach directly to a standardized test and I would base instruction on individual needs rather than the whole class needs. **I:**… asked a lot of questions and he gave a lot of answers and he encouraged us to think I: …not that the professors didn't know math. They didn't know how to teach math to students. **I:** clear that the professor knew what they were doing. They'd get up there and write 3 blackboards full and then go see you're done. Okay now try the next 15 problems. And you just absolutely have no idea what they did from step 1 to step 50. Because they're doing it, they know how to do it, they're just going step-by-step-by-step and they're assuming because they know how to do it you know how to do it.	**CO:** Not really high level questions. **CO:** encouraged them to read questions and instructions. **FN:** Reads questions, shows book, shows reasoning, continues reading questions and the correct responses. Gives answers while providing explanation. Asks why next question is "weird" and reiterates why it is important to read labels on graphs. Sometimes gives reasoning… **FN**: explains that she is going to collect data from the students and do this kind of graph because it is faster/more accurate than listing all data in order. **FN:** Gives answers while providing explanations. Asking students to provide key words [to check for student comprehension]. **FN:** Walks around and gives direct instruction to student groups, gives advice on how they can do the work the most efficiently. **FN:** constantly moving, she can gauge what the misconceptions and issues are **FN**: You had to	**I:** everybody's working together **I:** you can group people strategically so you can have some highs and some lows and they can help each other out and you're more available um you know to help everybody. I: safe learning environment. **I:** take grades off the table I: if they correct it they can earn all the points back. If they don't do well on a test, they can correct it and earn half the points back. **S:** "Small!!! Group setting with lots of collaboration. Student driven with peer interaction and input" **L**: I feel that math is essential and that without good instruction our kids will not be successful learners. **I:** they need the good instruction to be successful learners and good instruction could be tied back to this best way for kids to learn math **I:** I guess some aha moments and really starting to love mathematics **I**: its collaboration all over the place **I:** positive learning	**FN**: Students know expectations **CO**: Asked to make conjectures about data analysis **CO:** Students have specific tasks they do to collaborate with one another in completing an activity/project, etc. **CO**: : Closed-ended questions… likely only to answer direct questions **CO**: 90-100% of students are on task for the entire class period **CO:** demonstrated confidence in "doing" math; active participation with content

Themes: Affective Disposition Characteristics	Mathematics		Mathematics Teaching		Mathematics Learning	
	Self-Reported	Observed	Self-Reported	Observed	Self-Reported	Observed
			I: pairing them up you know using strategies, if it means teachers working collaboratively to come up with the best teaching practices, **I**: nobody tell me what to do. That's best case scenario for me no testing, small groups, you know teach what you know they need to know, um you know take 5 days on something that should only take one day if they need the 5 days. I: I'm not going to do the same thing every year – you know it's that constant evolving. I: . Best instruction is going to be when everybody is working together	manipulate the formula to get this, right?" "I'm giving you answers and it's no points if there's no work associated with it FN: Focus more on follow-up questions. Each group gets individual attention.	environment. Which means everybody is working all the time, you know, good, bad, and ugly, but everybody's working together to make sure that these students are successful. **I:** encourage them to make the mistakes because I believe that the learning is really in the mistakes. You know if you know how to do something you not really learning something. If you make mistakes and then aren't willing to correct them or see the mistake then it's a mistake and you're not going to benefit from it.	
Worthwhileness						
Usefulness						
Sensibleness			**I**: find one okay that they are slow enough or at least taking a little bit more time that they will give me the opportunity then go spend hours in tutoring or than teaching myself how to do it.			
Self-Concept			**L:** I am confident in my teaching skills and I feel that my love of the subject makes me a good teacher. I am also very willing to tweak my teaching style to	**FN:** "If you screwed this up then you weren't paying attention"	**I:** I had enough of a background and liked it enough to at least to stick with it. **I:** it forces you to just let those kids fall by the wayside because you only have time to focus	

	Mathematics		Mathematics Teaching		Mathematics Learning	
Themes: Affective Disposition Characteristics	Self-Reported	Observed	Self-Reported	Observed	Self-Reported	Observed
			suit the needs of my students which makes me flexible. I am not afraid to learn along side with my students and this encourages and facilitates a positive learning environment. **I:**… even I had to go to tutoring. I had to find some people that were helpful and could explain and tweak it in a way that I could understand it. **I:** Just because you say it's so doesn't mean that people understand why it's so. **I:** its spreading yourself too thin; you can't be everywhere and everything to everybody. **I:** constantly evolve, I'm not afraid of making mistakes I'm not set in my ways. So I believe that in and of itself, just that philosophy probably makes me one of the better teachers I: I'm giving 150% every day **I:** gets you in a position where everybody better teach the same thing, the same way the same day and then to me that takes away all the individualness of each of us **I:** I've been doing this long enough and I'm good enough at knowing what I		on that group of kids that you're really going to be able to get to pass, and you know show improvement. You don't have time to pick up the pieces on the ground… **I:** makes me fantastic because I've opened up the possibility that they could go on with confidence and learn	

	Mathematics		Mathematics Teaching		Mathematics Learning	
Themes: Affective Disposition Characteristics	Self-Reported	Observed	Self-Reported	Observed	Self-Reported	Observed
			need to do to get to where I need to be			
Attitude	**L:** I have a natural love of math and feel I have a lot to offer as a math teacher. I want to instill that love of math. **I:** math is like - I got to pick what it was like. I picked what it was like with the ending in mind. I already knew what I wanted to put so then I manipulated it into what I wanted it to be. "I have a natural love for math and feel that I have a lot to offer as a math teacher. I want to instill that love of math."		**I: ,** I knew I wanted to be a math teacher **I:** …was just a friendly, friendly man.. who just…you know he didn't get mad if you did something wrong. He was very encouraging and it just his personality and his connections with the kids. **I:** just because you know what you're doing doesn't mean you can teach what you're doing. **I:** they couldn't teach what they knew **I:** If you could teach it to yourself then you wouldn't have to take classes. **I:** just because you know the content that you can teach someone else how to do it. **I:** make sure that the kids are doing what they're supposed to be doing. **I:** classes are too big it's babysitting **I:** putting the emphasis on the wrong things. The emphasis ought to be on the learning daily the things that you need to learn. **I:** With the standardized test comes the paperwork and comes all of the it you know it just seems like a lot of	**FN:** "You're just copying data. I don't know! Count it! Are you seeing what we're supposed to be doing?" **FN:** "Why do you think they put bolded instructions in front of a problem? So you could ignore them?" **FN:** Question to student not on task: "About 3 seconds away from a lunch detention" **FN:** "Class set. What does that mean? Don't write on it!" Repeats multiple times. "Plenty of time because this is so easy' "I don't care what you meant to write. What you write is the answer" "I don't know why you're not working on your fix-its?" "You want more to do in five minutes? **FN:** "If you don't have a formula chart, it's because you lost it. 4 minutes, let's go!"	I: loving the class… really liking what I was doing. **I:** huge classes and you're talking about 60 minutes you can't get everybody. **I:** only people you're really getting are the ones in the middle. The high learners are doing their own thing and the low, super low learners are on their own because you can't you know you're spending a lot of time with the kids you can help in the middle. So you get fallout on the top and fallout on the bottom. Can't be helped, but that's what happens when classes are too big. **I:** encourage them to make the mistakes… not to fail by failing, **I:** some of the things they want our kids to do per grade are ridiculous. **I:** you look at the standardized testing and you look at the percentage they need to pass… That's not real life, what kind of standardized test is that? **I:** if we're thrilled to be above 44%, there's something wrong overall with either with the	**FN:** Continues making demands and giving orders **CO:** lack of tolerance for incorrect responses (I interpreted those kinds of responses to slowing things down) **CO**: demonstrated enthusiasm -Not sure, seemed like they just wanted to keep up

	Mathematics		Mathematics Teaching		Mathematics Learning	
Themes: Affective Disposition Characteristics	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**
			stuff that has nothing to do with teaching. **I**: most of the time I love that part of my job. I love the shutting the door and having you know maybe the 6 minutes that I'm allowed to do what I want to do the way I want to do it **I:** some days I love it some days I don't.		standards or the standardized testing… **I:** it doesn't do anybody any good to know that there is a test at the end of the year and then do nothing but teach to the test, that's all the kids do, the minute they take their test they're done, they shut down. **I:** we're only focusing on a particular group of kids, the ones in the middle, the average kids; **I:** You've lost the really low end remedial kids… they're never going to pass… You know they're never going to show huge growth. And you're really kind of losing the upper end **I**: it's really important for me to instill that love. And even if the kids leave and have learned nothing, they will say "wow I don't hate math" "wow I didn't think I could do math". **I:** safe learning environment. And the biggest way you accomplish that is to take grades off the table.	
Anxiety			**I:**… they'd give you assignments and they put some notes on the board and if you could decipher and work your		**I:** and my teaching practice is I'm really am not going to penalize kids for mistakes… takes the fear of getting a bad	

	Mathematics		Mathematics Teaching		Mathematics Learning	
Themes: Affective Disposition Characteristics	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**	**Self-Reported**	**Observed**
			way through than you could, if not they were dropping like flies **I:** every teacher's nemesis you know the standardized test… tremendous pressure to the teachers… can't guarantee that my kids are going to pass the test unless I take it for them. **I:** If they're not going to do well, they're not going to do well. So, I don't feel like I should be held accountable for that. **I:** we're doing what we need to be doing every day. And the idea that one test is going to hold everybody accountable I think is ridiculous. Um, not everybody tests well.		grade. **I:** my math classes at UXYZ…. Terrible **I:** my class is really all about hoping if they have shut down to open them back up or to at least open them to the possibility that "I don't have to hate math, I don't have to be afraid of math	
Notes on Classroom Drawing					"Groups and/or pairs of students working together. My desk which is in the front corner because it is not the focal point of the classroom. Groups and pairs of students desks because my class is student-centered with collaborative groups	Drawing included groups of desks in 4 and a teacher's desk

Appendix G – Mean Rating Data

Geographic School Area	Participant Code	Gender	Ethnicity	Years Teaching	n(students)	Delphi Teacher Rating	Mean Student Rating	Overall Student Rating Distribution			2012 STAAR
								5.00-4.00	3.00	2.00-1.00	
Northeast	045-045	F	Wh.	7	23	3.33	2.8	11	9	3	71.81%
Northeast	045-046	M	Wh.	8	12	3.33	3.28	3	4	5	61.28%
Northeast	045-047	F	Cau.	2	24	3	3.43	7	6	11	53.33%
Northeast	045-048	F	Hisp	7	17	3.33	2.65	5	5	7	52.70%
Northeast	045-049	F	Hisp	5	21	4	2.75	8	10	3	55.27%
Northeast	045-052	F	Hisp	1	13	4	3.85	7	4	5	50.63%
Northeast	045-053	F	n.a.	5	23	3.67	3.45	7	4	12	49.80%
Northeast	047-035	F	Afr. Amer	14	21	3.67	3.3	11	5	5	55.14%
Northeast	048-099	M	Cauc	13	20	4.33	2.82	13	6	1	64.41%
Northeast	048-175	F	Hisp	n.a.	23	3.33	3.06	11	8	4	59.70%
Central	052-001	F	Hisp	17	25	3.67	3.4	11	13	1	56.53%
Central	052-004	M	n.a.	10	10	3.67	3.36	5	3	2	52.53%
Central	052-006	F	Wh	23	25	3.33	3.3	13	4	8	83.47%
West	053-140	F	Hisp	8	23	3	3.65	13	8	2	82.65%
West	053-142	F	Wh	5	21	4	3.13	18	1	2	63.81%
West	**053-144**	**F**	**Wh**	**20**	**12**	**2.67**	**2.58**	**3**	**3**	**6**	**66.50%**
West	053-145	F	Wh	5	23	3.67	4	9	9	5	74.80%
West	053-146	M	Hisp	10	24	3.67	3.25	12	6	6	58.94%
West	053-148	F	Wh	18	24	3.67	2.83	12	6	6	64.07%
West	**053-149**	**F**	**Hisp**	**34**	**23**	**3.33**	**3.19**	**10**	**6**	**7**	**52.18%**
West	056-022	F	Hisp	n.a	16	3.67	3.42	7	3	6	57.09%
	N= 21			Mean(20) = 10.7	423	3.54	3.21428571				

n students adjusted for linked teacher deleted - unable to rate (lack of response)

Curriculum Vita

Ruby Lynch-Arroyo earned her Bachelor of Arts degree in Sociology and Social Work from New Mexico State University. Subsequently, she earned a Masters of Public Administration from the University of New Mexico. Ms. Arroyo entered the University of Texas at El Paso doctoral program, Teaching, Learning and Culture, in the Teacher Education Department and pursued the Mathematics, Science and Technology strand. Under the guidance of Dr. Mourat Tchoshanov and Dr. Olga Kosheleva, she pursued many academic endeavors including teaching high school students mathematics in UTEP's Project Best summer program which was recognized by the Texas Higher Education Coordinating Board for significant improvement in mathematics scores. Ms. Arroyo has presented her research at numerous conferences including the North American Psychology of Mathematics Education Conference and the Society for Information Technology and Teacher Education Conference in 2012. In collaboration with Dr. Tchoshanov, Pre-service elementary teachers' affective disposition toward mathematics is published in Development of creative abilities of students: In the context of implementation of federal state educational standards of new generation (V. Gabdulhakov, Ed.), Kazan, Russia: The National Book Center. While pursuing her degree, Ms. Arroyo taught as an undergraduate instructor, part-time faculty in the Math Education Department, with UTEP and occupies the position of Administrator of Campus Support with El Paso Independent School District.

Permanent Address: P.O. Box 445

Santa Teresa, New Mexico 88008

rllynch@miners.utep.edu