

A GROUNDED THEORY INQUIRY INTO THE PEDAGOGICAL SOCIALIZATION
OF GRADUATE STUDENTS WITHIN GRADUATE QUANTITATIVE METHODS
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ABSTRACT

Quantitative methods are one of the most highly technical fields of study within social sciences graduate programs. Although classroom pedagogy is an important factor connected to student success within graduate quantitative methods courses little is known on the pedagogical socialization experiences of masters and doctoral students. The purpose of this grounded theory inquiry was to discover graduate students perspectives on their pedagogical socialization experiences and the norms, values and role expectations transmitted during the teaching and learning of quantitative methods. Narrative data was collected from in-depth interviews among a theoretical sample of 31 masters and doctoral students enrolled in introductory, cognate or specialization quantitative methods courses in the United States. Interview data was digitally codified and analyzed in NVivo v. 12 using open, substantive, and theoretical strategies, memoing and the constant comparison method.

A process theory of pedagogical socialization was discovered during this investigation. Graduate students experience pedagogical socialization as a combination of transactional and transformational teaching and learning modalities which constrain and enable their learning, understanding and mastery of quantitative methods. Findings indicate that the process of pedagogical socialization within graduate quantitative

methods courses influence graduate students professional identity development based on their ontological understanding of quantitative methods, themselves as graduate quantitative methods students and quantitative methods courses as an ontological thought space. Recommendations for updating the Technological, Pedagogical and Content Knowledge (TPACK) framework, re-structuring graduate quantitative methods learning environments and improving faculty's pedagogical practices using growth oriented and Justice, Equity, Diversity and Inclusion (JEDI) frameworks are discussed.

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CHAPTER ONE

Background to the Study

Throughout my undergraduate, Masters and Doctoral career, enrollment and completion of Quantitative Methods Courses (QMC) has always been a requirement for achievement of my social sciences degrees. While I have never viewed Quantitative Methods (QM) as overly challenging, when I reflect upon my time spent within my QMC I recognized that specific, values, norms and expectations were connected to students, faculty, and the learning environment within quantitative methods classrooms. I enjoyed some QMC and struggled through others. I encountered ineffective and on occasion exceptional pedagogy. I lived through welcoming and supportive but also unwelcoming and fiercely competitive classroom climates. I wished some QMC would never end, while I counted down the weeks towards the completion of others. Despite having multiple faculties, at different institutions, using a variety of pedagogical approaches, at all levels of the higher education sequence my experiences persisted.

As I progressed through my Doctoral coursework it became increasingly apparent that these dynamics occurred during lectures, classroom discussions, consultations with faculty and while completing individual and group assignments. It is only when I moved into the Dissertation phase of my Doctoral career that I seriously wondered about the

extent this variation connected to my experiences were more than due to chance. I needed to know whether these circumstances were indicative of an underlying socialization process associated with the teaching and learning of quantitative methods.

Even when I transitioned into my professional roles as a graduate teaching and research assistant and undergraduate QM faculty, I found that many of my colleagues and students anticipated that I would perpetuate many of these norms, values, and expectations pedagogically. Although I felt and lived through these dynamics, I was never able to name them. When I looked to the literature for guidance to make sense of my experiences, I found an absence of scholarship on the process of pedagogical socialization for masters and doctoral QM students.

While I recognize that every student's experience is unique, at its core my Dissertation is intended to theorize about graduate students shared and diverse lived experiences within their GQMC. Most of the three million students projected to enroll in graduate programs in the United States (US) (National Center for Education Statistics NCES, 2020) by 2028, are expected to participate in at least one QMC. This anticipated increase in student enrollment and the designation of QM as a required component of graduate education, calls for a well-thought-out re-evaluation of teaching and learning within Graduate Quantitative Methods Courses (GQMC). Therefore, my grounded theory inquiry into the pedagogical socialization experiences of GQMS is timely and necessary.

Introduction

What is Pedagogical Socialization?

Pedagogy is the art, science, and profession of teaching (Meriam Webster, 2019). It transcends teaching as a standalone endeavor and encompasses the judgements, choices and beliefs, instructors use to inform teaching and learning (Breault & Breault, 2010). Socialization is the process whereby historical, socio- cultural, emotional, and personal factors influence an “individual’s endorsement of the rules, roles and values needed for membership within a social group” (Grusec & Hastings, 2015, preface xi). When taken together both definitions provide a backdrop into pedagogical socialization as a process by which teachers and students exist as an interdependent social group, transmitting norms, values and expectations during teaching and learning. For graduate students, this pedagogical socialization process is also nested within higher education institutions, academic departments, curriculum, syllabi, course content, and routine class times. As a result, unpacking these relational and contextual dynamics are important for understanding graduate students’ experiences with the teaching and learning of Quantitative Methods (QM) within GQMC.

Why Graduate Quantitative Methods Courses?

Quantitative Methods (QM) are a cross disciplinary collection of systematic and numerically driven approaches to data collection, analysis, and interpretation. In the social sciences Graduate Quantitative Methods Courses (GQMC) are regularly scheduled classes and seminars within master’s and doctoral programs, based on the teaching and

learning of QM for analyzing complex differences and relationships between variables, measurement (e.g., psychometrics, classical test theory, item response theory) and statistical modelling (e.g., structural equation, hierarchical and latent growth) (Counsell, Cribbie & Harlow, 2017). QM also includes data sciences (e.g., machine learning, artificial intelligence, and data mining) and the use of analytic methods to decipher meaningful patterns within large digital datasets (Corea, 2018).

Classroom pedagogy is one of the most important factors which contributes to graduate students learning and understanding of QM (Nind, Holmes, Insenga, Lewthwaite & Sutton, 2019). Graduate students enrolled in master's and doctoral programs are exposed to pedagogy within GQMC for compulsory degree requirements, a cognate or core specialization in QM. Introductory QMC are general prerequisites for graduate degree completion. Introductory courses also serve as entry requirements for intermediate and advanced QMC (O'Connell, 2002). A cognate provides a research-based complement for graduate students to acquire additional quantitative knowledge and skills from scholars with different backgrounds (Christensen, Gibson & Vernon, 2010). A core concentration exposes students to mono-disciplinary training and a specialized curriculum for advanced proficiency in theoretical and applied QM. Throughout my Dissertation I collectively refer to students pursuing any of these three options as GQMS.

Completion of these courses implies students have participated in activities supportive of applied competencies in QM. Graduate students are expected to demonstrate proficiency within QMC by attending lectures, following course

requirements, reading recommended materials, mastering data analysis software, participating in group discussions, and maintaining high levels of faculty engagement (Gelman, 2005; Hicks & Irizarry, 2018). Indicators of student success includes completion of all assignments, achieving a passing grade and the transformation of coursework into presentations and publications, (Kainz, Jensen & Zimmerman, 2018; Weidman & Stein, 2003). A master's thesis or doctoral dissertation is the final stage of graduate programs reflective of a student's capability to apply skills learnt within QMC. The ability to secure Research and Development (R&D) funding to improve systems and services is an additional outcome metric attached to the pedagogy and training students receive within their quantitative courses (Hather, Haynes, Higdon, Kolker, Stewart, Meyer, Ozedemir, Smith, van Belle, Wooley & Kolker, 2010).

In institutions within the United States and around the world there is substantial evidence of a growing demand but limited supply of trained professionals in theoretical and applied QM. This has brought about an almost ubiquitous expectation that the GQMS enrolled in introductory, cognate, and specialization courses will fill this expanding gap for informed consumers, faculty, researchers, consultants, and practitioners of QM (Brown, 2017; Cook, Watson & Vougas, 2018).

Problem Statement

Although Quantitative Methods (QM) is one of the oldest disciplines taught within higher education institutions in the US (Peden & Carroll, 2009) “insufficient attention has been paid to the pedagogy of advanced methodological learning in the

social sciences” (Nind, et al. 2019, p. 12). In order to address the absence of unified pedagogical standards within QM classrooms (Garner, Wagner and Kawulich, 2009), the American Statistical Association (ASA) (2016) endorsed the Guidelines for Assessment and Instruction in Statistical Education (GAISE). The GAISE outlined six recommendations for creating optimal QM learning environments which included (ASA, 2016):

1. The teaching of statistical thinking
2. Development of a conceptual understanding of statistics
3. Integration and contextualization of data
4. Student engagement during teaching
5. Emphases on technologically driven approaches
6. Utilization of valid assessments to evaluate student learning.

While these strategies are useful for the teaching and learning of undergraduate QM, it contains no recommendations specifically for graduate students and faculty. Although all six recommendations point towards highly technical content and skills as the focal point of QMC (Nind et al. 2019; Johnson & Dasgupta, 2005), the social norms, values and expectations transmitted while teaching QM have not received explicit attention.

Scholars reporting on research methods courses have cited difficulties in pinning down the socialization practices which informs the pedagogical approaches used to direct methodological learning (Nind, 2020; Nind, Kilburn & Wiles, 2015). Researchers have pointed towards a lack of faculty consideration when graduate students are unable to

grasp the departmental culture, norms, values and role expectations related to QM teaching and learning (Ross, Dennis, Zhao & Li, 2017). For these reasons additional inquiry is needed to define the pedagogical nuances connected to GQMC and specify the ways QM pedagogy fails to connect with the larger needs and goals of graduate students (Daniel, 2018).

In order to open up pedagogical socialization as a minimally understood process, I will address methodological gaps in the socialization research, such as the absence of substantive theory, conceptual models, and qualitative research approaches (Spera & Matto, 2007; Vancouver & Warren, 2012). Grounded theory emerged as the most suitable qualitative research design for meeting these gaps because it is an inductive approach which enables social scientists to develop theories from empirical data which capture complex social phenomenon (Glaser & Strauss, 1965; Glaser & Strauss, 1967).

Purpose of the Study

My research is intended as an exploratory study into the personal, historical, relational and, contextually driven factors which influence the pedagogical socialization of Graduate Quantitative Methods Students (GQMS). I combined classical and updated grounded theory methodologies, methods, outcomes and interpretation strategies, to conceptualize, interpret and describe graduate students' lived experiences within their Graduate Quantitative Methods Courses (GQMC). I selected grounded theory as the most suitable qualitative design for finding answers to the three research questions I developed to guide my inquiry:

1. How do graduate students describe and understand the process of pedagogical socialization they experienced within their graduate quantitative methods courses?
2. What are graduate students' perceptions about the recurring patterns of interaction between themselves and graduate quantitative methods faculty?
3. What are the underlying dimensions of a process theory which captures graduate students' pedagogical socialization experiences within graduate quantitative methods courses?

Overview of my Grounded Theory Research Design

Grounded theory is a qualitative research design based on the inductive discovery of theory from data (Glaser & Strauss, 1967). I uncovered a process theory of pedagogical socialization based upon masters and doctoral students' narratives on their experiences within their introductory, cognate and specialization QMC. Using a combination of theoretical, chain referral and maximum variation sampling strategies, I recruited a heterogenous sample of 31 GQMS attending private and public higher education institutions in the US. I conducted one in-depth and one follow-up interview with participants using the Zoom Video Communications Software (Zoom Video Communications Inc, 2021).

I digitized most of my data management and analysis procedures within the Qualitative Data Analysis Software (QDAS), NVivo v. 12 (QSR International Pty Ltd, 2020). I applied open, substantive, and theoretical coding strategies and further analyzed my data using constant comparison techniques. I used my codified and memoed data to

develop relevant concepts, categories, properties, and propositions. My application of these rigorous methodological approaches led to the development of a grounded theory of pedagogical socialization which makes an original contribution to the QM pedagogical literature and adds to already existing scholarship (Glaser, 1998). The empirical viability of my theory is based on my transformation of students' personal accounts into a well codified set of categories, subcategories, properties and propositions which capture recurring patterns of "beneficial and problematic behavior" students experienced within their GQMC (Glaser & Strauss, 1967, p. 31). In Chapter three, I fully discussed the grounded theory research design I developed to guide my research.

Definition of Terms

In this section I present the conceptual definitions guiding the modes of inquiry I applied during my research.

A **Graduate Student** is someone who has completed a bachelor's degree and is pursuing post-baccalaureate education within a graduate school that confers a Masters' or Doctoral degree upon completion of that program of study (Education USA, 2020).

Graduate Quantitative Methods Classrooms are the virtual or physical spaces where quantitative methods teaching, training, and learning occurs.

Graduate Quantitative Methods Courses are programs of study which offer introductory, intermediate, and advanced training in quantitative data collection, analyses, and interpretation. These courses are situated within master's or doctoral

programs as compulsory, cognate or specialized options that are for credit and applicable to different fields of study in the social sciences.

Graduate Quantitative Methods Faculty are the academic staff within a graduate school who teach quantitative methods within introductory, cognate or specialization quantitative methods courses. Graduate quantitative methods faculty may include full, associate, assistant and adjunct professors, and instructors.

Graduate Quantitative Methods Student is a graduate student enrolled in master's or doctoral programs pursuing introductory quantitative methods courses, a cognate or core specialization in quantitative methods.

Grounded Theory Research Design are the collection of methodologies, methods, outcomes, and interpretation strategies I used to develop a substantive process theory on the pedagogical socialization experiences of graduate students within graduate quantitative methods courses.

Pedagogy is the art, science, and profession of teaching oriented towards achieving social goals using different instructional modalities within specific learning contexts (Hinchliffe, 2000; Meriam Webster, 2019).

Pedagogical socialization occurs when the historical, demographic, socio- cultural, emotional, cognitive, and personal characteristics of teachers and students reinforce specific values, norms, expectations and attitude orientations during teaching and learning (Grusec & Hastings, 2015).

Socialization is the range of activities which influence an individual's endorsement of the values, norms, roles, expectations, and attitude orientations needed for membership within social groups (Grusec & Hastings, 2015).

Study Significance

Between 2009- 2019 the Council of Graduate Schools (CGS) enrollment data illustrated the trending up of first generation, Black, Latinx, low income, international and female students, achieving masters and doctoral degrees in the social sciences (CGS, 2021; Okahana, Zhou & Gao, 2020). During this decade, a steep decline in face-to-face teaching also coincided with an increase in web based synchronous and asynchronous teaching modalities (Lederman, 2018; Goodman, Melkers & Pallais, 2019) and the increasing importance of big data and analytics for QM (Hwang & Ryan, 2019; Megahed & Jones- Farmer, 2015). These changeovers to a more diverse, 21st century, data driven educational landscape necessitates reform of 20th century pedagogy to embrace more inclusive, innovative, and responsive strategies (Pineault, Patridge & Bierstead, 2021). Graduate Quantitative Methods Students (GQMS) and Graduate Quantitative Methods Faculty (GQMF) are the primary audience intended for my work because both exist as the stakeholders most affected by these changing dynamics within Graduate Quantitative Methods Courses (GQMC).

The importance of generating an inductive process theory of pedagogical socialization lies in its “subsequent use and effectiveness in research and application” (Glaser & Strauss, 1970 p.188). Valuable outcomes such as lower attrition rates (Sithole,

Chiyaka, McCarthy, Mupinga, Bucklein & Kibirige, 2017; Lott, Gardener & Powers, 2009) more students thriving within identity affirming QM classrooms (Singer, Montgomery & Schmoll, 2020), greater representation of women and students of color (Porter, Posselt, Reyes, Slay & Kamimura, 2018), and responsive pedagogical decisions and curriculum design (Danowitz & Tuitt, 2011; Tuitt, 2003; Srinivasa & Kurni, 2021) are all linked to the application of inclusive and innovative pedagogies within graduate courses. Consequently, I will use my dissertation findings to provide recommendations for an inventive re-structuring of the QM teaching and learning environment to secure similar outcomes for graduate faculty and students within GQMC.

Improving Outcomes for Graduate Quantitative Methods Students

In the face of increasing graduate student dissatisfaction with GQMC, building scholarship which prioritizes their common struggles is essential (Daniel, 2018; Glaser, 1998). Providing greater clarification of the pedagogical socialization process will lead to a better understanding of the dynamics which enable and constrain more meaningful forms of student participation and success within GQMC. My work provides robust evidence to help students and faculty to look past content as the most significant predictor of achievement to the values, norms and expectations connected to participation within GQMC.

My grounded theory of pedagogical socialization provides valuable information that masters, and doctoral students can suggest to faculty, QM advisors, departmental Chairs, and professional organizations such as the ASA for creating and sustaining

learning environments more supportive of their professional aspirations and identities (Chen & Yiao, 2015; Garner et al. 2009). Since the pedagogy of GQMF extends well beyond graduate classrooms and into students professional careers, pedagogical improvements will provide progressive steps for helping students fulfil future roles as faculty (Harris, 2020; Weidman & Stein, 2003), consultants (Chance, 2002); skilled researchers (Gliner, Leech & Morgan, 2016; Karpov, 2016), applied practitioners (Duran & Allen, 2019), replicators (Mayo 2021; Smith, Yu & Schmid, 2021), critical consumers (Coughlan, Cronin & Ryan, 2007; Gould, Wild, Baglin, McNamara, Ridgway, & McConway, 2018) and policy makers.

Reforming Faculty Pedagogy

There is a growing body of research calling for reform of graduate faculty's pedagogical practices (Gunn, 2017; White & Gorad, 2017). Higher education institutions are seeking to recruit and retain faculty more amenable to using inclusive and culturally engaging pedagogical strategies to facilitate learning within increasingly diverse and culturally engaging classrooms (Tuitt, et al. 2018; Museus, Yi, & Saelua, 2017). Having an in-depth knowledge of pedagogical socialization could facilitate faculty transitioning towards a more reflexive praxis to “improve what one does, to develop and grow or to find new ways of thinking and doing” (Coughlan & Brydon- Miller 2014, p. 675).

My work provides a crucial starting point for faculty's reconsideration of how to improve their pedagogical practices (Glaser & Strauss, 1967) by highlighting how faculty present themselves in academic spaces and how that self is projected onto graduate

students during the teaching and learning of QM. When graduate students and faculty interface with positive pedagogical socialization practices it fosters strong relationships, and mutually rewarding opportunities for professional development and institutional capacity building (Brown, 2017; Langrehr, Green & Lantz, 2017).

Methodological Contributions

I use grounded theory research design as a collective term to communicate my application of a combination of classical and contemporary grounded theory worldviews, methodologies, methods, outcomes, and interpretation strategies at all stages of my research process (Creswell, 2013; Charmaz, 2009; Glaser, 2004). My study contributes to the methodological scholarship in demonstrating that when researchers apply grounded theory it is based on the modes of inquiry needed to support the direction of their data. Even though Cutcliffe (2005); Glaser (1992); Glaser (2001) were adamant that any shifts away from classical grounded theory can weaken the credibility of this approach, I argue that grounded theory like all other research will continue to evolve based on the training, background, research beliefs, needs of the researcher and research participants (Guba & Lincoln, 2014; Dunne, 2011; Charmaz, 2009).

Assumptions, Delimitations and Limitations

Assumptions

The assumptions I bring to my study are the social knowledge I hold to be true about reality (Creswell, 2013). I assume GQMS are actors “able to make choices according to their perceptions, which are often accurate, about the options they

encounter(ed)” within their QMC (Corbin & Strauss, 1991, p. 5). Although socialization is a multi-directional process, I hold that facilitating students narratives about their experiences is sufficient for my exploratory research into the pedagogical socialization of GQMS. I also assumed that the grounded theory research design I developed to conduct my study enabled me to discover levels of experiential validity (Araneda, 2020) between students narratives and the interpretive concepts, categories, properties and propositions which comprised my grounded theory of pedagogical socialization.

Delimitations

During my study only GQMS who self-reported as completing introductory, specialization or cognate options were interviewed about their experiences with pedagogical socialization. Since my goal is to better understand how students make meaning of their experiences, I accept that graduate students may pass on their own biases about their courses and faculty. Observing classrooms and interviewing faculty was not a feasible triangulation strategy given the limited timeline for completing my study. In my future research I intend to fill this gap for faculty perspectives.

Limitations

In the absence of scholarship specifically on social sciences GQMC most of the literature supporting my study is based on research conducted within graduate STEM programs and statistics courses. I used the term QM to include the multi-disciplinary range of courses based on the teaching and learning of QM applicable to different fields of study such as data sciences, computer and information sciences, social work, Science

Technology Engineering and Mathematics (STEM), education, sociology, psychology, economics and business. All exist as subfields which heavily utilize the QM research paradigm.

Chapter Summary

Doctoral and master's student's enrollment in introductory, cognate and specialization quantitative methods courses is projected to double in the United States within the next seven years. Graduate students lived experiences with pedagogical socialization within GQMC remains an under-researched area of inquiry. This gap in the literature necessitated conducting grounded theory research into the pedagogical socialization of graduate students within their QMC. Pedagogical socialization is a process whereby norms, values and expectations are transmitted during the teaching and learning of QM within GQMC. I intend for my study and emergent theory of pedagogical socialization to provide methodological, content related and praxis-oriented contributions to reform the teaching and learning of graduate level QM. I aimed to create a more nuanced understanding of faculty's contributions to the development of graduate students' professional identities in QM.

Dissertation Outline

I organized my dissertation using six chapters. In Chapter One I outlined the importance of conducting a grounded theory inquiry into pedagogical socialization for improving the teaching and learning experiences of master's and doctoral students within their QMC. In Chapter Two, I completed a summative review of multi-disciplinary

socialization and QM pedagogical literature relevant to graduate students experiences within GQMC. In Chapter Three, I presented the logic, rationale, and procedural development activities which comprise the grounded theory research design I developed to study pedagogical socialization. In Chapter Four I provided a theoretical explanation of the main themes, concepts, categories properties and propositions comprising my pedagogical socialization theory. I structured Chapter Five around interpreting and discussing my findings to answer my three research questions. Chapter Six is my final chapter where I discussed the implications of my work and provided recommendations for improving the pedagogical socialization practices connected to the teaching and learning of QM within GQMC.

CHAPTER TWO

Literature Review

Methodological Considerations

Dey (2007); Glaser and Strauss (1967); Glaser (1978), Glaser (1992) and Strauss and Corbin (1998) all cautioned grounded theory researchers against completing an extensive literature review. A review should be avoided because it can lead researchers to force convergence between their primary data and apriori assumptions (Glaser, 1998; Urquhart, Lehman & Myers, 2010). Although literature reviews provide overviews of relevant conceptual and empirical scholarship, for these writers, putting together concepts before actual research can result in preconceived notions of what your theory should eventually cover. There is a possibility that a priori knowledge can detach grounded theory researchers from capturing participants lived experiences (Dunne & Üstündağ, 2020; Timonen, Foley & Conlon, 2018). This is counterproductive for developing an inductive theory relevant to participants lives.

Despite these warnings, Breckenridge and Jones, (2009); Corbin and Strauss, (1987); Corbin and Strauss, (2008); Heath (2006); Strauss and Corbin, (1998) all endorsed literature reviews as supportive of grounded theory development. This view is more in keeping with the aims of my research. A preliminary overview of supporting literature

was required for my comprehensive exams, proposal defense and Institutional Research Board (IRB) approval. Since pedagogical socialization is an under-researched area of inquiry, I pulled together multidisciplinary perspectives to supply background knowledge for myself and readers of my dissertation (Urquhart, 2013), identify relevant scholarship gaps (Denzin, 1994; Hutchinson, 2013), develop my interview protocol (Dunne, 2011) and facilitate theoretical sampling and conversational rapport with participants as a data collection strategy (Adhadi & Anozie, 2017; Strauss & Corbin, 1998).

Eventually Glaser (1998) reneged on his early condemnation of literature reviews, urging its function as a secondary data source for weaving together “emergent theory with existing knowledge” after data analysis (Heath 2006, p. 519). My subsequent review of the literature also facilitated development of my theoretical sensitivities to detect similarities and differences between my emergent theory and existing knowledge (Corbin & Strauss, 2008). At the end of my data analysis and interpretation process I found that some of the extant literature had definitely earned its way into my theory of pedagogical socialization (Charmaz, 2006). As a result, I completed a more comprehensive review of the literature in Chapter Five to identify the extent my qualitative inferences added to the scarce pedagogical socialization scholarship.

Topical Organization

I organized my review into two sections. In section one I provided conceptual and empirical overviews of the socialization experiences connected to enrollment and completion of Graduate Quantitative Methods Courses (GQMC). I also provided relevant

academic debates and critiques on the unidirectional focus of the graduate student socialization process. In section two I summarized the graduate student academic and professional socialization literature and reported on the implications of these socialization practices on students QM aspirations post-graduation.

Search Strategy. The keywords I used to guide my searches within Google Scholar and the University of Denver libraries' integrated electronic catalogue included: "graduate students", "quantitative methods", "quantitative methodology", "quantitative research", "statistics", "pedagogy", "teaching", "learning", "socialization", "masters students" and "doctoral students". I also used forward and backward searching of retrieved articles as a form of citation chaining to identify relevant literature.

Databases and Data Management. The databases I searched included: Academic Search Complete, American Doctoral Dissertations, Education Administration Abstracts, Education Collection (ProQuest), Education Database (ProQuest), Education Resources Information Center (ERIC), Education Source, Psychology and Behavioral Sciences Collection, PsycArticles, PsycInfo, Soci- Index, ProQuest Dissertations and Theses full text. I stored and organized my information sources using the Mendeley reference management software v1.19.5 (Mendeley Limited, 2020) to track citations and discern historical, conceptual, contextual, and methodological shifts in the literature.

Conceptual theorists highlighted social knowledge transmission as the primary function of all socialization. In this first section I address socialization as a highly

adaptable sociological construct with specific applicability to the teaching and learning of QM within GQMC.

Socialization Overview

Socialization is a temporal construct used to explain the lifelong experience of acquiring relevant norms, values and, expectations for social roles within social groups (Macionis, 2007). Van Maanen & Schein, (1979) provided the most cited definition of organizational socialization as “the process by which an individual acquires the social knowledge and skills needed to assume an organizational role”, (p. 210). Socialization is the acquisition of the knowledge, skills, attitudes, and behaviors required to adapt to a new role and function within an organization (Wanberg, 2012; Chao et al., 1994).

There is a socialization process specific to graduate students within QMC (Ross et al., 2017). Classroom teaching at the graduate level is a developmental process of socialization where Graduate Quantitative Methods Students (GQMS) internalize “behavioral norms and form a sense of identity and commitment to a professional field” (Weidman et al., 2001, p. 6). The transmission and acquisition of social knowledge for social roles are necessary functions of socialization. When individuals transition into their role as GQMS, various norms, values and expectations make up the social knowledge needed to complete QM activities and adjust to QM classrooms. For these reasons, deconstructing culture, norms, values, and role expectations are important for understanding how each contributes to socialization as a seemingly inevitable internalization process for GQMS.

Social Knowledge within Graduate Quantitative Methods Courses

Cultural Activities

A meaningful nexus exists between socialization and culture in higher education (Chen & Zhao, 2015; Back, Bennett, Edles, Gibson, Inglis, Jacobs & Woodward, 2012). Tierney (1997) emphasized this connection by defining culture as “the sum of activities in the organization” and socialization as “the process through which individuals acquire and incorporate an understanding of those activities” (p. 4). In other words, culture is the collection of actions and behaviors social groups perform over time. During socialization norms, values, symbols, worldviews, communication patterns and role expectations informs the cultural activities performed by group members (Anderson & Thomas, 2013; Antlová, Chudý, Buchtová, & Kučerová, 2015).

QM and statistics are culturally classified as hard and applied sciences within the social sciences (Merton, 1996; Frankfort-Nachmias & Nachmias, 2000). The application of scientific realism, positivism and post positivism as philosophies of science to QM lends itself to this cultural classification. The tenets of scientific realism dictate that “observable and unobservable features of the world can be known by the proper use of scientific methods... and theories which closely approximate truth” (Haig 2018, p. 3). The words proper use and related terms such as correct, appropriate and most suitable are stated and implied within most QM studies (Garfield, 2017). All suggest there is a right and only way to conduct QM activities (Trout, 1998).

Positivism is used to provide a “theoretically neutral basis for testing theories” and determining causality (Cook & Campbell, 1979, p. 23). Determinism suggests that QM users must replicate specific rules to produce generalizable results. Establishing cause and effect is an impersonal endeavour because the researcher and participants played no role in the development of a priori theory, and the procedures used or adapted to verify theory (Cook & Campbell, 1979; Philips & Burbules, 2000). Post-positivism evolved to correct lapses within positivism. The post-positivist philosophy of QM is used to guide social scientists into considering facts as conjectural and theories as presumptive (Lees, 2007). Knowledge has limited applicability to a range of social situations. Contextual and individual factors are equally important to provide multiple sources of evidence for validation (Cook & Campbell, 1979; Philips & Burbules, 2000).

There is significant consensus within the quantitative methods community that all three philosophies inform the cognitive activities at the core of QM such as rationality, measurement, empiricism, causation, estimation, reduction, generalization, error avoidance, replication, testing, calculations, and prediction (Haig, 2018; Stigler, 1986; Cook & Campbell, 1979). Quantitative research designs are comprised of quantitative methodologies and methods of data collection, analysis and interpretation. Statistical formulae, statistical models, data, analytics, data analysis software, databases, symbols and notations, numbers and the graphical representation of results are all examples of QM material culture.

Collecting and interpreting students narratives on their teaching and learning experiences within GQMC will allow me to explore the extent scientific realism, positivism and post positivism show up during the pedagogical socialization process and the extent faculty's pedagogical strategies contributes to students' acceptance or rejection of the justification these philosophies provide for conducting QM activities. Next, I transition to norms, values and role expectations as three additional forms of social knowledge that graduate students need to understand QM, engage in QM activities and participate within GQMC.

Normative Guidelines

Norms are standards for acceptable behavior within social situations (Macionis, 2007). Most graduate schools outline expectations for acceptance into GQMC (Garner & Barnes, 2007). Students must have high grades in high school math, QM at the undergraduate level or the quantitative reasoning module of the Graduate Record Examinations (GRE) exam (Ben-Zvi & Garfield, 2004). Students are also supported by strong letters of recommendation from academic mentors who testified on their capacity to excel within GQMC. When coupled with a track record of applied research practice, these past experiences are held as strong predictors of student achievement within GQMC (Posselt, 2016; Perepiczka, Chandler & Becerra, 2011).

Although acceptance into graduate programs is marketed via a meritocratic ethos that all students were formally evaluated and found to possess qualities as ideal candidates for GQMC (Witteveen & Attewell, 2020; Posselt, 2016), many students enter

into these courses and persist through graduate school with a definite advantage for pursuing QM over other students. In STEM disciplines, White, male, international and higher income students, with more exposure to STEM activities, whose parents possess higher levels of education persist and outperform peers with different life chances (Hurtado & Figueroa, 2013; Trapani & Hale, 2019). Additional predictors of performance include overwhelmingly positive experiences with instructors, the ability to pay for tutors, participate in advanced placement programs and interface with targeted support for QM activities (Banerjee & Lamb, 2016)

Normative requirements for learning QM are also provided during teaching (Weidman et al 2001; Weidman et al. 2003) within department handbooks (Tierney, 1997; Peden & Carol, 2009) and syllabi (Corlu, 2013; Tink, 2012). Social sciences graduate students typically pursue between 9 and 24 QM credit hours within introductory or cognate courses (Christensen et al. 2010; Schneider, 2011). Introductory GQMS are expected to enroll in courses which cover an array of quantitative topics such as sampling and a broad range of descriptive and inferential statistics inclusive of parametric methods such as t-tests, correlation, regression, Analysis of Variance (ANOVA) and non-parametric methods i.e.: Chi-square, Kruskal Wallis and Mann Whitney U tests (Elmore, 1998; Hutchinson & Lovell, 2004). Students are taught these techniques using a combination of lectures and labs, faculty approved data sets and statistical software packages (Ekmekci et al. 2012; Maravelakis, 2019). Within more intermediate and advanced GQMC, faculty train students within special topics seminars with focused

expertise to facilitate their development into professionals well versed in probability distributions and advanced applications for cross validation, linear, non-linear and multi-level modelling. Specialization students are predominantly taught to create source code for machine learning via open source or proprietary computer analytics (Tang & Sae-Lim, 2016).

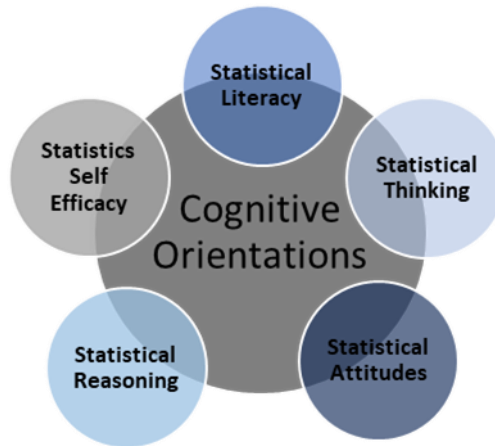
Most GQMF and GQMS focus on coursework activities and completing assignments as the core cultural activities connected to teaching and learning QM. Typical assessment strategies include writing papers (Woodard, Lee and Woodard, 2020); mid-terms and final exams (Gelman, 1997); problem solving and worked examples (Ross et al. 2017; Brisbin & Nascimientto, 2019), structured and open-ended data analysis (O'Connell 2002), group assignments (Jiao & Onwuegbuzie, 2007; Titman & Lancaster, 2011), reading and critiquing applied articles (O'Connell, 2002; Rossman & Chance, 2007), coding, annotating, interpreting and writing up computer output (O'Connell, 2002) and applied research skills (Hoerl, Snee & De Veaux 2014; Tishkovskaya & Lancaster, 2012). By and large it is assumed that most learning goals connected to these assignments are cognitive in nature (Han & Qingdong-Du, 2018; Lovett & Greenhouse, 2001). In my next section I discuss some of these cognitive processes students are expected to develop while participating in QM activities.

Statistical Reasoning, Literacy, Thinking, Attitudes, and Efficacy

The five cognitive orientations represented in Figure 1. are most associated with the teaching and learning of QM within GQMC. All are posited as learning goals students

should acquire, improve upon, and actualize after participating in GQMC (Garfield & Ben Zvi, 2007).

Figure 1. Five Cognitive Orientations Associated with Statistics Education



Statistical reasoning, literacy and thinking are three orientations advanced by the statistics education reform movement of the 2000's. Faculty were strongly encouraged to use their teaching strategies to socialize students into these cognitive orientations (Garfield, 2004). Statistical attitudes were introduced into statistical education since the 1970's as one of the key predictors of students success within QMC (Griffith, Adams, Gu, Hart, & Nichols- Whitehead, 2012). Many researchers felt that identifying graduate students' levels of self- efficacy will enable faculty to tailor their teaching practices to improve students' positive statistical attitudes (Schneider, 2011; Onwuegbuzie, DaRos & Ryan, 1997). It must be noted that all five constructs have a track record of extensive study among undergraduate students within introductory statistics courses using predominantly quantitative research methods.

Statistical Attitudes. Statistical attitudes are the affective responses students develop towards learning statistical content. Griffith, et al. (2012) and Bandalos, Finney and Geske (2003) found that most studies of students statistical attitudes were based on cognition theories of expectancy value, attribution, social cognition and goal setting. Griffith et al. (2012) argued that students statistical attitudes were predominantly measured using three inventories: the Statistics Attitudes Survey (SAS); Attitudes Towards Statistics (ATS) and the 28 and 36 item Survey of Attitudes Towards Statistics (SATS). All instruments with the exception of the SAS are multidimensional measures of students positive or negative attitudes on the value, usefulness, relevance and difficulty of statistics. Most researchers who used these measures produced results indicating that most graduate students possess overwhelmingly negative attitude orientations towards learning statistics (Coleman & Conrad, 2007; Emmioglu & Capa- Aydin, 2012).

Although qualitative research has rarely been conducted on statistical attitudes, the grounded theory phase of Griffith et al. (2012) mixed methods study found that students developed negative attitudes towards statistics because of the difficulties they experienced understanding content, its' perceived unimportance for their future careers, math aversion, and course professors (Coleman & Conrad, 2007). Students with positive attitudes considered statistics as necessary for graduate school and their future career. Students also reported on their love of math, challenging courses and course professors. These findings supported quantitative results on all themes but professors. Griffith et al. (2012) was unclear as to whether this meant that students liked or disliked faculty's

pedagogical strategies, personalities or attitudes towards students while teaching. Another notable limitation of this study included the dichotomous coding of students open ended responses as positive or negative which failed to provide a more nuanced description of the range of attitudes students can have towards statistics content, classes and professors.

GQMF have also reported experiencing challenges in developing teaching strategies to overcome students negative attitudes, while lamenting the ease in which some graduate students perceive QM as irrelevant for their professional practice (Lalayants, 2012). Additional student orientations described as negative includes anxiety about numerical content, fear of failing, an inability to retain information and, low levels of confidence in their ability to understand QM (Lalayants, 2012; Onwuegbuzie & Wilson, 2003; Onwuegbuzie, 2008). While there are many articles on student negative attitudes towards QM, few exist on faculty attitudes towards GQMS and how these attitudes are directed towards students while teaching and learning and its effects.

Statistical Thinking. Statistical thinking involves understanding the how, why and when of the entire quantitative research process for establishing causation, differences and the relationships between variables (ASA, 2016). It is knowing exactly when to formulate questions, collect data, grasp assumptions, choose appropriate analyses, make probabilistic inferences and evaluate statistical results (Garfield & Ben Zvi, 2007; Chance 2017; GAISE 2016). For Chance (2002) statistical thinking are six habits students should develop to understand the statistical process: “always be skeptical, think about the variables involved, relate data to the context, understand and believe in

the relevance of statistics, and think beyond the textbook” (p. 4 -5). This suggests that statistical thinking can be acquired during exposure to QM classroom activities over time but does not provide much detail on how faculty pedagogy or students learning strategies can be updated to achieve these outcomes. Another definite pattern in the statistical thinking literature is authors attention to the linear sequence of quantitative research and the expectation that all students are expected to internalize and process QM in a similar format. Bratianu & Vasilache’s, (2009) exploration of linear thinking among 400 masters students confirmed it is held as an indicator of cognitive aptitude particularly within mathematics, business and economic courses.

Statistical Reasoning. Reasoning within quantitative methods courses is synonymous with statistical inference (Garfield, Ben Zvi, Chance, Medina, Roseth & Zieffler, 2008). Statistical reasoning is the way students understand the logic of statistics and make linkages between conceptual and theoretical information and real-life applications (Garfield & Ben Zvi, 2007; Garfield, 2002). Statistical inference is the ways individuals understand how sampling is crucial for answering research questions and making estimations (Moore, 2004; Garfield et al. 2008).

The Statistical Reasoning Assessment (SRA) contains subscales which measure correct statistical reasoning and the misconception of general statistical topics (Garfield, 1998; Garfield, 2003). Examples of correct reasoning about data, representing data, sampling, central tendency and dispersion, differences between groups, relationships between variables and statistical techniques are included in this measure. Incorrect

reasoning is measured as misconceptions about the law of large numbers, central tendency, variability, and statistical outcomes. Researchers using this measure has shown that most students apply incorrect reasoning when using statistics, applied weak informal and formal inference skills and have trouble in “understanding and using statistical inference” (Garfield, et al. 2008). Kaplan (2006) attributed this difficulty to predetermined belief bias and low levels of student adaptive capacity. This is an overwhelmingly pessimistic portrayal of student’s agency. Some research suggests statistical reasoning can be improved by pedagogy that makes understanding the real-life application of statistics easier (Garfield, 2017; Lawson, Schwiers, Doellman, Grady, & Kelnhofer, 2003).

Statistical Literacy. Statistical literacy is based on three components: a basic understanding of statistical terminology, placing relevant statistical language and concepts within social discussion and an ability to question information posited using weak statistical proof (Chance, 1997; Roohr, Graf & Liu, 2014). These three learning outcomes are based on the extent students acquire a foundational understanding of concepts, vocabulary, symbols and probability (Rumsey, 2002; Moore, 1998; Garfield, 1999; Garfield & Ben Zvi, 2007), proficiency in organizing and working with different data collected within different contexts and making sense of statistics in the mass media and journal articles (Garfield, 1999; Watson, 1997). Focusing on real world applications has important implications for GQMS who wish to engage in community-based praxis and develop real world interventions using QM. This is in keeping with Engel (2017)

findings that statistical literacy is a crucial skill for students development into actively engaged citizens.

Self-Efficacy. Statistics self-efficacy is the level of confidence students have in their ability to learn and perform the tasks attached to statistics courses (Onwuegbuzie et al. 1997; Schneider, 2011). For Onwuegbuzie et al. (1997) students confidence in their ability to complete statistical assignments is a key predictor of students statistics success. Even while Schneider (2011) found no significant correlation between student self-efficacy and GQM performance. Larwin (2014); Einarson and Santiago (1996) all argued that prior experiences with mathematics in undergraduate or high school is a strong predictor of GQMS self-efficacy. Bartsch, Case and Meerman (2012) demonstrated that graduate students can be socialized into having a strong sense of self efficacy in affirming environments with adequate social support (Perepiczka, Chandler & Becerra, 2011). In both studies higher levels of self-efficacy emerged among the graduate students who experienced more student-centered and peer focused teaching strategies, in contrast to students who interfaced with traditional lectures. GQMS self-efficacy research is supportive of the need to understand whether good pedagogical strategies are an important predictor of a range of positive student outcomes within research driven classrooms.

Cognitive Competences with Socio- Cultural Implications. There is substantial overlap in the conceptual definitions, levels of understanding and learning outcomes of statistical literacy, statistical thinking and statistical reasoning processes. There is also an

implied hierarchy among all constructs with some requiring higher order thinking skills than others (Garfield & Ben- Zvi, 2007). Garfield (2004) ranked statistical literacy, statistical reasoning and then statistical thinking as having the lowest to highest level of difficulty for students. Statistical attitudes stand on its own as the most affectively driven student orientation while self-efficacy is based on students beliefs about their ability. Given that these concepts have been operationalized mainly among introductory GQMS and undergraduate students this does not belie the assumption that some faculty carry the expectation that classroom assignments will socialize graduate students to accept, internalize and demonstrate these cognitive orientations. However, the extent to which GQMF pedagogical strategies contributes towards these outcomes are not easily discernable and have not been adequately studied.

Socialization is a useful construct for looking at the socio- cultural implications of these cognitive factors and the extent GQMF pedagogical strategies impacts on student's process of acquiring statistical attitudes, literacy, reasoning, efficacy and thinking. Although some GQMF tend to focus on the natural ability orientations of their students, their assignments and classrooms activities could be designed to socialize students into these five habits of mind through socio-cultural disciplinary engagement (Chance, 2002; Wild & Pfannkuch, 1999). It is for this reason my qualitative work is necessary for understanding the extent GQMF pedagogical strategies includes considerations supportive of students sense making process while completing QM activities within GQMC.

The Hidden Curriculum and Informal Socialization

Most scholarship on graduate quantitative methods faculty, students and classrooms prioritize formal activities and overlook informal socialization processes. The hidden curriculum is a form of informal socialization defined by the undisclosed agendas and socio- cultural cues hidden in plain sight during teaching and learning QM (Hyttén & Stenmager, 2020). The graduate students in Cotton et al., (2012) study described the hidden curriculum within their geography graduate courses as the surreptitious and undercover ways faculty used lectures to advance unsupported personal views as facts about students, their lives and public issues.

Networking during recreational and social activities, and mirroring professors are informal norms that some graduate students internalize to secure the best professional and career development opportunities within their departments (Elliot, Bengtson, Søren, Guccione & Kobayashi, 2020). Gardner (2007) qualitative study on the informal grapevine among 20 chemistry and history doctoral students found that students who received beneficial informal information from academic advisors and peers reported significant cognitive, personal and professional benefit as well as increased financial support to complete their programs.

Gardner (2009) qualitatively studied 60 doctoral students and 34 faculty members perspectives on the attrition rates of high and low completion mathematics and psychology doctoral programs. Faculty's viewpoints were that high attrition rates are due to low ability students, students who should not be accepted into graduate school and

those with personal problems. Conversely, graduate students reported that high attrition occurred because of departmental politics, wrong fit and personal issues (Gardner, 2009). Personal problems are the only theme that faculty and graduate students had in common. Faculty attributed attrition to the lack of cognitive ability while students attributed attrition to their inability to cope with the tension filled politics connected to their respective departments. Students who were older or female with low financial support also experienced strong informal socialization for attrition and not retention. Faculty most frequently ascribed low ability categorizations to high attrition among graduate students without a consideration of the effects of their perception while interfacing with these students.

Gardner, (2010) provided insight into the wider implications of faculty's biased signals about who is worthy of graduate education, who benefits from graduate training and gains departmental support. Doctoral students reported that most of their socialization takes places within a highly inequitable department climate particularly for older students, women, students of color, mothers and students with family obligations (Gardner, 2008). Students whose opinions and values are strikingly similar to professors and the departmental culture tended to report more positive experiences on account of being favored by faculty (Cotton et al. 2012; Golde, 2005). Although Gardner (2007); Gardner (2008) and Gardner (2010) did not have a pedagogical focus, all three studies provide an important backdrop for my inquiry into faculty perception of student ability

within their GQMC and the practices they use to convey their perception during teaching and learning QM.

Classical researchers have defined the hidden curriculum as having a predominantly negative impact on graduate students. Critical perspectives framed the hidden curriculum as a mechanism for socializing graduate students into groups of winners and losers. However contemporary scholars denounced this past research as unconstructive thinking, advancing that management of the informal graduate school culture is valuable training which allows students to derive maximum personal benefits for future roles (Elliot et al. 2020).

The Value of Completing Graduate Quantitative Methods Courses

Values are the levels of esteem or significance individuals hold towards particular objects, people and social interactions within any institutional structure (Macionis, 2007; Türkkahraman, 2014). Values are learned through socialization into the decisions and behaviors connected to systems of knowledge (Antlová et al. 2015). The value systems connected to academic disciplines impact upon students perception of their professional selves (Antlová et al. 2015). The networks, prestige and status obtained during and after completing QM courses creates social and economic value (Brian & Guccione, 2018; Elliot et al. 2020). Faculty and graduate students have high esteem for the benefits gained from acquiring QM master's and Doctoral degrees (Blagg, 2018; Brian & Guccione, 2018). Most faculty and students anticipate that their QM credentials will rebound into higher labor market status, professional credibility, increased income, and entrepreneurial

opportunities (Brian & Guccione, 2018; Tribunella, 2005). For Brian and Guccione (2018) and others (Wang, 2008; Parker, 2018) all graduate students who complete their degrees demonstrate resilience and tenacity in the face of adversity because of the high personal value placed on degree completion.

The upward trend of graduate student enrollment within social sciences, statistics and mathematics programs may be indicative of students willingness to make sacrifices and invest considerable time, money, and effort into GQMC in hopes that they will benefit from the social knowledge gained while completing QM activities (CGS, 2020; NCES, 2020). For the most part there is very little literature on how institutional value placed upon QM and students personal values may coincide or conflict with each other.

Roles and Role Expectations

Roles classify social actors based on their ability to actualize the activities, norms and values within an established social structure (Erickson, 2009). Individuals are conferred the role of GQMS when they satisfy entry requirements, enroll within GQMC, pay tuition and complete all course requirements within their QM syllabi (Peden & Carroll, 2009). Garner and Barnes (2007) applied a grounded theory methodology to understand how 10 doctoral students were socialized into the graduate student role. Students reported that their socialization process was highly dependent on the levels of involvement they experienced within their departments. There is a very limited range of roles and involvement opportunities for graduate students within GQMC. These include the lone role of GQMS, an advisee, mentee, mentor, QM graduate teaching or research

assistant (Garfield & Everson, 2009; Justice, Zieffler & Garfield, 2017; Justice, 2020), group member as well as formal and informal peer tutors (Bartsch et al., 2012).

My study fits in with this body of work because I seek to understand GQMS perceptions about student roles within QMC and departments and the socialization process and social knowledge they consider necessary for functioning within each role. Importantly my research is not only limited to the impact of students roles within the QM classroom context. It is also important consider the impact of the role GQMS on additional professional and personal responsibilities that graduate students navigate inside and outside the classroom setting.

Role Clarity

Faculty should provide GQMS with transparent guidelines for understanding the tasks and task priorities needed to function within their social roles (Bauer, Erdogan, Bodner, Truxillo & Tucker, 2007; Wanberg, 2012). Strong positive relationships exist between clear written and verbal communication about course objectives, faculty expectations and student success in statistics courses (Wagaman, 2016). When related to methodological learning, O'Connell (2002) advocated for faculty to provide greater statistical clarity for students within GQMC. Statistical clarity is the absence of tension between the knowledge and skills transfer process while students complete relevant statistics learning activities (O'Connell, 2002). There is a dearth of scholarship providing an in-depth analysis of faculty role expectations towards introductory, cognate and specialization GQMS. Students should understand whether the skills taught within their

GQMC are sufficient for completing assignments and acquiring applied competencies for future professional roles (Brophy, 1996).

Tang and Sae- Lim (2016) content analysis of 30 data science programs found that faculty provided greater clarity on skills and performance for tasks requiring lower-level analytic skills. For upper-level courses there was weaker clarity on the higher-level analytical skills needed to complete these assignments. Faculty pedagogy and modes of interaction with graduate students is based upon the different prompts provided for task completion within introductory, cognate or specialization courses. Greater role clarity for students can also go a long way towards decreasing negative attitudes towards statistics, student anxiety, ambivalence and stress (Frögéli, Rudman & Gustavsson, 2019).

Theorizing about role clarity during pedagogical socialization is an important outcome of my research. By unpacking the obvious and underlying culture, norms, values and role expectations transmitted during the teaching and learning of QM, I will illustrate the dynamic forces at work and its implications for GQMS.

Adjustment

Socialization is an adjustment period when individuals seek confirmation on the quality of their performance and whether they have internalized sufficient social knowledge to perform their roles and tasks. (Bauer et al. 2007; Ibarra, 1999). The social dimensions of students adjustment to GQMC can be theorized as attempts to understand: “How do I do this well?”, “How well do I fit in and feel accepted?” and “How well do I understand the norms and expectations?” of GQMF (Ashford & Nurmohamed, 2012 p.

14). Ashford and Nurmohamed, (2012) and Bauer et al. (2007) argued that some level of adjustment, is required for conformity to role expectations and acceptance into the social groups. For Roberts (2005) this shows up through personal inference or formal or informal cues by supervisors to tone down or emphasize the identities, behaviors and attitude orientations needed for success and greater legitimacy among faculty and academic peers (Eliot et al. 2020).

Gaining group membership within GQMC is a period of adjustment for students which allows them to acquire and share the social knowledge relevant to their roles, participate in group activities and gain access to group resources (Grusec & Hastings, 2015). Little is written on this process of social adjustment within GQMC. Existing research on group membership within graduate statistics courses focus on its impact on cooperation for completion of classroom assignments (Donohue & Richards, 2007; Jiao & Onwuegbuzie, 2007). In the next section I transition into my discussion on how the social knowledge connected to completing QM activities within GQMC are transmitted to GQMS.

Social Knowledge Transmission

Explicit and Implicit Communication

Explicit communication is the written and oral words that faculty use to pass on relevant social knowledge to students while teaching QM (Cruciani, 2018; Duff, 2010). Implicit communication are the non- verbal cues transmitted during teaching and learning which includes “head nods, use of personal space, eye contact, body position, facial

expression, posture” and the “tone, rate, pitch, and volume” of people’s voices (Butland & Beebe, 1992 p. 8). The interplay between explicit and implicit communication includes what you say, how you say it and to whom it is said (Butland & Beebe, 1992). This includes positive, negative or ambivalent communication practices which stimulate various forms of student adjustment to transmitted social norms, values and role expectations (Anderson & Thomas, 2013; Bauer et al. 2007).

Graduate students perception of explicit and implicit communication contributes towards their acceptance or rejection of the social knowledge transmitted during socialization (Anderson & Anderson, 2012; Butland & Beebe, 1992). Positive transmission mechanisms include constructive feedback, affirmation, and support. Negative communication approaches include exclusion, being ignored, ridiculed, and judged incorrectly (Anderson & Anderson, 2012; Beilock, Schaeffer, & Rozeck, 2017; Butland & Beebe, 1992). In graduate STEM classrooms students perceived as high ability and high achievers are more likely to receive positive communication while students perceived as low ability and low achievers are more likely to receive negative communication from faculty and peers (Rosenthal & Jacobson, 2000). It is harder to identify the influence of implicit communication during teaching and learning (Allen, Sherman & Klauer, 2010). At the same time, the absence of clear explicit and/ or implicit communication prompts some students to infer their role expectations for completing assignments and related tasks (Golde, 2008; Bierber & Worley, 2006).

My dissertation is invested in bringing to light the explicit and implicit communication patterns that faculty enact within their GQMC and the extent these transmission strategies may harm or affirm GQMS. In the following section I examine traditional, inquiry based, cooperative and flipped modalities as four of the most popular pedagogical strategies used to transmit social knowledge within QMC and outline the implications of each approach for GQMS socialization experiences.

Pedagogical Strategies

Traditional Lectures

Lectures are the most explicit strategy faculty use to transmit QM content to students (Bledsoe & Baskin, 2014; Jiao & Onwuegbuzie, 1997). Traditional lectures are a pedagogical approach linked to the banking system of education which socializes students to accept teachers as the lone knowledgeable actor within classroom settings (Freire, 1970). Lectures are based on direct and uninterrupted knowledge transfer from faculty to students (Freire, 1970; Johnson & Dasgupta, 2005; Aguilera & Perales-Palacios, 2020). Hence the reasons why lectures are informally known as the ‘sage on the stage’ approach to teaching with centers faculty and faculty driven content.

Lectures, textbooks, and assessments are unidirectional means of learning QM and the primary sources of information on QM techniques (Blessinger & Carfora, 2015). Faculty also utilize assessment methods which rewards students for replication of the information presented via lectures and textbooks. Students exist as passive recipients of QM knowledge communicated via these mediums. Their lived experiences has minimal

relevance to the subject matter discussed within QM lectures (Ross et al. 2017). These findings demonstrate that the traditional lecture model mirrors the unidirectional orientation of the QM socialization process.

Since the 1990's there has been a steady stream of research calling for reform of traditional lectures in QMC. Many researchers have found that traditional lectures contribute to statistical anxiety, fear, reduced cognitive functioning within classroom settings (Bledsoe & Baskin, 2014; Connors & Franklin, 1999) and low levels of student satisfaction (Daniel, 2018). Students have consistently complained that proverbial use of highly technical jargon during lectures decreases their ability to understand QM (Nind & Lewthwaite, 2018). Although faculty have reported on their use of rhetorical questioning and accessible materials to facilitate discussions during lectures, research has shown that informal discussions with students served as a platform for some faculty and students to prioritize their personal views on specific topics and the best and only way to conduct research (Cotton et al. 2012).

Freeman, Eddy, McDonough, Smith, Okoroafor, Jordt & Wenderoth (2014) found overwhelming evidence that traditional lectures is an ineffective modality for QM problem solving, and critical thinking. Although students preferred more active teaching methods this did not produce higher levels of achievement than students exposed to traditional lectures (Loveland, 2014). Researchers have also documented that some GQMS prefer traditional lectures and related classroom activities (Johnson & Dasgupta, 2005; Aguilera & Perales- Palacios, 2020). They also found significant faculty push back

against active and more student-centered teaching. Since graduate students perceive faculty as subject matter experts of QM they may also prefer adopting a passive role to glean as much faculty driven content and training as possible.

Freeman, et al. (2014) is the most frequently cited meta-analysis when tracking evidence supportive of active strategies over traditional lectures in STEM higher education classrooms. These authors demonstrated that students exposed to more active teaching strategies performed better than students exposed to only traditional lectures. One critique of this work is that these authors classified pedagogical strategies into two large camps and did not provide much evidence to differentiate between different QM active teaching strategies such as inquiry based, cooperative and flipped modalities. In the discussion that follows I summarize the main modalities connected to inquiry-based learning, cooperative learning and flipped classrooms as active teaching and learning approaches adopted into GQMC.

Active Learning

Since the early 1990's statistics teaching reform advocates have implemented active learning strategies within some undergraduate statistics courses (Strayer, Gerstenschlager, Green, McCormick, McDaniel & Rowell, 2019). Active learning needs flexible learning environments and teaching strategies which engages students in learning by doing and thinking deeply about what they are doing (Weltman & Whiteside, 2017). Specifically, for GQMF active learning of QM is a student centered model which promotes students as knowledge holders and faculty as facilitators of learning

experiences through different teaching modalities, problem solving activities and datasets to promote statistical thinking through active learning (GAISE 2016; Strayer et al., 2019). In this section I provide summaries of the application of inquiry based learning, cooperative learning and flipped or hybrid approaches to facilitate the active learning of QM within GQMC.

Inquiry Based Learning

Inquiry Based Learning (IBL) is a student-centered approach to teaching which focuses on learning by doing based on group discussions, dedicated question and answer segments, seminars, informal discussions, role assignments and poster sessions (Albright, Petrulus, Vasconcelos & Wood, 2012). When compared against traditional lectures, IBL is a learner guided rather than teacher directed model where faculty facilitate collaborative and individualized projects which center student creativity (Blessinger & Carfora, 2015). While there is no comprehensive study on IBL within GQMC, three meta- analyses conducted across pre-k- 12 settings by Alfien et al. (2012); Furtak, Seide, Iverson & Briggs, (2012) and Lazonder & Harmsen, (2016) all provide evidence supportive of IBL as a more effective pedagogical approach than traditional lectures. Students exposed to IBL have reported positive outcomes such as an enabling learning environment, higher levels of academic motivation, improved skills and increased confidence (Kempler, 2006). Albright et al. (2012) found that students preferred IBL discussion groups above traditional lectures because it is a modality which placed

teachers in an advisory role and facilitated dialogue about student contributions to methods and course content.

The extent IBL approaches are considered a radical departure from traditional pedagogy is highly contested. For Lazonder and Harmsen, (2016) IBL has not been fully operationalized as a robust teaching approach because of challenges with faculty implementation. Faculty were perceived as having stronger commitment to course objectives rather than how or what students learned. Students feedback on faculty's classroom delivery were largely ignored. Some faculty complained IBL requires continuous "planning, design and assessment by the instructor" (Blessinger & Carfora, 2015). Science teachers using IBL reported difficulties in determining how much guidance teachers should provide to facilitate students understanding of hypotheses, experimental design, and evaluating evidence (Lazonder & Harmsen, 2016).

Cooperative Learning

When using Cooperative Learning (CL) instructors seek to improve classroom climate and student achievement through peer or group learning (Chen, 2015; Giraud, 1997). Like IBL, CL is a collaborative modality which accesses students' performance through teamwork (Johnson & Johnson, 1993). CL is based on in class strategies such as self-assigned pairs and groups for working on class assignments and data analysis labs (Donahue & Richards, 2007). CL teaching encourages constructive interdependence for problem solving activities. Students can learn from each other by comparing the different approaches needed to arrive at various solutions (Garfield, 1993). CL also includes

developing checklists for accessing the integration of theory, research and practice within each group and how each activity creates learning opportunities (Johnson & Johnson, 1993).

CL instructors claim that this approach diverges from the competitive and individualistic learning climate of traditional QM classrooms (Johnson et al. 2000; Donohue & Richards, 2007). CL has been linked to positive student outcomes such higher achievement, psychological well-being, self-esteem, shared competency and helpful relationships within diverse learning groups (Johnson & Johnson, 1993). It is also linked to reduced levels of graduate student statistics anxiety, (Onwuegbuzie, 1998).

In one instance of applied research Jiao and Onwuegbuzie (2007) organized 28 CL learning groups within their GQMC. Each cooperative group were given two assignments: an article critique and research proposal. Authors hypothesized that CL students will produce lower scores on the Statistics Anxiety Rating Scale (SARS) than students enrolled in traditional lectures. Cooperative groups experienced higher levels of academic performance and lower anxiety than groups exposed to traditional instruction (Jiao & Onwugbuzie, 2007). The CL group explained 37.9% of the variation connected to student performance. Worth of statistics, assignment anxiety, computational self-concept, fear of the professor and asking for help yielded significant results. Both authors pointed out that more research is needed to uncover additional sources of variation for CL outcomes.

Despite these positive outcomes some faculty reported experiencing difficulty implementing CL. McNeil and Payne, (1996) problematized CL classrooms as having a linear modality which impedes mastery of the teaching process. Like IBL, faculty's roles during CL has been weakly operationalized (Lazonder, 2016). Donohue and Richards (2007) reported resistance to group work and lower satisfaction ratings by female students for in class collaborative groups. Students expressed difficulties with an asymmetrical workload, interpersonal conflict, and lack of interest which contributed to their widespread preference for traditional lectures and assignments (Donohue & Richards, 2007). Ray, Coon, Al- Jumaili and Fullerton (2019) concluded that CL offers no viable solution to the levels of isolation and competitiveness which informs STEM graduate student culture within higher education. The absence of student to teacher feedback loops are also suggestive of the uni-directional foci of the pedagogical socialization process within CL classrooms.

Flipped Classrooms

Flipped classrooms incorporate eLearning strategies to invert traditional lectures (Lage et al. 2000) into an online modality. In flipped classrooms Students follow content via uploaded lectures and synchronous and asynchronous class activities (Mills & Raju, 2011). Worksheets, review questions, course homepages, electronic libraries and interactive quizzes are administered within flipped classrooms with the expectation most of the groundwork is laid outside class for student engagement with the material (Fulton, 2012). Flipped classrooms leave more time for interfacing with faculty expertise and

tools only available in class and labs (Fulton, 2012). Students reported increased autonomy and reduced anxiety while participating in flipped classrooms because of the ability to complete preparatory work and catch up on missed content (Immekus, 2019).

McLaughlin and Kang (2017) found that their application of flipped modalities within their graduate biostatistics courses resulted in increased engagement, a higher motivation to learn and higher scores among students. Despite this evidence of improved learning outcomes, students still expressed strong preference for face-to-face lectures and laboratory sessions (Johnson, Dasgupta, Zhang & Evans, 2009). Flipped modalities also proved challenging in underfunded colleges and universities with limited access to technology (Mills & Raju, 2011). Since GQMC are lab and software driven this may be a barrier for many low-income students. Flipped classrooms also resulted in heavy dependence on uploaded course materials and much like traditional lectures also facilitated rote memorization as an indicator of student success (Nielsen, 2012).

Conclusively although inquiry based learning, cooperative learning and flipped modalities all exist as active alternatives to traditional lectures they all contribute towards the historical continuity of the lecture format within GQMC. Active modalities within research methods courses contribute to higher levels of student engagement, student confidence, satisfaction, statistical literacy and statistical thinking (Allen & Baughman 2016; GAISE 2016; Weltman & Whiteside, 2017). Despite exposure to the positive outcomes of different modalities some students still preferred lectures as the main means of transmission for QM content. This is not surprising given the overwhelming focus on

subject matter expertise within GQMC. Since most of this existing research is not current, it would be very interesting if my study would confirm or refute these longstanding results. In the next section I discuss scholarship on the pedagogical culture of research methods courses which developed over time given faculty's application of traditional and active pedagogical strategies within GQMC.

Pedagogical Culture

Pedagogical culture is “the exchange of ideas within a climate of systematic debate, investigation and evaluation surrounding all aspects of teaching and learning in a subject” (Wagner et al. 2011, p. 75). The pedagogical culture of research methods courses is informed by faculty and students accumulated experiences on what works and how this is transmitted during the teaching and learning of research methods (Nind & Lewthwaite, 2018). Kilburn et al. (2014); thematic review of articles on research methods courses and Sullivan & Maxfield (2003) content analysis of research methods syllabi led to the overall conclusion that the research methods pedagogical culture is disjointed. These are significant findings especially since both authors used different methods and units of analyses and yet arrived at the same conclusion.

For Kilburn et al. (1994) this disjointed pedagogical culture is based on the teaching expertise of senior faculty with little opportunity for student driven dialogue on teaching effectiveness (Kilburn et. al. 2014). When teaching was disconnected from students learning preferences this impeded their understanding of research methods. Sullivan and Maxfield, (2003) illustrated the presence of low consensus among faculty on

the best strategies for teaching research methods courses. Pedagogical strategies were not only disconnected from students' needs but also based on a strong culture of replication of past studies (Janz, 2016; Yu & Schmid, 2021). While these papers provide valuable insights, both reported on research methods courses and not QMC. Convincingly my study fills important gaps identified by (Kilburn et. al 2014) for future qualitative research for developing more student-centered teaching strategies. In focusing on GQMC and putting students concerns at the center of my data collection and analysis process I aim to create knowledge on how faculty's pedagogies can place students understanding of QM at the center of their teaching process.

Lewthwaite and Nind (2018) followed up on Kilburn et al. (2014) with a qualitative multi-method study on the pedagogical culture of 21 prolific quantitative and qualitative research methods faculty and practitioners. Their three themes captured salient cultural practices for successful student learning. A culture of accessible communication through pedagogic hooks allowed faculty to move away from technical jargon to more accessible language (Lewthwaite & Nind, 2018). Learning by doing gave students the confidence to generate and apply empirical data for real world research. Faculty cultivated students critical reflexivity in locating themselves within their methodological decision-making process (Lewthwaite & Nind 2018; Tabron, Hunt-Khabir & Thomas, 2020; Danowitz & Tuitt, 2011).

While Lewthwaite and Nind (2018) highlighted the value of star faculty's signature pedagogy and how it solidified over time, this research was not reflective of the

conventional pedagogical practices GQMF used within GQMC. Signature pedagogy are the “disciplinary habits of mind” reflective of faculty’s past and continuing academic and professional socialization (Guring, Chick & Haynee, 2009, p. 5). Most of the prolific scholars interviewed used their signature pedagogy during teaching and learning. Most signature pedagogy tends to be practiced by one or a few faculty members and rarely become commonplace among all faculty. For the most part, GQMF pedagogical culture and the teaching strategies used depends upon how they learned and were taught QM (Golde, 2007; Wagner & Okeke, 2009).

Sometimes senior faculty may socialize junior faculty into adopting their best strategies. No research exists on the extent junior faculty are able to influence more senior faculty to adopt contemporary teaching modalities. If graduate students can be taught QM using connective, inclusive, responsive and innovative strategies this may serve as a reference point for GQMS who become future GQMF. Introductory GQMC host larger class sizes with different sections taught by different faculty. It is vital to generate a more relevant understanding of pedagogical culture within these spaces to lessen the disjointedness between QM teaching and learning.

Many additional reasons exist on why students perceive the culture of teaching and learning within research methods classrooms as disjointed and difficult to follow. Therefore, it is imperative to use my grounded theory inquiry to unpack the norms, values and role expectations informing GQM pedagogical culture.

Critique of Unidirectional Socialization

The graduate student socialization literature abounds with linear depictions of the GQMS socialization process. This contributes to the perception that graduate student socialization is predominantly uni-directional with students as passive recipients of transmission, adjustment and conformity during classroom activities. Graduate students are also presented as having a learned helplessness towards deterministic QM worldviews (Yang, 2006), uncontrollable programmatic elements and faculty as the primary agents of socialization within the classroom contexts in which they are embedded (Yates, 2009; Tierney, 1997). Grusec and Hastings, (2015); Bauer et al. (2007) and others failed to consider the influence of individuals prior experiences during their transmission and adjustment period. This is contrary to the stated goals of graduate education which includes exchanging ideas and engaging in conversational rapport with professors and peers to encourage independent and critical thinking among scholars within research methods courses (Collins & Onwuegbuzie, 2000). However unidirectional this body of research may be, most classroom socialization researchers contends that this sums up the experiences of the majority of graduate students.

Most of the available scholarship related to pedagogical socialization is comprised of conceptual definitions and few tested socialization models over time (Spera & Matto, 2007; Vancouver & Warren, 2012). Despite nuanced shifts in the focus of socialization theorists, the recurring query within most research is related to: how agents of socialization prompt individuals to adjust to organizational roles? (Vancouver & Warren,

2012). I intend to move my research beyond this passive transmission tradition by centering GQMS narratives on how they activate their agency within GQMC. These critiques guided contemporary scholars towards a more balanced presentation of graduate students as equally important agents within graduate classrooms (Tuitt, 2016; Tuitt, Haynes & Stewart, 2018). GQMS are not only passive but also “agentic and proactive” architects of their own academic experiences (Ashford & Nurmohamed, 2012 p. 8; Freire, 1970). Socialization during graduate education was eventually re-defined to include dual and multidirectional processes inclusive of the social knowledge students brought into organizations.

Social Identity Development

GQMS identities are equally important factors attached to their QM socialization process (Ross et al. 2017). Identity led socialization is informed by students family background, race, ethnicity, gender, nativity, socio economic status and the intergroup relations they have participated in over time (Anderson & Thomas, 2013; McLean & Syed, 2015). These factors influence the “identities graduate students enact, their ability to enact them” and their “quality of adjustment within organizations” (Ibarra & Barbulescu, 2010 p. 18). Courses consists of students who matriculated into doctoral programs upon completion of their undergraduate degrees. GQMC also contain students who spent most of their adult lives in professional employment who return to graduate school for upgraded qualifications, greater job security, a higher salary or access to occupational promotions (Shaunessy, 2013). The identity climate of GQMC should relate

to the demographic profile of graduate students, the experiences which compelled them to enter graduate school and the most salient identities they connect to their academic experiences (Ross et al. 2017).

Graduate students also reflect upon whether pedagogy transmits positive or negative information on their social identities and its effects on how others perceive them and how they perceive themselves (Butland & Beebe, 1992; Ibarra & Barbulescu, 2010; McLean & Syed, 2015). Some students have reported feelings of dissonance, alienation and isolation when their lived experiences were incompatible with some of the norms and values within graduate classrooms (Toynton, 2005) and empowerment and affirmation when their identities were supported by it (Tuitt, 2013). Adult students appreciated participation in statistics classes when their experiences and expertise proved useful for co-constructing and guiding the content and practical examples faculty used to teach graduate level statistics (Bradstreet, 1996). These studies point to individualized identity development as an important outgrowth of the contemporary socialization literature. Few studies has been conducted on the impact of classroom composition and graduate student identities on the teaching and learning strategies faculty use within GQMC. My research is significant because I highlight the pedagogical strategies which contributes to students social identity development within GQMC.

Andragogy or Pedagogy?

In studying pedagogical socialization, I introduce one rarely acknowledged yet highly contentious issue into my work. Pedagogy is the art, science and practice of

teaching children within k-12 classrooms while andragogy is focused on the teaching and learning process for adults. Higher education faculty are tasked with creating learning environments which facilitate adult learners need to learn, understand and apply content that make the most of their lived experiences going into graduate programs (Caruth, 2014). Most adults reject pedagogy based strategies such as rote memorization, assigned readings, notetaking, quizzes and exams and prefer practices within graduate education classrooms based on attitudes of “reciprocity and mutuality” (Caruth, 2014, p. 21). This introduces a different epistemological foundation for teaching statistics in the social sciences (Calderwood, 2002).

Despite andragogy’s existence as a concept with greater applicability for higher education environments, it is highly interesting that pedagogy persists as the main construct used to describe teaching and learning. Since graduate education is based on adults teaching and learning with adults only adult learners can assume the role GQMS. (Chan, 2010). It would be a thought-provoking outcome of my research if students reported on the extent their role as a Graduate Quantitative Methods Student (GQMS) and Quantitative Methods (QM) pedagogy retained some similarity to their elementary and even high school experiences.

Contextual Considerations

Although context is one of the most important predictors of doctoral student retention and success, very little attention has been paid to its influence as a socialization mechanism for GQMS (Gardner, 2008; Grusec & Hastings, 2015). Differences in

institutional structural elements socialize students into different QM research orientations. Public universities place heavy emphases on research for the public good, (American Academy of Arts and Sciences, 2015). Because race/ ethnicity (Garces, 2012; Chari & Potvin, 2018), and lower socio- economic status (Lei & Chuang, 2010) impacts on the life chances of Black, Indigenous and People of Color (BIPOC) students, most research from Historically Black Colleges and Universities, Tribal Colleges and Hispanic Serving Institutions (HSI) tend to focus on how to improve the lived experiences and life chances of historically marginalized groups (John & Stage, 2014).

Students enrolled in Carnegie classified Very High and High Research Activity institutions and within STEM programs regardless of institutional classification tend to receive the highest amount of non- repayable financial aid (Enderlein, 2017). Higher levels of financial support sometimes allows some of these students to maintain a competitive edge over peers who self-finance their graduate education (Enderlein, 2017). Graduate students at research driven universities who identified as having low financial support and low academic preparedness have reported on the adverse effects of being on the receiving end of discouraging faculty interaction during teaching. The most notable effect being a regression of their academic goal pursuits in keeping with faculty's lowered expectations (Glass, Kocielek, Wongtriat, Lynch & Cong, 2015).

Organization- Environment Misfit

Socialization misfit occurs when there is substantial incompatibility between the organization and an individual's personal norms, values and role expectations (Cooper -

Thomas & Wright, 2013). Misfit is a highly stressful and anxiety laden process which leads individuals to temporarily conform, withdraw or part ways with an organization (Ashforth et al. 2007; Cooper- Thomas & Wright, 2013; Gardner, 2008). High attrition rates out of STEM disciplines are connected to students inability to live up to the informal and formal norms, values and role expectations prescribed by faculty and the larger departmental culture (Eliot et al. 2020; Gardner, 2008; Gardner, 2010).

For the graduate students who persist fitting in is not always the goal during socialization (Bauer, et al. 2007). The information seeking behaviors students enact to fill in knowledge gaps from ineffective socialization may not be compatible with faculty's teaching strategies or the larger departmental culture (Chen & Klimoski, 2003; Cooper-Thomas & Wright, 2013). Counter norms and oppositional values are viable student responses to the tensions experienced during graduate student socialization (Gonzalez, 2006). Both are important sources of non- normative socialization originating from students personalities, lived experiences, interpretations of science and responses to organizational socialization (Anderson & Louis, 1994). Counter norms are a form of divergent thinking which has been shown to stimulate creativity and innovation among students to learn and improve upon assigned tasks (Runco & Acar, 2012). Further to this, creative problem solving, and skepticism are crucial elements known to facilitate statistical thinking (Hu, Xiaohui & Shieh, 2017; Smith, 1999).

More research is needed to investigate why graduate students accept or reject QM pedagogy, how faculty respond to these students and the extent their pedagogy stimulates

a classroom culture of critical inquiry for all QM students (Wild & Pfannkuch, 1999). Since socialization incompatibility exists on a continuum related to socio-demographic, individual, structural and social factors, (Cooper-Thomas & Wright, 2013; Haynes 2016) strongly recommended that researchers study how institutions can create and sustain expansive environments more supportive of diversity. In my final subsection I discuss academic and professional graduate student socialization to identify additional issues relevant to GQMS pedagogical socialization process.

Academic Socialization

Academic socialization is a process of anticipatory socialization when faculty prepare graduate students to become academic faculty (Austin, 2002). Most graduate faculty uphold academic scholar as the most prestigious role expectation for graduate students (Weidman & Stein, 2003). Similarly, Bieber and Worley (2006) and Anderson and Lewis, (2004) reported on an almost unanimous agreement among graduate students that tenured faculty is a projected ideal they should aspire to post graduation. Among 83 Ph.D. students Weidman et al. (2003) found strong positive relationships between these six programmatic factors associated with academic socialization for the professoriate: student scholarly encouragement, participation in scholarly activities, supportive faculty environment, supportive departmental climate, department collegiality and healthy student to faculty interactions. This study was particularly useful in identifying the key factors associated with successful graduate student academic socialization. Overall results

led to creation of the popularly cited Weidman framework and survey of graduate student professional socialization.

GQMS have testified on the positive impact of academic socialization via teaching and research assistantships and grant driven research (Brown, 2017) for successful integration into academia (Gardner, 2007). Lab work, office hours, student engagement, course site maintenance and grading are crucial activities faculty use to socialize their GRA and GTA to become future QM faculty (Justice et al. 2017; Garfield & Everson 2009; Justice, 2020). Although these activities are institutionalized within graduate education departments, there is some variation in its implementation (Gardner, 2007; Gardner, 2008 & Gardner, 2010). The decline of tenured academic jobs, steady growth in the number of adjunct faculty and the fact that most master's and Ph.D.'s work outside of academia (Fetcher, Lam, Cid & Mourad, 2019) are important issues requiring explicit attention within the academic socialization literature (Turk-Bicakci, Berger & Haxton, 2014). All graduate QM students do not aspire towards the faculty role post- graduation. Given this one-track focus, Weidman and Stein (2003) and Bieber and Worley (2006) problematized the minimal foci on the private sector, ethics and service as guiding frames of reference for graduate students.

Professional Socialization

Professional socialization is the social knowledge students acquire to fit in with faculty and peers expectations of the knowledge and skills needed for successful applied practice (Weidman et al. 2003). Pusztai and Csok, (2020) spoke about the pervasiveness

of non-existent or ambivalent professional socialization for graduate students in the social sciences. In order to remedy this, using a sample of 278 doctoral counselling psychology students Langrehr et al. (2017) emphasized the importance of professional society memberships for socialization experiences outside of academia and academic departments.

Goodfellow (2015) administered Weidman and Stein (2003) Doctoral Student Socialization Questionnaire (DSSQ) to 26 doctoral nursing students. The data yielded no significant correlations that future scholarly activities is a priority for their service orientations. Quantitative social work and education scholars have directed considerable focus towards evidence- based GQMC for designing caring and community-based interventions (Beth-Marom, Fidler & Cumming, 2008). Goodfellow (2015) recommended professional socialization practices include exposure to Evidence Based Practices (EBP). EBP is a form of statistical cognition based on the integration of theory, research, and relevant applications to design and administer interventions within different environments and populations (Beyth- Marom et al., 2008). Conclusively a broad range of doctoral student professional socialization experiences exists however none are geared towards understanding how QM can be taught within GQMC to support students' professional aspirations outside of the professoriate and the limitless possibilities of how students can apply their QM training and skills.

Chapter Summary

Contrary to the advice of grounded theory methodological purists I conducted a multidisciplinary and comprehensive review of the literature relevant to graduate students socialization experiences within GQMC. My literature review was necessary to develop my theoretical sensitivities to detect areas of convergence and the novel contributions my findings will provide for QM graduate education. Traditional lectures have persisted as the most widely used teaching modality within GQMC. I detected a predominantly unidirectional foci within the classroom socialization research which depicted students as passive recipients of QM social knowledge and the transmission strategies faculty used while teaching QM. Social identities, student agency and organization misfit emerged as viable counter information graduate students develop to contest uni-directional socialization. Most graduate faculty project tenure track faculty as an ideal professional aspiration for GQMS post-graduation.

CHAPTER THREE

Research Design

Why Qualitative Research?

“Qualitative data is rich in substance and full of possibilities” (Corbin & Strauss 2008, p. 34). Since my area of inquiry has limited previous study, it was important for me to utilize the qualitative research paradigm to creatively stimulate my capacity to produce a rich yet substantive theory of pedagogical socialization (Glaser & Strauss, 1967; Strauss & Corbin, 1990). In order to capture the *how* of qualitative inquiry (Johnson & Rowlands, 2012), I selected grounded theory as the best qualitative approach for answering my primary research question: How do graduate students describe and understand their pedagogical socialization experiences within Graduate Quantitative Methods Courses (GQMC)? I designed my two additional research questions to facilitate my gleaning of graduate students’ perspectives on the recurring patterns of social interaction which underlie their pedagogical socialization experiences. Through each research question I aimed towards holistic knowledge creation (Hesse- Biber & Levy, 2006) where “meaning, interpretation and representation are deeply intertwined” (Denzin 1998, p. 322; Morse, 2018).

The value of conducting qualitative research lies in the importance placed upon actors' interpretations of life events as units of analyses for understanding the thoughts, people, groups, events, processes, and actions comprising their lived experiences (Strauss, 1987). I used the inductive logic of qualitative research to pluralize Graduate Quantitative Methods Students (GQMS) common and varied experiences (Marshall & Rossman, 2011; Meriam & Tisdale, 2016) to provide insight into their Quantitative Methods (QM) "life worlds" within their GQMC (Flick, 2009). I remained committed to documenting my personal subjectivities and those of my participants as data, despite ongoing critiques about subjectivity as a reification of personal bias (Marshall & Rossman, 2011; Meriam & Tisdale, 2016). The subjective orientation of my research process produced a degree of closeness between myself, and participants based on our shared experiences as GQMS and our mutual roles as primary data sources (Lincoln & Guba, 1985).

Grounded Theory Research Design

Grounded theory was developed to strengthen the theory development capacity of qualitative research (Glaser & Strauss, 1965). After over 40 years of individual and collaborative effort, Glaser and Strauss (1967) created a corpus of grounded theory methodologies, methods, outcomes and interpretation strategies which facilitate studying a wide range of events, processes, and conditions inductively. In this chapter I discuss the works of the GT developers, and detractors relevant to the grounded theory research design I developed to capture students lived experiences with pedagogical socialization.

The Formative Years

By merging the methodological, philosophical and historical elements of their professional and social lives, Barney G. Glaser and Anslem L. Strauss formulated grounded theory as a qualitative approach for developing substantive and formal theories in the social sciences (Glaser & Strauss, 1965; Glaser & Strauss, 1967; Strauss, 1987; Strauss & Corbin, 1990). Their first co-authored articles, *Constant comparative analysis: Method of qualitative analysis (1965a)* and the *Discovery of substantive theory: A basic strategy underlying qualitative research (1965b)* introduced concurrent data collection and analyses and constant comparison as indispensable techniques for inductive theory development. In *Awareness of Dying (1965c)* Glaser and Strauss outlined the importance of coding interactional patterns and structural conditions leading to the development of an awareness typology and a contextual theory of dying in hospital settings. This formative work was soon updated in *Temporal Aspects of Dying as a Non- Scheduled Status Passage (1965d)*. Here Glaser and Strauss expanded on time as a determinant of participants everyday social conditions. The longer individuals interact with the phenomenon under inquiry, the more attention qualitative researchers should divert to transitional and structural conditions.

In their subsequent monographs, *The discovery of grounded theory: Strategies for qualitative research (1967)* and *Time for dying (1968)* Glaser and Strauss set out additional guidelines for classifying participants trajectories based upon temporal, behavioral and contextual patterns and their deeper significance for grounded theory

development. *Status Passages* (1970) is Glaser and Strauss summative demonstration of all the grounded theory techniques they developed over time. The seminal contributions of this work as their final co-authored monograph lie in their recommendations for theory development based upon multi-dimensional propositional analyses highlighting the important and mundane aspects of everyday life (Glaser & Strauss, 1970).

Methodological Tension

Despite the notoriety Glaser and Strauss gained as the duo which conceptualized grounded theory, tension surfaced between them on the different paths towards theory development. The strong positivist training of Glaser clashed with the symbolic interactionism of Strauss. This created the rift whereby they parted ways as methodological collaborators. Subsequently each methodologist advanced their own style of Glasserian and Straussian grounded theory (Locke, 1996). Glaser published *Theoretical Sensitivity* in (1978), *Doing Grounded Theory* (1998) and *Emergence vs Forcing: The Basics of Grounded Theory* in (1992). Strauss countered with *Qualitative Analysis for Social Scientists* (1987) and advanced his second iteration of grounded theory with a new female collaborator, Juliet Corbin.

Strauss and Corbin's *Basics of qualitative research: Grounded theory procedures and techniques* (1990) introduced open, axial, and selective coding as additional analytic procedures researchers needed to discover theory (Strauss & Corbin, 1990; Strauss & Corbin, 1998; Strauss & Corbin, 2008). These hierarchical strategies provided important guidelines on the importance of causal and intervening conditions, consequences, and

social change for developing process driven grounded theories. Glaser raised many critiques of Strauss and Corbin's approaches, namely that these changes impeded constant comparison while contributing towards data forcing among the new generation of grounded theory researchers (Glaser, 1992; Glaser, 1998). In *Conceptualization: On theory and theorizing using grounded theory*, Glaser (2002) solidified his reputation as a classical purist by reinforcing the early principles of constant comparison, pattern naming and conceptualization as emergent analytic processes. Throughout much of his later career Glaser continued to cast aspersions on Strauss and Corbin's approaches, arguing that it led researchers to self-select the categories comprising their final theory.

Tension also emerged between Glaser and Strauss on account of Qualitative Data Analysis Software (QDAS). Glaser labelled QDAS as a "rote sorting" and "mechanistic re-modelling" of qualitative data analysis (Glaser 2002, p. 29; Glaser & Holton, 2004) while Strauss & Corbin, (2008) embraced QDAS as a data management tool for tracking hierarchical coding and developing process driven grounded theory. Glaser eventually found a like-minded female collaborator in Judith Horton, and they encouraged both novice and well- seasoned grounded theory researchers to stay open to the classical theoretical coding techniques from Glaser's earlier work *Theoretical Sensitivity* (Glaser & Horton, 2005).

The Softer Paradigm

Although qualitative research is critiqued as a softer, less rigorous approach to research it is not important for me to dispel these assumptions (Charmaz, 2006; Guba &

Lincoln, 1994). Grounded theory was always intended as a methodology that is different from but not equivalent to quantitative research. Grounded theory researchers create their own theories to ensure their independence from the ‘a priori one theory explains all’ mandate of positivist approaches for formulating, testing and verifying theory. The rigor of my substantive theory of pedagogical socialization stems from the several rounds of meticulous coding, comparative analytics, memoing and trustworthiness strategies I applied to ensure my final theory is grounded in participants lived experiences (Glaser & Strauss, 1965).

Positivist Underpinnings

Grounded theory has been critiqued as following after the positivist philosophy of quantitative research (Åge, 2011; Charmaz, 2006; Birks, Nind & Chapman, 2015; Dey, 1993). Glaser and Strauss (1965) countered this evaluation throughout their professional career by advancing that constant comparison is far removed from the hypothetico-deductive logic of quantitative research. For them grounded theorists formulate theories based on emergent hypotheses from sensitive and varied data, not the testing of apriori theory using one single hypothesis at a time. By capitalizing on the “sensitivities of the analyst” (Glaser & Strauss, 1965, p. 438) grounded theorists create emergent theory which captures the full range of personal, temporal and structural conditions which underlie social action, reaction and emotions (Glaser, 1978; Corbin & Strauss, 2008).

Although generalization and quantification are not the goal of grounded theory research this does not belie instances when the language, methodology, methods, and

outcomes of grounded theory designs are congruent with quantitative research (Åge, 2011; Glaser and Strauss, 1967). Parsimony (Glaser and Strauss, 1967; Glaser, 2005), hypotheses testing (Glaser and Strauss, 1965), theoretical fit and modification (Glaser, 1978), logical deductions (Glaser, 1978) and validity (Glaser & Strauss, 1965; Strauss, 1987; Corbin & Strauss, 1990) are all advanced within classical and contemporary GTA using an underlying logic very similar to quantitative research.

Possibilities for Mixed Methods Research

Glaser and Strauss were very forward thinking in their assertion that grounded theory research should provide “clear enough categories and hypotheses” which can be “readily operationalized in quantitative studies” (Glaser & Strauss, 1967 p. 3). Their support for quantitative follow up studies were significant especially during the 1970’s when researchers pitted qualitative and quantitative research as oppositional paradigms contending for methodological dominance. In this era, a mixed methods research paradigm was only a highly contested possibility (Guba & Lincoln, 1994). Glaser and Strauss’ acknowledgement of the possibilities for linking grounded theory with quantitative research is a prelude to exploratory sequential mixed methods research designs. This has important implications for my future work, and identity as a mixed methods researcher. In Chapter Six I discuss my intent to conduct mixed methods research on pedagogical socialization and operationalize my pedagogical socialization theory for subsequent testing among a larger probability sample of GQMS (Glaser & Strauss, 1967).

Procedural Development

It is impractical for me to assume I can replicate every classical and contemporary grounded theory approach within my research design (Strauss & Corbin, 1998).

Understanding these historical issues were integral for me to avoid staging my research design as a smooth coherent whole with minimal tensions attached to its use (Heath & Crowley, 2004; Strauss & Corbin, 1990; Timonen et al. 2018). I integrated some of Glaser and Strauss (1965a); (1967); (1968) classical grounded theory approaches with the second iteration conceptualized by (Strauss & Corbin, 1990; Strauss & Corbin, 1998; Corbin & Strauss, 2008). For the former, the constant comparison analytic technique proved crucial for comparing the codes, concepts, categories, properties and propositions arising from my data. For the latter, Corbin and Strauss provided the most explicit guidelines for generating my integrated process theory on pedagogical socialization.

I also modified some tenets of Glasserian and Straussian grounded theory from the individual works of each author particularly for my open, substantive theoretical coding activities, theoretical explanations and evaluation of my final theory (Heath & Cowley, 2004; Locke, 1996). I understand grounded theory as a genre of qualitative research based upon compatible and competing perspectives. This facilitated my specification of how and why I used different methodologies and methods to support the direction of my data and justify the grounded theory research design I applied to study the pedagogical socialization of GQMS within their GQMC (Strauss & Corbin, 1990).

Grounded Theory Methodology

Methodology is the way grounded theory researchers think about data to conceptualize and develop grounded theory (Strauss & Corbin, 2008; Strauss & Corbin, 1998). I used five “recursive (and) process oriented” grounded theory methodologies to inform the methods of data collection, analysis, verification, and interpretation (Locke 1996, p. 241) I applied to study the pedagogical socialization of GQMS. These grounded theory methodologies include interrelatedness, temporality, contextualization, parsimony, and theoretical sensitivity. In selecting, merging, and applying the methodologies most relevant to my grounded theory research design I demonstrated the value of methodological pluralism within qualitative research (Ralph, Birks, & Chapman, 2015).

Concurrent Data Collection, Analysis and Interpretation

I considered all of my data collection and analysis procedures as interconnected processes to “generate theory while the study is being conducted” (Glaser 1978, p. 2). I recruited participants, refined interview questions and located my sensitivities while coding, memoing, sorting and comparing my data throughout my research process (Glaser & Strauss, 1970). I did not relegate generating findings to the end of data analysis (Glaser & Strauss, 1965; Glaser & Strauss, 1967) but “synchronously collected, analyzed, and interpreted participant data” starting from my first interview (Strauss & Corbin, 1990 p. 6) while I remained flexible to the direction of my data throughout my research process.

Tracking Temporality

Glaser and Strauss (1967); Glaser and Strauss (1968); Glaser and Strauss (1970) and Corbin and Strauss (1990) outlined the passing of time as an important methodological construct for grounded theory development. This assertion was extremely applicable to my study of pedagogical socialization given its existence as a temporal and process driven phenomenon (Miller, 2013; Macionis, 2006). For Glaser and Strauss (1968, p. 32) it is important for grounded theory researchers to pay attention to how the phenomenon intertwines with participants “lived trajectories” (Glaser & Strauss, 1968, p. 32). I codified my data to emphasize the temporal dimensions of the causal conditions, consequences and intervening factors as they occurred over time to create the pedagogical socialization process that graduate students experienced at the beginning, during and end of their time within their GQMC (Strauss & Corbin, 1990).

Contextualization

Grounded theory provides explanations relevant to participants lives and the setting in which they experience the phenomenon (Glaser & Strauss, 1970 p. 188). Contextualization is an important methodological strategy I applied to capture the incidents, conditions and “structural relevancies” (Glaser & Strauss, 1968; Glaser, 1965; Strauss & Corbin, 2008) which produced and reproduced students experiences with pedagogical socialization. Contextualization is a grounded theory methodology I used to code and memo instances when the QM learning environment contributed to the pedagogical socialization process (Glaser & Strauss, 1965; Glaser & Strauss, 1968). I

ensured that my substantive theory of pedagogical socialization contained contextually relevant codes, categories, properties and propositions explaining the QM classroom climate and its effect on the pedagogical strategies faculty used within GQMC. This led to my development of a deeply contextualized theory of pedagogical socialization (Glaser & Strauss, 1965).

Parsimony

Parsimony is an important methodological criterion to achieve maximum theoretical coverage with the fewest possible concepts, propositions and categories (Cutcliffe & Harder, 2009, p. 1401; Glaser, 2002; Glaser, 2005). Simplicity and relevance are the end goals of parsimony (Johnson & Christensen, 2004). I reduced my data via several rounds of coding, theoretical sorting and memoing to account for variations in participants' experiences (Cutcliffe & Harder, 2009). While aiming for a parsimonious theory I linked concepts, categories and their properties together as explanatory themes to achieve the broadest coverage of experiences most suitable to graduate students' pedagogical socialization process (Glaser & Strauss, 1967; Glaser, 2002).

Theoretical Sensitivity

Theoretical sensitivity is my researcher's intuition while querying data to detect "subtle nuances and cues that infer or point to meaning" (Strauss & Corbin, 2008, p. 20). I exercised a vigilant level of care in developing my emergent theory by constantly asking questions of the data during data analysis and interpretation (Glaser, 1978). I adjudged my emergent theoretical sensitivity as indispensable for generating a uniquely

situated parsimonious and contextual theory of pedagogical socialization (Strauss, 1987). During this process I embraced my identity as a grounded theory researcher and GQMS while guarding against preconceived notions based upon the similarities and differences between my personal and professional experiences, those of my participants, and the extant literature (Corbin & Strauss, 2008; Glaser & Strauss, 1967; Heath & Crowley, 1994).

Grounded Theory Methods

The multi-method grounded theory procedures I used to gather, analyze and interpret my qualitative data was founded upon the methodological principles I outlined in the previous section. I selected each method iteratively based on the direction of my data.

Data Collection

Gaining Access and Participant Recruitment

I secured approval from the University of Denver's Institutional Research Board (IRB) for conducting human subjects' research on December 7th, 2020. I began to recruit participants on January 3rd, 2021, and started my first interview on January 5th, 2021. I sent out introductory emails requesting permission from department chairs, academic services associates and administrative assistants at the University of Denver (DU) across the Graduate Colleges of Education, Arts and Humanities, Business and School of Professional Psychology to use departmental listservs to solicit enrolled masters and doctoral students' who completed at least one introductory, specialization or cognate

QMC within their social sciences programs of study (Appendix A). In my solicitation email I asked these students to participate in my participant information survey, one in-depth interview and one follow up interview (Appendix B). I ended all of my participant recruitment activities on February 7th, 2021.

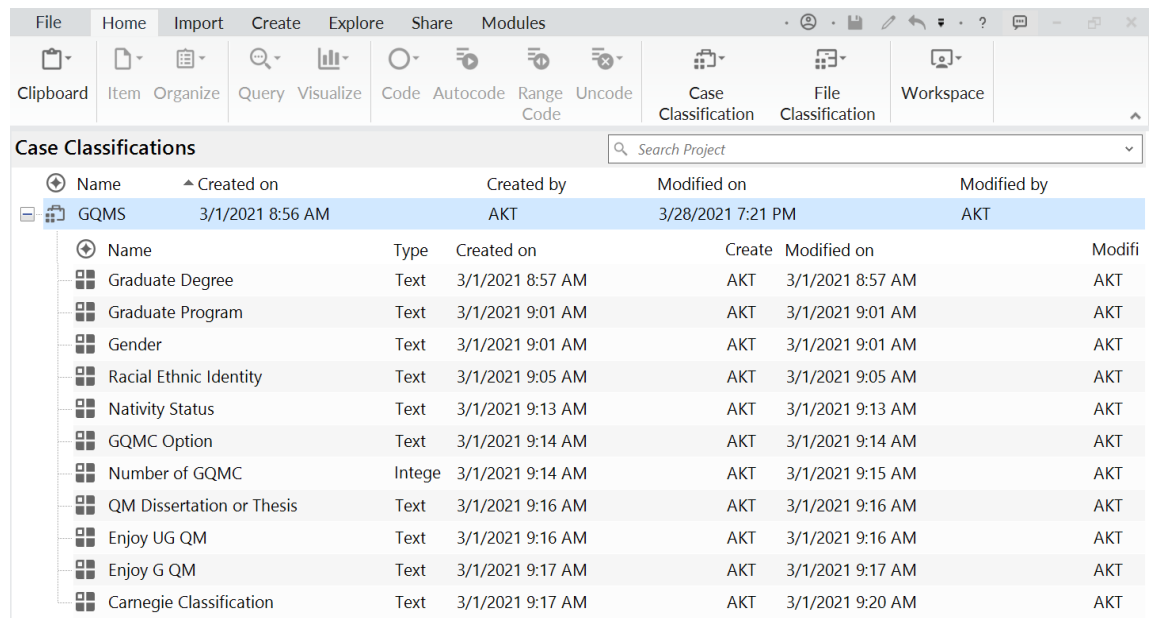
Participant Information Survey

My solicitation email also contained a Qualtrics link to my Participant Information Survey, (Appendix D). After clicking on the link, participants were invited to select the yes response option if they agreed to participate in the survey. Participants who did not consent to participate were invited to click on the no response option and were forwarded to the end of the survey. The graduate students who expressed interest in participating in the study were invited to complete my 12-item participant information screening survey. In this survey I created one question asking students to share their preferred email address for future correspondence. I designed my remaining 11 questions to generate a heterogenous non-probability sample based upon participants: program type, number of completed QMC, gender identity, enrollment status, levels of enjoyment within their undergraduate and graduate QMC, students intent to complete a quantitative thesis or dissertation, nativity, quantitative methods course options, race/ ethnicity and institutional status.

I left my survey open for five weeks while I selected and emailed participants who expressed interest in participating in one in-depth and one follow up interview. Out of a total of 51 participants who completed my survey, I selected 31 respondents for my

study. I used the attributes function in NVivo v. 12 to record the demographic information I generated from my participant information survey. This led to the development of a case classifications database outlined in Figure 2. I presented

Figure 2. Case Classifications Database



Name	Created on	Created by	Modified on	Modified by
GQMS	3/1/2021 8:56 AM	AKT	3/28/2021 7:21 PM	AKT

Name	Type	Created on	Create	Modified on	Modifi
Graduate Degree	Text	3/1/2021 8:57 AM	AKT	3/1/2021 8:57 AM	AKT
Graduate Program	Text	3/1/2021 9:01 AM	AKT	3/1/2021 9:01 AM	AKT
Gender	Text	3/1/2021 9:01 AM	AKT	3/1/2021 9:01 AM	AKT
Racial Ethnic Identity	Text	3/1/2021 9:05 AM	AKT	3/1/2021 9:05 AM	AKT
Nativity Status	Text	3/1/2021 9:13 AM	AKT	3/1/2021 9:13 AM	AKT
GQMC Option	Text	3/1/2021 9:14 AM	AKT	3/1/2021 9:14 AM	AKT
Number of GQMC	Intege	3/1/2021 9:14 AM	AKT	3/1/2021 9:15 AM	AKT
QM Dissertation or Thesis	Text	3/1/2021 9:16 AM	AKT	3/1/2021 9:16 AM	AKT
Enjoy UG QM	Text	3/1/2021 9:16 AM	AKT	3/1/2021 9:16 AM	AKT
Enjoy G QM	Text	3/1/2021 9:17 AM	AKT	3/1/2021 9:17 AM	AKT
Carnegie Classification	Text	3/1/2021 9:17 AM	AKT	3/1/2021 9:20 AM	AKT

a composite summary of GQMS characteristics within my survey and classifications database in Appendix I and J respectively. I also queried my data using the case classifications function in NVivo v. 12 to determine levels of conceptual consistency or divergence within each comparison group.

Consent and Participation

I contacted all selected participants who agreed to participate via the email they provided. In my email I asked for mutually agreed upon dates and times to conduct one 60-to-90-minutes in-depth interview and one 30 to 45 minutes follow interview via

Zoom, (Appendix C). I used my participant confirmation email provided in Appendix E to confirm a mutually convenient date and time for each interview. I also attached a copy of my verbal consent form (Appendix F) to each email with details on participants rights and responsibilities along with my study's purpose.

Theoretical Sampling

Theoretical sampling is an ongoing decision-making process to “maintain consistency in data collection” about when, where, and how to collect data for continuous grounded theory development (Glaser & Strauss, 1967, p. 9; Strauss & Corbin, 1990). I set Zoom to transcribe each interview immediately after completion. I began open coding and memoing immediately using my first interview transcript. I selected 17 participants via theoretical sampling who were most likely to contribute to my emergent findings. During theoretical sampling I added and refined my interview questions to reflect the direction of my data (Creswell, 2013) and my growing sensitivities about my emergent theory (Glaser, 1978).

Chain Referral Sampling

My initial call using the departmental listservs yielded predominantly White and female participants. Chain referral sampling proved useful for targeting participants who identified via additionally diverse characteristics. When my findings pointed out experiences which were connected to GQMS with specific characteristics, I asked my participants and colleagues without sharing any information about my study to distribute my recruitment email and survey link to help me recruit additional participants who may

be able to speak to the issues raised during my interviews (Glaser and Strauss 1967; Corbin & Strauss 1990). I applied this sampling technique to aid in theoretical saturation and increase the likelihood my findings will reflect a breadth of perspectives on the processes that different graduate students consider important (Creswell, 2013). I amended my IRB application to extend my solicitation process for one week to recruit additional participants via this strategy.

Maximum Variation Sampling

Since grounded theory data collection “involves the systematic choice and study of several comparison groups” (Glaser & Strauss 1967, p. 9), I applied maximum variation sampling to generate the fullest extent of my categories, subcategories and descriptive properties as possible (Glaser & Strauss, 1967; Glaser, 1978). Maximum variation sampling involves looking for positive, negative and outlier cases to investigate whether the main patterns still hold during data collection and analysis (Miles, Huberman & Saldana, 2013). This also informed my decision to recruit QM students who switched their intent to complete qualitative Dissertations instead of quantitative dissertations and those that enjoyed and did not enjoy their undergraduate and graduate experiences.

Interviewing

Interviews are my primary method of data collection. I began my in-depth interviews with get to know questions and introductory statements to establish casual closeness between myself and participants (Johnson & Rowlands, 2012). During each interview I used a rapport style delivery to encourage participants to reflect upon their

lived experiences within their GQMC (Johnson & Rowlands, 2012). Our in-depth interviews unfolded as conversations which searched for “deep information and understanding” about the values, norms, expectations, attitudes and behavioral patterns connected to students QM teaching and learning experiences (Glaser & Strauss, 1965; Johnson & Rowlands, 2012, p. 102).

Interview Protocol

I created my initial structured interview protocol based on my literature review. I pilot tested my initial structured interview protocol among a group of six colleagues; four doctoral and two masters’ students; who completed at least one GQMC. The structured protocol I furnished in Appendix G is the final product of my iterative interviewing process that began with 12 questions and expanded into 30 questions at the end of my pilot testing, theoretical sampling and interviewing process. I also asked all participants my initial 12 questions to maintain conceptual consistency between all responses (Creswell, 2013). In following the direction of my data, I sought concepts developed from initial interviews in all my succeeding interviews (Strauss & Corbin, 1990).

Unstructured Interviewing

I used unstructured interviewing to facilitate an emergent dialogue between myself and my participants (Marshall & Rossman, 2011). My unstructured interviewing strategy included free style questions based on participants last response. This ensured that I gained the information most relevant to graduate students pedagogical socialization process, (Seidman 2006, p. 83). I avoided asking leading questions and used responsive body

language, eye contact and attentiveness to communicate I was listening carefully and with thoughtful interest to what each participant was sharing (Hesse- Biber, 2007; Johnson & Rowlands, 2012). For Lester and Spencer (2011, p. 44) my addition of an unstructured approach to interviewing “facilitates a constantly changing dialogue which allows individuals to negotiate their sense of self, identity, (and) social or cultural meanings”. This is integral for an accurate depiction of the phenomenon under study from participants perspectives.

Follow Up Interviews

I conducted follow up interviews via Zoom with 29 participants as a member checking strategy. I also shared one in-depth interview transcript with one participant who was unable to attend our follow up interview due to a hectic schedule. During in-depth interviews I shared my screen on Zoom to facilitate participants viewing of their interview transcripts to clear up any possible ambiguity or misrepresentation. I also conducted follow up interviews to provide participants with a level of comfort about the data they shared for analysis. All follow up interviews lasted between 30 to 97 minutes. At the end of all interviewing, I created 60 transcripts from 31 in-depth and 30 follow up interviews. I converted my transcripts into 253 pages of single-spaced text documents in Microsoft Word format.

Audio and Video Recording

I audio/ video recorded all interviews via the Zoom Video Communications Software. Zoom is a collaborative video conferencing tool for real time audio, video, and

text- based communication (Archibald, Ambagtsheer, Casey & Lawless, 2019; Zoom Video Communications Inc, 2020). I completed each interview using my University of Denver Zoom student account. The software's audio video capabilities allowed for digitization of face-to-face interviewing, building rapport with my participants, and documenting facial expressions and gestures as additional sources of data. Zoom emerged as the most convenient strategy for completing in-depth and follow up interviews based on participants busy schedules and my remote location conducting my Dissertation research as an international Doctoral candidate in my home country, Trinidad, and Tobago. During this time, I also could not return to the US to conduct my research on account of the coronavirus pandemic and lockdown restrictions.

I asked all participants to record interviews verbally and via my individual consent forms I sent out on Qualtrics at least five days before each interview. I saved all interviews using the Zoom recording feature. I set Zoom to encrypt and protect each recording using a unique password. I alone had access to these passwords. I set Zoom to automatically transcribe each audio recording verbatim at the end of each interview to create raw qualitative data. The Zoom software completed transcription within seven hours of each interview. I de- identified all transcripts using the pseudonyms participants provided at the beginning of each interview. I also removed all identifiable references to participants, participants institutions and faculty teaching their GQMC.

Challenges with Zoom

I experienced technical lags and poor audio and video quality during eight in-depth interviews. These technical difficulties lasted between two to seven minutes. I also had a few challenges with Zoom's transcription features. Participants words were often mis-interpreted by the software's voice recognition technology. I cleared up all mistaken and misspelled words while listening and re-listening to participants audio recordings and during follow up interviews. I stored backup copies of all audio recordings and NVivo files on my password protected Zoom Cloud and Microsoft One Drive secure storage location. I completed all in-depth and follow up interviews on February 24th, 2021 and sent out emails two months later to four randomly selected participants to receive one Amazon \$25 gift card each.

Data Analyses

NVivo v. 12

I uploaded all my de-identified transcripts onto NVivo v. 12 to digitally manage, retrieve and analyze my raw qualitative data. Reading, re-reading and memoing individual transcripts within NVivo v. 12 marked more concrete development of my thought process about my data (Glaser & Strauss, 1965). I designed Table 1. to illustrate all of the grounded theory approaches I applied using relevant features within NVivo v. 12. In my first column I named the different coding, memoing and constant comparison analytic strategies I applied to analyze my participant data. In column two I listed the relevant NVivo v. 12 functions I used to digitally apply each method to each transcript.

The final column contains the outcomes I produced using these techniques. I began data collection and analysis on January 5th, 2021 and ended on April 20th, 2021.

Table 1

Grounded theory methods, NVivo v. 12. applications and outcomes

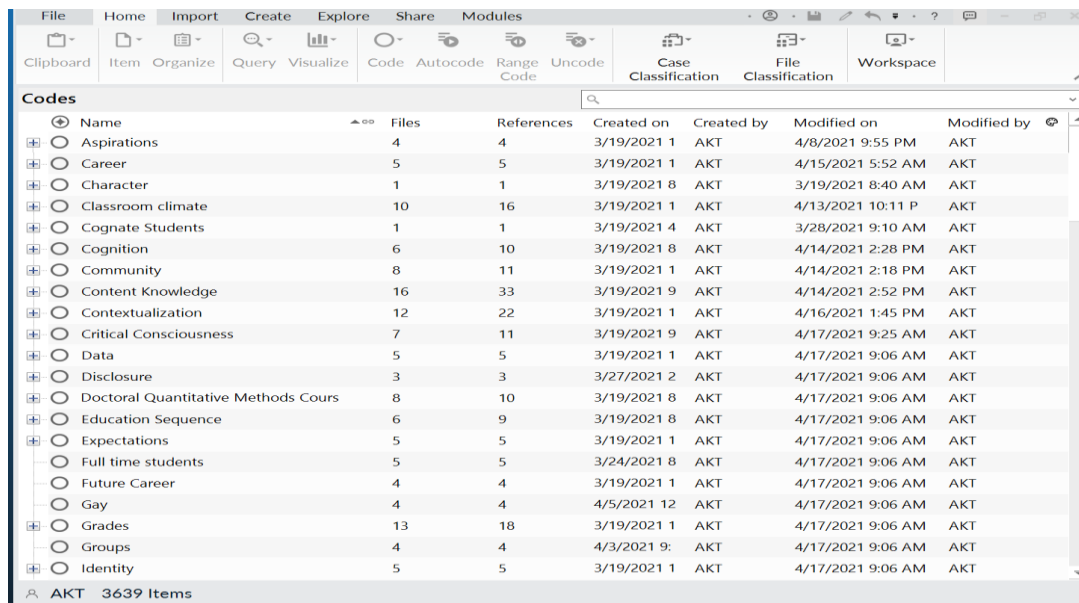
Grounded theory method	Function in NVivo v.12	Grounded theory outcome
Maximum variation sampling	Case classifications: Cases and attributes	Case classifications Demographic database
Open coding	Parent and child nodes	Concepts and properties
Substantive coding	Parent and child nodes	Categories, subcategories and properties
Theoretical sorting	Project maps	Theoretical explanations
Theoretical coding	Relationships and relationship types	Propositions
Constant comparison	Annotations Sort and filter cases and attributes	Theoretical notions
Theoretical sensitivity	Memos and annotations	Theoretical explanations reflexivity

Open Coding

I open coded my text segments using a line by line, word by word micro- analysis strategy to assign concepts to words and word clusters (Strauss & Corbin, 1998; Glaser & Strauss, 1987; Glaser, 1992). I constantly added concepts as I coded each transcript for the first time. Open coding is a crucial process of clustering data to form categories, subcategories and supportive properties (Corbin & Strauss, 2008). While fracturing my data I posed comparative questions to sustain my analytic sensitivities towards the personal, contextual, and temporal implications of GQMS experiences, (Strauss &

Corbin, 1990). I labelled the unique words or phrases participants used to describe their most pressing experiences as *invivo* codes (Creswell, 2013; Glaser & Horton, 2005; Strauss, 1987). I completed my open coding process within NVivo v. 12 using the parent and child nodes function. I created 3639 open codes at the end of my initial coding process

Figure 3. Open Codes Database



Name	Files	References	Created on	Created by	Modified on	Modified by
Aspirations	4	4	3/19/2021 1	AKT	4/8/2021 9:55 PM	AKT
Career	5	5	3/19/2021 1	AKT	4/15/2021 5:52 AM	AKT
Character	1	1	3/19/2021 8	AKT	3/19/2021 8:40 AM	AKT
Classroom climate	10	16	3/19/2021 1	AKT	4/13/2021 10:11 P	AKT
Cognate Students	1	1	3/19/2021 4	AKT	3/28/2021 9:10 AM	AKT
Cognition	6	10	3/19/2021 8	AKT	4/14/2021 2:28 PM	AKT
Community	8	11	3/19/2021 1	AKT	4/14/2021 2:18 PM	AKT
Content Knowledge	16	33	3/19/2021 9	AKT	4/14/2021 2:52 PM	AKT
Contextualization	12	22	3/19/2021 1	AKT	4/16/2021 1:45 PM	AKT
Critical Consciousness	7	11	3/19/2021 9	AKT	4/17/2021 9:25 AM	AKT
Data	5	5	3/19/2021 1	AKT	4/17/2021 9:06 AM	AKT
Disclosure	3	3	3/27/2021 2	AKT	4/17/2021 9:06 AM	AKT
Doctoral Quantitative Methods Cours	8	10	3/19/2021 8	AKT	4/17/2021 9:06 AM	AKT
Education Sequence	6	9	3/19/2021 8	AKT	4/17/2021 9:06 AM	AKT
Expectations	5	5	3/19/2021 1	AKT	4/17/2021 9:06 AM	AKT
Full time students	5	5	3/24/2021 8	AKT	4/17/2021 9:06 AM	AKT
Future Career	4	4	3/19/2021 1	AKT	4/17/2021 9:06 AM	AKT
Gay	4	4	4/5/2021 12	AKT	4/17/2021 9:06 AM	AKT
Grades	13	18	3/19/2021 1	AKT	4/17/2021 9:06 AM	AKT
Groups	4	4	4/3/2021 9:	AKT	4/17/2021 9:06 AM	AKT
Identity	5	5	3/19/2021 1	AKT	4/17/2021 9:06 AM	AKT

AKT 3639 Items

Substantive Coding

The goal of substantive coding is to hypothesize about the “empirical substance” of each open code to integrate several codes to form categories. (Glaser, 1978, p. 55; Glaser, 1978; Hernandez, 2009). During open coding I fractured my data and took apart each participants story to put the data back together via a re-ordered scheme of categories, subcategories and their properties (Glaser & Strauss, 1967). Categories must be fully developed and interconnected (Corbin & Strauss, 1990). During this intermediate

phase I also created and subsumed sub-categories under a central or core category. My substantive coding process marked the beginning of the refinement phase of my grounded theory analysis because as I formed subcategories around each core category. I developed the codes and concepts which emerged during open coding as properties explaining the dimensions of each subcategory. This was integral for my theory development process because during substantive coding I began to ‘see’ what was going on in my data (Glaser, 1998). I created 729 substantive codes using the parent nodes function in NVivo v. 12. I created project maps in NVivo v. 12 of all substantive codes and engaged in a continuous process of selecting, assigning, reassigning and sorting my open codes to form each category, subcategory and supporting properties. I named all of the categories I built up during substantive coding using my code properties function.

Figure 4. Substantive Codes Database

Name	Files	Reference	Created on	Created by	Modified on	Modified by
Aspirations	2	2	3/19/2021 12:47 PM	AKT	3/20/2021 5:08 AM	AKT
Career	1	1	3/19/2021 12:51 PM	AKT	3/19/2021 12:51 PM	AKT
Character	1	1	3/19/2021 8:40 AM	AKT	3/19/2021 8:40 AM	AKT
Classroom climate	3	6	3/19/2021 11:27 AM	AKT	3/21/2021 10:34 PM	AKT
Cognate Students	0	0	3/19/2021 4:32 PM	AKT	3/19/2021 4:32 PM	AKT
Cognition	3	5	3/19/2021 8:49 AM	AKT	3/21/2021 10:24 PM	AKT
Community	2	3	3/19/2021 1:20 PM	AKT	3/19/2021 9:59 PM	AKT
Content Knowledge	3	10	3/19/2021 9:26 AM	AKT	3/21/2021 11:07 PM	AKT
Contextualization	3	7	3/19/2021 12:20 PM	AKT	3/21/2021 11:07 PM	AKT
Critical Consciousness	2	3	3/19/2021 9:41 AM	AKT	3/19/2021 9:39 PM	AKT
Data	2	2	3/19/2021 12:50 PM	AKT	3/19/2021 8:17 PM	AKT
Doctoral Quantitative Methods Courses	2	2	3/19/2021 8:50 AM	AKT	3/20/2021 10:54 AM	AKT
Education Sequence	2	2	3/19/2021 8:40 AM	AKT	3/20/2021 9:35 AM	AKT
Expectations	1	1	3/19/2021 12:28 PM	AKT	3/19/2021 12:28 PM	AKT
Future Career	1	1	3/19/2021 12:48 PM	AKT	3/19/2021 12:48 PM	AKT
Grades	3	6	3/19/2021 12:08 PM	AKT	3/21/2021 6:14 AM	AKT
Identity	1	1	3/19/2021 1:04 PM	AKT	3/19/2021 1:04 PM	AKT
Identity Development	3	3	3/19/2021 12:50 PM	AKT	3/21/2021 10:27 PM	AKT
Learning Style	1	1	3/19/2021 9:59 AM	AKT	3/19/2021 9:59 AM	AKT
Mathematics	3	3	3/19/2021 8:42 AM	AKT	3/21/2021 6:02 AM	AKT
Mixed Methods	1	1	3/19/2021 9:41 AM	AKT	3/19/2021 9:41 AM	AKT

AKT 729 Items

Theoretical Coding

I created my theoretical codes while sorting through my codified data, analytic memos and during constant comparison (Glaser, 1978; Glaser, 2005). I applied theoretical coding to “conceptualize relationships between my substantive codes as propositions to be integrated into the theory” (Glaser, 1978, p. 55). I found that a number of theoretical codes emerged to specify the relationships between two or more of my substantive codes (Hernandez, 2009). I created theoretical coding families based on relationships and interrelationships within my categories and subcategories (Glaser, 1978). Creating theoretical codes was crucial to my grounded theory development process because it resulted in my wide ranging yet parsimonious theory (Glaser, 2005). I also used the project maps function in NVivo to sort all my theoretical codes leading to the development of my three main themes. All data and my audit trail supportive of the development of my three main themes can be found in Appendices L, M and N respectively.

Memoing

I listened and re-listened to each audio recording while reading my uploaded transcripts within NVivo v. 12. This process proved beneficial for analytic memoing. My memos are my reflective and analytic notes I jotted down during and after interviews and my three round data codification process (Corbin & Strauss, 2008). I began analytic memoing when I wrote a summary of my main thoughts on each participant, their narratives, and my impressions about what they revealed at the end of each interview. As

I began to think about emergent concepts and relationships my memos proved useful for capturing my internal dialogue with my data (Glaser, 1965; Glaser & Strauss, 1965; Corbin & Strauss, 2008). I created memos to bracket aside my preconceived notions while creating autobiographical sketches of instances when participants experiences coincided with my own. I utilized the annotations function within NVivo v. 12 for memoing. I added all of my manually created memos to the relevant participant transcript within NVivo v. 12. At the end of this process, I created the 116 memos presented in Figure 5. below.

Figure 5. Analytic Memos and Annotations Database

File	Home	Import	Create	Explore	Share	Modules									
Clipboard	Item	Organize	Query	Visualize	Code	Autocode	Range Code	Uncode	Case Classification		File Classification		Workspace		
Annotations									Search Project						
	File Name	▲ Number		In Folder	Created on		Created b	Modified on	Modified						
	Interview 1- Isabelle	1		Files	3/23/2021 4:36 AM		AKT	3/23/2021 4:37 AM	AKT						
	Interview 1- Isabelle	2		Files	3/23/2021 4:49 AM		AKT	3/23/2021 4:51 AM	AKT						
	Interview 1- Isabelle	3		Files	3/23/2021 4:55 AM		AKT	3/23/2021 4:59 AM	AKT						
	Interview 1- Jane	1		Files	3/23/2021 1:32 PM		AKT	3/23/2021 1:33 PM	AKT						
	Interview 1- Jane	2		Files	3/23/2021 6:06 PM		AKT	3/23/2021 6:06 PM	AKT						
	Interview 1- Jane	3		Files	3/23/2021 6:14 PM		AKT	3/23/2021 6:15 PM	AKT						
	Interview 1- Jane	4		Files	3/23/2021 6:42 PM		AKT	3/23/2021 6:44 PM	AKT						
	Interview 1- Jane	5		Files	3/23/2021 7:21 PM		AKT	3/23/2021 7:26 PM	AKT						
	Interview 1- Jessica	1		Files	3/24/2021 3:22 PM		AKT	3/24/2021 3:23 PM	AKT						
	Interview 1- Jessica	2		Files	3/24/2021 7:30 PM		AKT	3/24/2021 7:30 PM	AKT						
	Interview 1- John	1		Files	3/25/2021 12:34 PM		AKT	3/25/2021 12:35 PM	AKT						
	Interview 1- Lini	1		Files	4/1/2021 6:05 AM		AKT	4/1/2021 6:06 AM	AKT						
	Interview 1- Lini	2		Files	4/9/2021 9:38 AM		AKT	4/9/2021 9:38 AM	AKT						
	Interview 1- Lini	3		Files	3/27/2021 5:03 PM		AKT	3/27/2021 5:03 PM	AKT						
	Interview 1- Lini	4		Files	3/27/2021 5:12 PM		AKT	3/27/2021 5:13 PM	AKT						
	Interview 1- Lini	5		Files	3/27/2021 5:16 PM		AKT	3/27/2021 5:17 PM	AKT						
	Interview 1- Lisa	1		Files	3/28/2021 9:15 AM		AKT	3/28/2021 9:16 AM	AKT						
	Interview 1- Lisa	10		Files	4/1/2021 6:27 AM		AKT	4/1/2021 6:28 AM	AKT						
	Interview 1- Lisa	11		Files	4/3/2021 11:53 AM		AKT	4/3/2021 11:53 AM	AKT						
	Interview 1- Lisa	12		Files	4/3/2021 12:00 PM		AKT	4/3/2021 12:01 PM	AKT						
	Interview 1- Lisa	13		Files	4/3/2021 12:08 PM		AKT	4/3/2021 12:09 PM	AKT						
	AKT 116 Items														

Constant Comparative Analysis

The relationships function in NVivo v. 12 was useful for carrying out constant comparison analysis on my codified and memoed data. The goal of constant comparison is conceptual and categorical integration (Glaser & Strauss, 1967). I constantly compared my old information with all new and incoming information based on my theoretical sampling strategy (Chiovitti & Piran, 2003). I used constant comparison as a developmental method of data analysis to compare, contrast and integrate codes, categories and properties to make sense of my emergent theoretical notions about pedagogical socialization (Corbin & Strauss, 2008; Glaser, 1965). I arranged my interrelated propositions to reflect my open, substantive and theoretical codes.

During constant comparison I remained vigilant for parsimony, conceptual fit and levels of embeddedness between concepts, categories and the relationships between them (Glaser, 1978). Glaser, (1967, p. 441) summed up constant comparison as activities which keep “a close correspondence of the theory to the data”. I also recorded any tensions between structure and participants agency while comparing my codified data (Glaser & Strauss, 1967). Constant comparison marked the beginning of my grounded theory verification process based on several hypotheses which arose from varied data (Glaser & Strauss, 1965.) At the end of my constant comparison process I verified that participants narratives were well represented by my well-developed categories, subcategories with supportive properties explaining the “what, how, when, where and why” (Strauss & Corbin 2008, p. 42).

Theoretical Saturation

Saturation means no additional information is forthcoming from my data. I experienced different levels of saturation while coding and comparing my data. I experienced conceptual saturation during open coding as my initial stage of theoretical saturation (Breckenridge & Jones, 2009). I experienced theoretical saturation during substantive coding and my category development process when “no new properties, dimensions, or relationships emerged during analysis” (Strauss & Corbin, 1998, p. 143). I achieved saturation during my theoretical coding when analogous relationships between categories continuously re-occurred until I could produce no new propositions (Glaser, 1978). My theoretical gaps decreased during theoretical saturation (Glaser, 1965b). At the end of my constant comparison process I was certain I created the most parsimonious yet expansive theory which could emerge from the different levels of my data (Glaser & Strauss, 1967).

Theoretical Sorting

I applied theoretical sorting as an analytic procedure while grouping together my analytic memos. During this process I developed a deeper understanding of all my concepts, categories, subcategories and properties emerging from my data (Glaser, 1978). This proved crucial for creating my initial theoretical outline of my pedagogical socialization theory. The theoretical sorting of my theoretical codes is presented in Appendix L, Appendix M and Appendix N. The project maps function in NVivo v. 12 proved crucial for looking across my data for theoretical explanations and verbatim

quotations for my final write up of my theoretical framework (Glaser, 1978; Strauss & Corbin, 1998).

Grounded Theory Outcomes

A “theory is a set of well- developed concepts related through statements of relationships which together constitute an integrated framework which can be used to explain or predict phenomena” (Strauss & Corbin, 1998, p. 15). This means that my entire analytic process of generating concepts and properties from open coding, categories and propositions during substantive coding, theoretical propositions during theoretical coding and conceptual and categorical relationships during constant comparison are all interrelated developmental processes for creating my substantive pedagogical socialization theory. In this section I provide a more detailed description of the products of each of these analytic procedures and its implications for my theory development process.

Concepts

Concepts are the initial data produced by open coding (Glaser, 1978). All the concepts created from my initial data analysis process represents the experiences, spoken words, actions, interactions, problems, and issues of my participants (Glaser, 1978; Strauss & Corbin, 2008). The conceptual density of my open coding process is represented by the breadth of emergent categories and subcategories which emerged to describe GQMS pedagogical socialization experiences in Chapter Four.

Categories and Subcategories

Categories are higher-level concepts I created after joining my open codes during substantive coding (Glaser, 1978; Strauss & Corbin, 2008). I created meaningfully integrated categories and subcategories representing the full range of concepts, dimensions, the conditions representing students major concerns about their pedagogical socialization experiences (Glaser & Strauss, 1967). My categories also emerged after constant comparison analysis to reveal the theoretical properties of my pedagogical socialization theory which arose from the different levels of data (Glaser, 1987). I also developed three main themes to capture all the categories, subcategories and properties underlying my pedagogical socialization theory.

Properties

Due to the volume of qualitative data forming the properties of each core subcategory was an important step which ensured I was not engulfed by my data and emergent findings during coding (Corbin & Strauss, 2008). My properties emerged while open coding and breaking apart my data during micro analysis. My properties became solidified as I created and integrated my core categories and subcategories and brought each together to specify and describe participants experiences (Corbin & Strauss, 2008, p. 32). I compared each property during constant comparison analysis to show variation in the dimensions of my emergent data, (Timonen et al. 2018). While forming the properties of my core and subcategories I started hypothesizing about the interrelations between

them. This provided a comparative basis for the theoretical explanations and propositions comprising my grounded theory of pedagogical socialization (Birks & Mills, 2015).

Propositions

I theoretically coded my data to “conceptualize relationships between substantive codes” and form “propositions to be integrated into the theory” (Glaser 1978, p. 55).

Propositions are the final outcome of substantive and theoretical coding when the researcher develops hypotheses on the relationships between categories (Strauss & Corbin, 1998) and finds evidence which represent participants premises about the relations of their everyday life (Glaser, 1978; Glaser, 2005). I created my propositions in directional form within NVivo v. 12 to interrelate my categories and properties (Creswell, 2013). In my final write up I checked my propositions against incoming literature and modified or extended all of my propositions during constant comparison (Strauss & Corbin, 1998). In Chapter four I wove together my propositions as relational statements to produce a cohesive narrative about GQMS pedagogical socialization experiences.

Substantive Process Theory of Pedagogical Socialization

My pedagogical socialization theory is a substantive rather than formal theory. Substantive theories emerge when grounded theory researchers present and substantiate core categories using subcategories, properties and propositions to describe their theory’s inner intricacies while demonstrating deep relevance to participants experiences (Corbin & Strauss, 2008; Glaser & Strauss, 1967). In keeping with my interrelated, parsimonious, contextual and temporal methodologies my main themes demonstrated the “greatest

explanatory relevance and highest potential for linking all other analytic sources together” (Corbin & Strauss, 2008, p. 59; Glaser & Strauss 1967). My theory also inductively emerged as a set of causal conditions, consequences and outcomes that are internal and external to GQMS socialization experiences (Corbin & Strauss 1998; Corbin & Strauss, 2008). I embedded a combination of visual diagrams within my writing to communicate the overall flow of these processes. In Chapter Four I presented my grounded pedagogical socialization theory as a thick, contextual, and descriptive theoretical discussion of GQMS experiences (Glaser & Strauss, 1967; Strauss & Corbin, 1997).

Trustworthiness

Those reading my Dissertation should develop a level of trust about my findings. In order to increase the levels of rigor within my study I used a variety of qualitative research techniques to evaluate the trustworthiness of my grounded theory research design and interpretive knowledge claims (Strauss & Corbin, 1998; Morse, 2015). I joined the longstanding tradition for demonstrating qualitative rigor and trustworthiness using credibility, transferability, dependability and confirmability techniques within my qualitative research process (Lincoln & Guba, 1985; Morse, 2018).

Credibility

Credibility is based upon my ability to present believable evidence that my theory is a faithful and vivid presentation of participants experiences with pedagogical socialization (Chiovitti & Piran, 2003). My credibility as a grounded theory researcher is

also established when participants and all readers of my Dissertation can find affinity with my findings as reflective of their own experiences. In this section I also built an awareness of my feelings and relevant experiences (Strauss & Corbin, 2008). I laid bare my subjectivities so my audience can distinguish how my experiences impacted upon my work.

My Role as a Researcher

I am the primary medium framing my research. Therefore, it is unrealistic to assume that I collected and analyzed data without different mental models and lived experiences guiding my research (Heath & Crowley, 1994; Glaser, 1967). In this section I frame my role as a researcher by describing my reflexivity and personal positionalities which were present during all stages of my research design.

Reflexivity

The best thing I can do for my readers is to outline some of my most impactful experiences and show how those defining moments shaped my research (Corbin & Strauss, 2008; Ralph et al. 2015). I began my Dissertation with my introductory vignette to describe my personal experiences which influenced my selection of my study's research problem (Lincoln et. al. 2018). I approached my grounded theory study from a position of personal wonderment about my experiences and identity as a GQMS throughout my educational trajectory and most importantly as a doctoral student. This is what Strauss and Corbin (1998); Corbin and Strauss (2008) called putting my experience to good use especially

because I shared a common culture and participated in similar cultural activities as my participants.

Positionality

I identify as a Black Trinidadian, female, cisgender, first generation, international doctoral candidate. The island of Trinidad in the Caribbean is my native home. In 2016, I travelled to the United States to pursue my Ph.D. in the University of Denver's Research Methods and Statistics specialization program. I was dependent on myself, my family, community and institutional funding to finance my Doctoral degree. Four years prior I taught undergraduate social sciences qualitative, quantitative research methods courses as fulltime faculty and a Tutor at two of the local Universities.

When I transitioned to my Doctoral program I was prepared for the triumphs but not the struggles I encountered. Some accomplishments included presenting at a few conferences, completing publications, finding mentors inside and outside of my program who were invested in my success and gaining a small but supportive community of fellow graduate students. However enjoyable these positive experiences were they did not prepare me for some of the challenges I faced within my GQMC. I did not think that GQMF and students perception of my nativity and the color of my skin would impact on my ability to learn understand QM within my GQMC, but sometimes it did. Back home my introverted personality as a Black woman was never perceived as problematic until I began to interact with some of the students, faculty and advisors within my department. I never expected that some faculty would hold up some of the Black students enrolled

within my program as templates I should follow. After all we were different people who lived different lives before we came into the program.

I realized that within the QM classes I enjoyed instructors were consistent in their treatment of me as with all students. I appreciated whenever their love for their profession and skills shone through, and they demonstrated genuine interest in relating QM to the needs of each student. In the classes I did not enjoy, I knew I was not valued, and my presence was not welcomed by faculty, students and even the graduate teaching assistants faculty selected to support their teaching. In those classes I existed as a silent observer of the topics and students being affirmed and those who were not.

As a sociologist I was socialized to understand that people are inherently subjective and tend to imbue all their activities with subjectivity. When coupled with my lived experiences within my GQMC I began to perceive that GQMF, QM approaches to research and the classroom pedagogy GQMF used within their classes were neither neutral nor objective. As I embarked upon my Dissertation research I journaled my experiences and wrote about the ways GQMF could improve their pedagogy to ensure that every GQMS can learn and understand QM, while being valued and affirmed within GQMC.

Research Journal

Throughout all stages of my research process, I kept a research journal to maintain the credibility of my grounded theory results (Chiovitti & Piran, 2003; Corbin & Strauss, 2008). In my journal I meaningfully recorded dates and times, logistical issues and

fieldnotes on capturing participants spoken words, body language and backgrounds within the Zoom virtual space, my personal feelings and reflections about GQMS, how students described their experiences and the inductive nature of my grounded theory research process (Corbin & Strauss, 2008). My journal emerged as a crucial tool for balancing my subjectivity with a reflexive consciousness about the impact my experiences can have on my research process. I cross referenced my handwritten jottings with my digitized analytic data in NVivo v.12. This proved helpful for tracking my data and verifying findings (Maher, Hadfield, Hutchings & de Eyfo, 2018).

Triangulation of Interview Questions

Triangulation is a validation strategy based on the application of multiple methodological approaches to study the same phenomenon. I used differently framed questions about students teaching and learning process within GQMC at the beginning, middle and end of each interview (Appendix G) as a triangulation strategy to collect and analyze “different data on different levels and with different qualities” (Flick 2018, p. 787). I also triangulated my interview questions as a self-correcting procedure of qualitative research which increased the relevance and interpretability of my findings (Creswell & Miller, 2000; Yin, 2009).

Theoretical Credibility

Grounded theory researchers “maximize their theory’s credibility by using comparative groups” within their research design (Glaser & Strauss 1967, p. 5). Using theoretical, chain and maximum variation sampling strategies which facilitated

generating a heterogeneous sample comprised of diverse subgroups of GQMS. Through constant comparison analyses, I gleaned crucial details on the similarities and differences between both groups and the interpersonal and structural circumstances which contributed towards their experiences (Glaser & Strauss, 1967).

Dependability

Dependability is the consistency with which I documented all my research procedures. My audit trail is very important for establishing this trustworthiness criteria because it will facilitate readers of my work into following, repeating and critiquing my methodological procedures (Lincoln & Guba, 1985).

Audit Trail in NVivo v. 12

When using any form of QDAS it is best practice to give a transparent account of each analytic strategy and its practical applications to increase methodological rigor and trustworthiness (Corbin & Strauss, 2008; Maher, et al. 2018). An audit trail is a detailed discussion and representation of the reflexive choices (Morse, 2018) I used to manage my qualitative data and conduct each method of data analysis within NVivo v. 12. In Table 1. I presented each grounded theory analytic strategy along with the function in NVivo v. 12, I used to carry out each technique.

I also created and perused my 69-page NVivo codebook using the reports and queries function within the software. I also provided screenshots of the relevant sections of my NVivo database to provide visual evidence which confirms the research process I

used to arrive at my findings (Maher, et al. 2018). My audit trail also provides useful guidance for researchers on using NVivo to conduct their own grounded theory research.

Transferability

Transferability is based on a researchers ability to gauge whether their findings significance is shared with broader social audiences (Lincoln & Guba, 1985). I pilot tested my interview protocol, completed peer reviews and member checking to establish the transferability of my research findings. My qualitative contextualization methodology and three sampling techniques also proved useful for understanding the extent my theory holds true among introductory, cognate and specialization GQMS, within different GQMC at multiple institutions (Lincoln & Guba, 1985).

Pilot Testing my Interview Protocol

The key to getting good data is asking good questions. I conducted six pilot interviews with four doctoral GQMS and two masters students. My pilot interviews were crucial for getting interviewing practice, and learning which questions were confusing and needed rewording based upon respondents suggestions (Meriam & Tisdale, 2016). When I cleared up the ‘what and how’ I needed to ask participants this minimized “confusing positioning between myself and my participants within my interview schedule” (Bryman 2012, p. 263). Testing my interview protocol also increased my ability to obtain responses not based on misinterpreted questions. This increased the quality and dependability of the raw qualitative data I collected.

Peer Review

This was part of my process for authenticating my qualitative findings among peers and colleagues external to my study but well versed in grounded theory methodology (Creswell, 2013; Morse, 2018). I scheduled one 60-minute Zoom meeting with two colleagues. One colleague is a junior faculty in sociology and the other an education researcher. During each meeting we discussed my research design and all the functions I used within NVivo v. 12 to conduct my research. Both colleagues shared valuable insights, critiques and asked deep questions which helped me to strengthen the methodological and practical significance of my design and emergent results (Morse, 2018).

Member Checking

Having participants review their in-depth interview transcripts and clear up any ambiguity in their responses proved useful for ensuring that all GQMS felt satisfied their de-identified data will produce the most accurate representation of their lived experiences (Corbin & Strauss, 2008).

Maximum Variation Sampling

I used a maximum variation sampling technique to select diverse subgroups of graduate students to understand the common patterns within and between groups. Using the case classification function in NVivo v. 12 (Figure 2.) proved useful for capturing the extent my main themes, categories, subcategories, and properties portrayed students shared experiences (Johnson, 2008).

Confirmability

Confirmability are the steps I took to internally verify the analytic methods I used to arrive at my findings (Morse, 2018; Strauss & Corbin, 1990). There is a possibility that during my data analysis process in NVivo v.12 I accidentally placed data in “a category where it did not analytically belong” (Strauss & Corbin, 1990 p. 13). Engaging in constant comparison was a useful procedure which allowed me to locate any errors I committed during open, substantive and theoretical coding. I corrected these missteps by reassigning data and concepts to appropriate classifications (Wilson & Hutchinson, 1990). Using constant comparison proved helpful for ensuring fidelity to my methodological process.

Chapter Summary

I merged classical and contemporary approaches to create the grounded theory research design I put together to follow the direction of my data. I applied interrelatedness, temporality, contextualization, parsimonious and theoretically sensitive methodologies to the methods of data collection, analysis and interpretation I applied within my design. In-depth interviews with 31 GQMS via Zoom was my primary method of data collection. I analyzed my raw qualitative data digitally within each interview transcript using a combination of open, substantive and theoretical strategies, memoing and constant comparison within NVivo v. 12. These techniques facilitated emergence of the concepts, categories and subcategories, properties and propositions explaining the causal factors, intervening conditions and consequences which comprise my substantive

process theory of pedagogical socialization. I used a combination of credibility, transferability, dependability and confirmability procedures to ensure the trustworthiness of my emergent findings.

CHAPTER FOUR

Findings

In this Chapter, I present the findings which led me to develop my theory of pedagogical socialization. First, I provide a composite overview of the 31 Graduate Quantitative Methods Students (GQMS) who participated in in-depth and follow up interviews. Next I discuss the implications of confidentiality, representation and participants voices for centering graduate students lived experiences within their Graduate Quantitative Methods Courses (GQMC). Finally, I provide a theoretical explanation of my three main themes, emergent concepts, categories and properties comprising my process theory of pedagogical socialization.

Participants Composite Summary

In Appendix I, I provided a composite summary of my final sample of the 31 participants I recruited and interviewed using my initial inclusion criteria, Participant Information Survey, theoretical, chain referral and maximum variation sampling strategies. Seven participants identified as introductory, five as cognate and 19 as specialization GQMS. Students completed a range of one to 20 GQMC at the masters or doctoral level. Nine students completed one to three courses, 13 completed four to six,

three completed between seven to 9 courses and six students completed 10 and upwards GQMC.

Two students were enrolled in Historically Black Colleges or Universities (HBCU), 20 within private and nine in public higher education institutions. 22 participants identified as female and nine identified as male. In answering my race/ethnicity screening question, six participants identified as African American, four identified as Asian and one as Asian American, two identified as Latina and one as Latino, one student selected the biracial category and two students identified as multiracial, eight students identified as White American and two as White European, one student is Pueblo Laguna, two GQMS identified as Saudi Arabian and one participant self-identified as South American. 21 students indicated that they were US citizens and 10 identified as international GQMS.

Regarding program status, four students were enrolled in masters programs while the remaining 27 were enrolled in doctoral programs. 18 participants reported they enjoyed their undergraduate quantitative methods courses while 13 students did not enjoy their undergraduate experiences. 17 students enjoyed their experiences within their GQMC, and 14 reported they did not enjoy their experiences. Finally of the 31 participants, 19 intended to complete their dissertation using only quantitative methods while 12 GQMS decided to complete their dissertations using different research paradigms.

Implications of my Participant Information Survey

My composite summary of Graduate Quantitative Methods Students (GQMS) characteristics represents participants responses to the options I provided within my screening survey. I am mindful that I represented student identities as predetermined social categorizations that I encouraged each participant to complete to participate in one in-depth and one follow up interview. During my in-depth interviews, some participants provided greater clarification on their responses to my screening survey. Some GQMS described the nuances connected to their racial and ethnic identities and programmatic classifications of their quantitative methods courses. Four GQMS who were US citizens emphasized their second-generation immigrant backgrounds. For the students who indicated they did not enjoy their courses most made sure to express their appreciation for QM. Ten students reported on their desire to complete a qualitative dissertation while two vouched for mixed methods.

Most GQMS enjoyed selecting their pseudonyms and spoke very openly about their experiences. Six students were very cautious in wanting to select the best pseudonym which would not allow them to be detected or identified by GQMF or peers within their GQMC. I asked each of these participants about their reactions/actions. Each shared that they experienced minor anxiety over possible repercussions should some faculty or students connect them to the information they shared while participating in my study. For these participants I re-iterated my consent form pledge to protect and maintain the privacy and confidentiality of everyone who participated in my research.

This was an unexpected dynamic which emerged during my interviewing process which lends credence to the widespread perception that because quantitative research is one of the most revered paradigms in the social and behavioural sciences (Creswell & Creswell, 2018), QM faculty wield considerable power and influence within academia (Teddle & Tashakori, 2009). I regarded this as an important initial data source that some GQMS must navigate the power dynamics and possible tensions connected to participating within their GQMC. I described these early dynamics while memoing their respective transcripts. I also analyzed each participants interview data to determine whether additional information emerged to solidify these preliminary findings.

Quotations, Representation and Participant Voice

Although this is a qualitative research project I do not provide any in-depth descriptions on each participant since:

In grounded theory, representativeness of concepts and not of persons is crucial. The aim is ultimately to build a theoretical explanation by specifying phenomenon in terms of the conditions that gave rise to them, how they are expressed through action/ interaction, the consequences that result from them and variations of these qualifiers (Corbin & Strauss 1990, p. 9).

While for some this may be an impersonal approach to qualitative research, I balanced this perspective by bringing in verbatim quotations from saturated categories, subcategories and properties to support my main theoretical points (Strauss, 1987). I cited students word for word to uphold their voices and weave in their personal narratives as oral portraits to ensure my research remains in touch with their lived reality (Eldh, Årestedt, & Berterö, 2020; Sandelowski, 1994). I also used selected quotations to reflect

turning points in participants perception of their pedagogical socialization process over time (Strauss & Corbin, 1997).

For a few categories and subcategories some respondents quotations received more coverage than others. However, this should not be perceived as qualitative ‘cherry picking’ where I selected the quotes I deemed most significant to establish the existence of pedagogical socialization. This affects the rigor of qualitative research especially when researchers; do not declare their personal subjectivities, insufficiently sample from their target populations, and stretch thin results from a small amount of data (Morse, 2018). These dynamics do not feature within my research. Past scholarship has endorsed my sample of 31 persons as necessary for data and theoretical saturation to develop a sufficiently dense grounded theory (Creswell, 2013; Strauss, 1987, Corbin & Strauss, 2008). I selected each quotation from the most saturated categories within my NVivo v. 12 database.

In keeping with my confirmability focus it was important for me to report on these logistical issues which emerged during data collection and analysis to provide additional verification of the research process I used to develop my findings. In subsequent sections of this Chapter I present the concepts, categories, subcategories, properties and propositions comprising the causal conditions, intervening factors and consequences which underlie my process driven theory of pedagogical socialization.

Theoretical Model of Pedagogical Socialization

Summary

The graduate students within my sample experienced pedagogical socialization as a combination of transactional and transformational teaching and learning modalities that Graduate Quantitative Methods Faculty (GQMF) enacted within their Graduate Quantitative Methods Courses (GQMC). Socialization via transformational pedagogical modalities was infused with deficit thinking, restrictive, racialized and highly discriminatory practices. Socialization via transformational pedagogical modalities emerged as a growth oriented, inclusive and affirming process. Exposure to both modalities compelled GQMS to develop their own ontological understandings of QM, themselves as GQMS and GQMC as a thought space to foster their aspirational QM professional identities.

Transactional and Transformational Modalities

Pedagogical modalities emerged as the range of explicit and implicit strategies, attitudes, values, norms and role expectations GQMF used to direct the teaching and learning of Quantitative Methods (QM) within GQMC. Transactional and transformational pedagogical modalities and ontological understanding are my three main themes which underlie the pedagogical socialization of GQMS. The sources of variation within each theme exists as a range of core categories presented in Figure 6. along with supportive subcategories and properties presented in Figure 7., Figure 8., and Figure 9.

Figure 6. Theoretical Model of Pedagogical Socialization

▽ Findings			
➤ Main Themes	▽ Transactional Pedagogical Modalities	▽ Transformational Pedagogical Modalities	▽ Ontological Understanding
	▽ Hands Off	▽ Hands On	▽ Empowerment
➤ Core Categories	▽ Rigidity	▽ Invested Support	▽ Identity Politics
	▽ Layers of Gatekeeping	▽ Contextual Content Knowledge	▽ Letter Grades
	▽ Cognitive Determinism	▽ Growth Mindset	▽ Resolving Paradigmatic Tension
	▽ Pedagogical Gaps	▽ Collaborative community	

For several students GQMF transactional pedagogical modalities were transmitted using hands off approaches, rigidity, layers of gatekeeping, cognitive determinism and pedagogical gaps. This is in stark contrast to the transformational pedagogical modalities that faculty transmitted using hands on approaches, invested support, contextual content knowledge, with a growth mindset for building a collaborative community of quantitative methods scholars. Both pedagogical modalities were found to define GQMS pedagogical socialization experiences in ways which were highly dependent upon faculty self-interest and their perceptions about student demographics, dispositions and abilities. I displayed these ongoing processes of action, interaction and emotions (Strauss & Corbin, 2008) in

the second and third columns of one of my theoretical model displayed in Figure 6. Ontological understanding is my third and final main theme which emerged to capture students' ontological understandings of their pedagogical socialization process, QM, themselves as GQMS and GQMC as an ontological thought space. The fourth and final column in Figure 6. displays empowerment, identity politics, letter grades and resolving paradigmatic tension as the four core categories underlying this ontological understanding main theme.

Each theme has enough analytic power (Glaser, 1978) to theoretically explain graduate students pedagogical socialization experiences within their GQMC as well as the comparable and distinctive happenings among the different subgroups within my sample (Corbin & Strauss, 2008). In keeping with Strauss and Corbin (2008) I provided this summative overview of my pedagogical socialization theory to help readers of my work to smoothly transition into a deeper discussion of my substantive theory inclusive of participants quotations in subsequent sections of this Chapter and with supporting literature in Chapter 5.

Transactional Pedagogical Modalities

Pedagogical socialization via transactional modalities is based on rigid hands-off approaches, pedagogical gaps, layers of gatekeeping and cognitive determinism that faculty used to transmit stagnant content knowledge to particular students who attempted to learn higher level quantitative methods (Figure 7.)

Figure 7. Transactional Pedagogical Modalities

➤ Main Theme	➤ Core Categories	▽ Subcategories
➤ Transactional Pedagogical Modalities	➤ Hands Off	▽ Benign Neglect ▽ Large Classes
	➤ Rigidity	▽ Stagnant Content Knowledge ▽ Textbook and PowerPoint Driven ▽ Replication
	➤ Layers of Gatekeeping	▽ Why are you here? ▽ Selective Guidance ▽ Deficit Ability Expectations ▽ Restricted Feedback
	➤ Cognitive Determinism	▽ Ideal Quant and Math Brain ▽ Processing Speed ▽ Recall and Retention
	➤ Pedagogical Gaps	▽ Quantitative Faculty are not trained teachers ▽ Poor Classroom Culture ▽ Avoidance ▽ Ineffective Presentation Skills

Graduate Quantitative Methods Students (GQMS) spoke about the “challenges” and “struggles” they experienced with transactional pedagogical modalities.

Transactional pedagogical modalities are based on “giving students less than what they paid for” (Angelica) or “whatever faculty believed you were worth” (Amy). It is “not a

student centric” modality because “faculty members were always concerned with something other than students” (Shaga). When participating in the socialization process connected to faculty’s transactional pedagogical modalities GQMS knew they “were not a priority” (Shaga) or “ a primary concern” (Lisa).

Hands Off Approaches

Hands off approaches to teaching Quantitative Methods (QM) emerged as a subcategory supportive of the transactional pedagogical modalities. There was an overall yet strong feeling of disappointment among some Graduate Quantitative Methods Students (GQMS) because of the high frequency in which they encountered hands off modalities within their Graduate Quantitative Methods Courses (GQMC). Hands off approaches were openly spoken of as the teaching strategy of faculty who “doesn’t really care about demonstrating anything to students to further their understanding” (Megan). For Rebecca hands off approaches typified “courses highly focused on the theoretical perspective without the space to talk about practical applications”. She continued that hands off approaches “were content focused and did not provide opportunities to discern when I would potentially use the methods which is unfortunate”. Shaga, described hands off approaches as the “loose” and “offhand” strategies GQMF used to teach the students “they don’t take seriously”.

Randolf implicated hands off approaches as a strong factor which contributed towards his disengagement for “those courses where they were not necessarily hands on, it’s just do whatever they placed in the slides. Since this was something, I could do on my

own I checked out and was not involved”. Students described hands off modalities as teaching strategies which did not facilitate their own understanding of QM. For Mike hands off instruction is a modality where faculty “leave you on your own because they assume they’ve laid out enough steps and provided enough materials for you to do it yourself”. For Bob “hands off is where they expect you to learn primarily through listening to everything they said during lectures”. Randolph expressed himself quite clearly in saying “I feel like most of my professors are hands off, they just talk, so by the time you're done with the class you have little focus, and you don’t know what you're doing. It shouldn't feel so open”. Noah zeroed in specifically on the one professor who taught most GQMC using predominantly hands off approaches:

Instructor X is very hands off. You’re always left to figure it out on your own.

He'll say, oh I don't know Google it. I’ve expressed to him that I don't know what I don't know and so I do need guidance but don't necessarily need him to give me an answer. So rather than say hey just Google it, why don't you say go look at X, Y or Z and that would be more helpful.

These narratives suggest that students perceive hands off approaches as contributing towards a pedagogical socialization process that positions lectures as the main mode of faculty to student communication. Hands off lectures are also a free form approach to teaching which places students in an unguided role during the teaching and learning process. It is a modality where students are left on their own and faculty expends minimal effort to help them understand quantitative methods. Two additional properties which

contributed towards students poor perception of GQMF hands-off approaches included: benign neglect and large class sizes.

Benign Neglect

Students experienced benign neglect as an additional transactional pedagogical modality connected to the socialization process they experienced within their GQMC. Helping students understand QM was identified by all students as one of faculties primary responsibility towards students. Students experienced benign neglect whenever faculty seemed to absolve themselves of any responsibility to help them understand QM. Students referenced the “polite” (John), “outright”(Yan), “rude” and “subtle” (Jane) ways benign neglect became the pervasive socialization modality experienced by particular students. Ines confirmed benign neglect was being “kind enough not to be obviously harmful”. Amy described benign neglect as instances when GQMF did not:

Meet me where I was during the semester. She said she meant well, she knew I was struggling yet never reached out and asked what she could do to help me fill the gaps I had in my learning. It was difficult when I came to the realization at the start of that course that faculty was not interested in helping me learn anything.

She was not even interested in helping me feel confident

Randolph’s narrative captures what students perceived as the dismissive nature of benign neglect and how he formed the opinion that GQMF “had a limited sense of responsibility” to help students to explore and creatively develop their research interests. He continued:

You were politely brushed off and more frequently when trying to approach something from a different angle. We do have a lot of professors that are very theory driven and once it wasn't necessarily their interest it became difficult to have a conversation with them. There are a few professors if you don't talk about specific methods and stuff they're interested in you might as well not have a conversation with them. As soon as you go out of their realm to discuss another idea their interest immediately falls away. It felt like a form of disregard I didn't appreciate.

Mike's perspectives ties in with Randolph's and adds additional nuances to faculty's hands off modalities where:

It's been a lot of here's the idea find a way to apply it. Then in some of the other courses, it's been find someone else who has applied this and review their work. It's kind of always been hands-off approaches within most classes.

Hands off strategies were consistently described as faculty's reluctance and unavailability to help students. For some students it also included what was perceived as faculty's uncivil attitudes to convey their lack of interest in helping them to understand and gain additional perspectives about QM. Students perceived faculty's reluctance to help as a form of pedagogical socialization connected to GQMF hands off teaching because:

We didn't have chances to practice things in class. After (names faculty) teaches content we are left to figure it out by ourselves. I was very frustrated because I spent hours on it, but still cannot figure it out because the instructor did not give enough

detail. When you approach the faculty for guidance or more tips you are turned away with no helpful information. This faculty just did not take the time to answer my questions. So being hands off is what I remember as my least favorite thing about that course (Yan).

In the data Amy, Lisa, Susanna, John, Noah, Rebecca, Randolph, Lini and Ines voiced additional experiences about being “ignored” and “quickly dismissed” by faculty when bringing up topics they were not interested in. Overall benign neglect is a modality where GQMS students navigated the contradiction where faculty “claimed to care about students and having their best interests at heart” (Amy) but did not demonstrate this while teaching or when students wanted to pursue topics faculty were not interested in.

Whenever some students reached out to faculty for help to develop their understanding of QM based on these values they were oftentimes “passed over” (Shaga) in ways they viewed as a form of mistreatment.

Large Class Sizes

Students recognized that they were being socialized via transactional modalities as part of faculty’s pedagogical response to having to teach very large class sizes.

Angelica vocalized:

We had 30 in a section, why do you need to do that especially at the doctoral level, why must there be this one big mega class especially for a field like quantitative methods? Our college isn’t prioritizing pedagogy and high-quality learning but prioritizing big batch teaching for tuition dollars and getting as many

people through. I've even got myself a separate tutor to help me because I can't rely on the professors to walk me through things or give the level of detail I need. Susanna added "the faculty, at least in the classes I've had which have been huge they don't have time to give that level of feedback you want for most things". Time was a highly commodified resource and as a result limited amounts were allotted for guidance and feedback because "faculty needed to divert their attention to too many students" (Randolph). Tiffany gave some poignant insight into her observations that one GQMF used "standardized lectures and classroom routines to manage particularly large courses" she continued:

My quantitative classes were taught with a one size fits all model. Individualized help if you needed to talk about things was an afterthought. She rarely walked around so there was no one-on-one teaching. The pedagogical style because of the huge class size overall was very one size fits all.

Rebecca alluded to large class sizes as contributing towards transactional pedagogical modalities because, "it's difficult with the large class sizes, to give focused instruction, guidance and correction to each student. You're not benefitting from these large classes, and these are very expensive courses to not be getting more guidance". Ramsey made linkages between hands off approaches and adjunct faculty in saying:

One negative aspect is we have more adjunct faculty. Our learning experience is going to go down, just because of that high student to teacher ratio. That's a key reason why we got so many hands-off classes with adjuncts they're just there for

the class and limited hours. If we don't have so many adjunct faculty we will not have those poor-quality hands-off classes.

Noah, Tiffany and Yan also echoed Ramsey's concern about the lower quality teaching offered by adjunct faculty, particularly for Bob who described his experiences with some adjunct faculty's hands off mode of delivery:

With the large classes it was a bumpy ride. So much content and so many students, you start losing track by the third, fourth to fifth class, so by the end of the 10th class you just want it to end and when it does you're not sure what happens. The random faculty do not invest a lot of time for students to understand anything. Week by week you're left to experience difficulties and turbulence, too many ups and downs and I didn't feel comfortable.

The data indicated that some students felt adjunct faculty were more likely to teach introductory quantitative methods classes. It also suggests that some adjunct and full-time faculty developed hands off strategies to cope with teaching large classes. This contributed to lecturing students through QM content without sufficient one on one interaction to answer questions. This produced a considerable source of "stress" (Amy) and the feeling of being "drained" (Angelica) when some students needed but did not receive in class support. These perspectives also reinforce Randolph's insistence that "most of the classes I've had have been huge, so faculty don't have time to give that level of feedback you want for everything. It's so disappointing". Lini found that some faculty used hands off approaches because:

When you have 20 to 25 students in your class how are you going to be able to communicate with everybody when we all have different learning styles? As a teacher and instructor, you have to step out of your own head to be creative enough to teach so many people. Some faculty preferred hands-off teaching because it was easier.

This quotation underscores students perception that they were being socialized within their quantitative methods courses to respond to teaching modalities which paid minimal attention to individual learning styles and the use of innovative strategies to engage learners within large and diverse graduate quantitative methods classrooms.

Rigidity

“Understanding content” (Lily) and “mastery of quantitative techniques” (Randolph) were two things GQMS valued the most within their GQMC. The data pointed towards transactional pedagogical modalities as rigid approaches for transmitting content. Most students remarked on rigidity as a pedagogical socialization process which impeded their ability to understand and master QM. This emerged as a pressing issue particularly when students used words such as “stagnant” (Randolf), “fixed” (Lisa, Lini, and Tiffany), “rigid” (Amy, Angelica, Lini, Lisa, Mike, Randolph, Rebecca, Shaga, Simple, Stephanie, Susanna and Tiffany) and “inflexible” (Randolph and Tiffany) to describe QM content, the way some faculty taught QM and the topics they presented within their GQMC. Sara, Jessica, Lily, Stephanie, Marie, Nora and Isabelle mentioned not experiencing any tension with rigid pedagogical modalities because they “just did

what faculty wanted most of the time to get through the course” (Kimberly). These students recognized that the key to success in these courses includes following the lectures exactly as outlined by faculty.

This rigidity pedagogical modality was summarized by Susanna as, “a very rigid approach to pedagogy to get students to internalize content and make it understandable”. Lini who identified as a research assistant within her department stated that rigidity means:

Trying to put me into a box. I’m just doing everything he wants that's not inside of me. I'm just really fighting and having a horrible time doing the writing, a really hard time. I’m just a student so I need the faculty backing but it's hard to do what they want all the time.

Lini’s quotation suggests students felt rigid approaches to presenting content inhibited students creativity and ability to think through quantitative methods. Additional properties which emerged in the data to sum up rigid approaches to teaching and learning QM included a heavy textbook and PowerPoint orientation, static content knowledge and, replication.

Textbook and PowerPoint Driven

Tom stated that throughout his time within his quantitative classes, “strong emphases were placed on the textbook as the end all be all for quantitative analysis”. Students recognized that faculty’s rigid pedagogical modalities were performed when they limited their teaching, assignments and classroom activities to dated and fixed

content provided on courses materials such as lectures, syllabi, PowerPoint slides, textbooks, online learning portals, uploaded videos and links to selected materials (All participants). Bob said, “faculty only cared about whether I met the expectations outlined in the syllabus for what I was supposed to be able to demonstrate, but I wanted more than what was offered in the PowerPoints and textbooks”. Lily’s face saddened while sharing her perspectives on the static nature of her specialization QMC:

It was heavily focused on classroom content. You weren’t motivated beyond anything but classroom content. This was one thing I didn’t like in our Ph.D. program they focused on doing so much coursework. I was so busy doing weekly assignments and it took a lot of time. I felt inactive doing only assignments which took all the time I had and didn’t give me the time to be innovative to update the methods I wanted and work on projects and publish.

Lily’s use of the words “not motivated”, “feeling inactive” indicates her perception that faculty did not design courses in ways which tapped into students creative potential. Much to Jessica’s chagrin QM coursework was structured using constant homework and assignments. This may lend itself to understanding how GQMF perceive students and how this impacts on the selection of hands off and rigid approaches to teaching graduate QM. Sometimes students felt they were interfacing with a teaching modality based on faculty’s beliefs that having access to course materials was sufficient to learn QM:

For faculty its always I gave what you need, you can reference this later on, you have the PowerPoint, save it. My perception of the teaching strategies is I have

given you everything you need to be able to do this assignment effectively and correctly. You have everything you need in front of you, everything, so you should be able to do everything (Sara).

Jane corroborated Sara's accounts but also stressed upon better ways for presenting course materials when she shared:

The lecture is formally standing with the PowerPoint, and going through slides. I did not come to class to learn only about the information you provided on slides. Faculty need to complement it with examples, case studies, trending topics and group activities that involve working on real world projects where you can sit in and learn Structured Query Language (SQL) together. This contributes to learning. The PowerPoint and using uploaded materials is not everything.

Considerable evidence emerged in the data which pointed out that "textbooks are not the best tool" (Stephanie) for teaching and learning quantitative methods. The highly technical jargon and complex descriptions within most textbooks prompted some students to always have questions for faculty about quantitative methods content. Faculty for the most part referred some students back to online resources like Google and YouTube but mostly textbooks for answers, as Tom stated for some courses "when I ask for direction I am constantly told to go back to the book". Rebecca provided a very vivid expose on the rigidity of the textbook oriented modality while teaching quantitative methods:

Some courses were organized as a review of chapters in the textbook followed by an application that was provided by the textbook. The lectures were a repetition of

what was in the textbook. There was rarely anything additional. We would have materials organized by week or by module with PowerPoint slides based on the chapters we should be reviewing in the textbook. When I had questions after reading the textbook, I was always referred directly back to the textbook. This was challenging because the textbook is the reason why I had questions in the first place.

John's voice rose while communicating his frustration towards this textbook orientation:

Too much focus on textbooks. Professors consistently emphasized whatever was in the textbook and (names online learning platform) which was never sufficient. It made me feel I would not be able to function when I went out into the world to use these analyses. They felt by having the textbook I could make it happen.

Tiffany captured a very important dynamic where because "statistical techniques and formulas tend to generalize, and be static, rigid and linear over time, faculty used a similar approach to teaching". For many students what made this modality especially challenging is "having to sit for multiple hours during class just listening to the lecture" (Marie).

It is important to note that some students "valued structure" (Kimberly). Ines valued faculty's textbook and PowerPoint orientation for "when we have structured assignments, they give you the answer sheet or it's at the back of the book with the examples and that was really, really helpful to finally see if I was understanding correctly or not". Bob added that some structure was extremely important for learning QM to:

Have a precise roadmap of what's the expectation, the amount of work and the challenges. The poorly structured courses were like roller coasters, you don't know what's going to happen, you don't know the challenges, you don't know the difficulties and you're on your own. It was not a pleasant experience. In the well-structured ones, it was easy to make connections and I enjoyed learning. The first classes were a warmup then the difficulty started growing constantly, you learned a number of techniques and things ended up smoothly. When comparing the bumpy ones sometimes its steady, we learn things and then any second when it comes to assignments it's like a roller coaster an extremely difficult down, up, down experience.

Lisa shared “the organization by modules on (names learning portal) has been really helpful. It's easier when faculty structure by week with both the lecture and PowerPoint components and additional resources, I find that helpful”. These examples suggest that while students may not like the rigidity of learning primarily from PowerPoints and textbooks they did appreciate the structure some faculty implemented for easily retrieving and managing content.

Static Content Knowledge

The data pointed towards static content knowledge as a modality which facilitated faculty's hands off approaches to teaching QM. Some activities promoted the pervasiveness of static content knowledge in ways that “makes it difficult for me is when stuff pulled out of the textbook has no current interpretation for applying the theoretical

concept to real-world scenarios. This made me really disconnected from the course.” (Tom). Static content knowledge appears to be content taught within GQMC which has very little applicability to students lived realities or “trending topics” (Jane and John) which capture students interests. Ramsey added another dimension to static content knowledge as a modality where faculty used outdated content to teach QM. He specified how this impacted on his professional pursuits outside the classroom:

They always tell you buy a textbook, of course do not buy a textbook because a lot of times you don't need it. I've learned that the content of doctoral quantitative methods courses are not supposed to be in a textbook. If what you need is in a textbook it means you're teaching classic stuff that's out of fashion. One time I used a textbook to write a proposal to a national conference. My proposal was accepted but the comments said my approach is out of fashion, outdated and a study people did 10 years ago.

Shaga shared a very similar perspective to Ramsey's when he shared:

It's more like hey read the slides, you know where the PowerPoint is it will tell you what you need to know about modelling, let's do this handout it will show you how to do calculations. This is very static. I started to get worried about whether I got anything current out of it.

Ramsey described his beliefs that the repetitive nature of QM course design is a definitive quality which contributed to his feeling of “not growing” within his GQMC. He furthered:

It's frustrating learning the same things again and again. Once the curriculum content is too classic or overlapping, students cannot benefit. They can benefit if you teach factor analysis in one class but if you teach the same techniques again in another class then the student can learn no more about factor analysis. Do we really need to spend that much of time talking about the same content again and again? What about other areas? how about the cutting-edge things they are doing? how about the professor's research in factor analysis?

Although both students were in different programs, Bob recognized the same dynamics as Ramsey in feeling that within his “quantitative track there's too much overlap and double allocation of the same topics within different courses”. Lily also noted that new faculty were encouraged to follow suit with the rigid and static orientation of transactional pedagogical modalities where: “most of the times adjuncts were following an old script from a previous Professor”. Lisa also lamented:

Some of the (names online learning platform) content had simply been copied over and over again from the previous courses, some of the online lectures were even there for years, there was no integration of new approaches, literature or updates to the software. I know some of the methods just don't change from year to year, but that copy and paste approach to teaching felt very static, made me feel they didn't care what they were teaching in those courses, and I should be a robot absorbing only what they needed me to absorb.

These narratives suggest that faculty spent very little time updating their content. It also suggests that teaching was not a strong priority for some QM faculty. John alluded to this static orientation in similarly vivid ways:

Some faculty have slides, modules and entire lectures they just transfer over from previous years. I know that's probably convenient because there's so much information to share but that communicates to me as a student that things are fixed and there really isn't any need to stray from that.

Michael perceived things in a different light and suggested that the re-using of old slides represents faculty passing on “valuable information to help new faculty maintain the high standards within the department”. Most of the evidence to support this subcategory crystallizes Graduate Quantitative Methods Students (GQMS) perceptions about faculty’s expectations that having access to course materials is enough to learn and understand QM. Consistently reifying static content knowledge underscores the very transactional nature of GQMC which includes giving students access to mainly “classical” (Ramsey) and “traditional quantitative methods” (Randolph) as what GQMF deemed sufficient for learning QM and most convenient for teaching QM.

There is an expectation by faculty that at the Doctoral level students would be adding and updating QM techniques. When faculty used transactional modalities, it included presenting a “a lot of content” (Nora) but not innovative strategies to train students to innovatively adapt and update content. Lisa mentioned static content knowledge is a modality which added a “rigidity that makes me want to give up

sometimes”. Ramsey expressed his disappointment especially when he pointed out that the content knowledge faculty presented within some of his courses “fell short of the quantitative content his peers were exposed to at different institutions”.

Replication

Replication emerged as another salient category supportive of transactional modalities. The data indicated that some GQMS associated their pedagogical socialization process as being connected to “positivism” (Tiffany and Lisa) and “positivistic research” (Shaga) that students should “duplicate exactly as shown in textbooks and PowerPoint slides” (John). Faculty’s “replication focus” (Sara) was perceived by students as transactional because this also included “timed and highly structured classroom activities and assignments” (Jessica). Ramsey expressed how much this was particularly debilitating for doctoral students:

The least favorite part is the courses where the faculty structured everything in a very strict way which means we have to follow things stepwise. I felt very exhausted when I did this, and I felt like I'm a robot, faculty is setting the code and I have to recall and react after that.

Tiffany also captured the almost robotic nature of replication implied in the way GQMF structured QM coursework activities:

Learning through rigid replication, this is how you get it, insert these things, just work with my data to mimic or replicate, that's primarily how I got through the

entire course. But I'm not sure the depth was really captured with the way that things were taught using that rigid replication model.

Many students stressed the limitations of taking such a rigid approach to teaching quantitative methods especially for applied practice. Megan expressed that:

This copy or mimic strategy doesn't always work, especially when we are learning steps in the beginning, if I needed something more, if I'm not starting with the same data set or I didn't have a clean data set and then I was copying something, and it didn't turn out well. So that one size fits all replication where everyone can just copy me but then for homework you're working with different data sets. I ran into a lot of problems, and I don't think that approach was good for many students.

This replication model was sufficient for completing coursework assignments as dictated by GQMF but “not for learning and understanding quantitative methods which involves teaching about the breadth, depth and meaning of these approaches” (Stephanie). The rigidity of transactional pedagogy was seen as a major inhibitor of creativity because:

In classes it feels I am following a script. I cannot be creative because I have very specific things I have to solve, and teachers expect a very specific answer. One strategy I have not seen and would love it is brainstorming which relates to creativity brainstorming for a problem and being creative as a class or as a group (Lini).

Susanna's quote closes out this saturated replication subcategory based on her poignant commentary about "just going through the motions and just doing it the way they taught it. It wasn't learning, it was repetition and regurgitation. I was just doing what the instructor told us should be done".

Layers of Gatekeeping

Gatekeeping was perceived as faculty and Graduate Teaching Assistants (GTA) acting as "the guardian of all things quantitative" (Mike) by engaging in different forms of "selective helpfulness" (Amy) based on their perception of particular students. Lisa stressed: "It's pretty hierarchical. There is a power dynamic; you can sense in those classes. It's how some students are directed to the slides and doing calculations, and some are just left there". Gatekeeping strategies were used to "deny" (Angelica, Susanna, Lisa and Yan) some GQMS access to strategies for understanding quantitative methods. These included a continuum of being completely "closed off", "unavailable" and having requests ignored while experiencing "very limited access" (Amy) to faculty's invested support and experiential expertise. The why are you here?, selective guidance, restricted feedback, and deficit ability expectations properties emerged to support this layers of gatekeeping transactional modality.

Why Are You Here?

This is an attitude displayed by some faculty, GTA's and students as a gatekeeping strategy within GQMS. It was reported as a sense of "exclusion" to communicate "that I did not belong" (Susanna) and would "be better off somewhere

else”(Ines). Shaga expressed deep sadness in explaining how this gatekeeping modality prompted him to “walk away” from completing specialization courses in QM:

It was always an attitude of why are you here? These are the feelings they transmit about not belonging in those classes. Students demographics obviously influenced how engaged the Professor was in the class and with whom. I really wanted somebody to be there to help me learn how to do these skills but that was not the case. It’s terrible, they just stare at you. It's different, it's a different environment (names program) is different. Some professors their priority was not helping students feel better about themselves, the professor of (names course) asked me a number of times why are you in this? when I asked for help on different assignments and then I started asking myself the same thing, why are you in this?

Tom associated interactions like these as contributing towards his feelings that “I didn't actually belong in these classes”. Several students expressed that some faculty set out to belittle students and say things about their work and assignments that made them “feel stupid” or “different” (Amy, Angelica, Ines, Jane, John, Lisa, Shaga, Susanna and Yan). The data revealed students perception that while faculty and GTA’s may not have much control over who can and cannot be in their classrooms layers of gatekeeping emerged as transactional pedagogical modalities enacted to communicate explicitly or implicitly who belongs within quantitative methods courses, who should pursue quantitative methods and who should not. For Shaga, Lisa, Susanna and Angelica these

deprecating attitudes were transmitted to the GQMS perceived in a “lower” or “negative light” to accept certain students and groups as having superior intellects or what Amy defined as an ideal “quant brain”.

The invivo code “shutting down” emerged in the data to explain what students perceived as a derogatory means of blocking students from coming to voice within GQMC. Faculty directed this modality to several students whenever they tried to dialogue about quantitative methods or to ask questions for furthering their understanding. Jane added additional explanations of what it means to be shut down as a form of gatekeeping:

When the faculty says you go figure it out by yourself. That doesn't help me, that doesn't help my learning and that doesn't help with my application into my work. When you tell me, you go figure it out, I'm not understanding the material, so I came to you. When I said I need help and you said go figure it out there's absolutely no concern for my learning as a student. My motivation goes down because I came to you for a reason and now you're shutting me down.

Lisa provided additional insight which allowed for further development of this invivo code as a property of this gatekeeping modality:

I had one experience with a faculty member who taught (names course) where I ignorantly was excited to share my ideas with them. They quickly shut me down like how could I possibly know how to engage in quantitative research. I felt a sense of elitism like I hadn't learned enough to be able to even talk about quantitative research with them. I felt both students and faculty believed only a

select few should participate in this elevated realm of research I could never understand. It's like how dare you try to engage me in a conversation. When these experiences happened, it made me think don't even try to do quantitative research because they'll shut you down every time.

Not only did faculty socialize particular students to “just stick to the content” (Marie) as presented but they also communicated that they had no desire to share their thoughts about the material and advanced topics with them. This lent itself to students feeling that they did not belong within their GQMC. Lisa like some of her peers felt marginalized and excluded while experiencing this transactional modality. This gatekeeping subcategory was further explicated by the selective guidance and restricted feedback subcategories.

Selective Guidance

Gatekeeping is a modality faculty and Graduate Teaching Assistants (GTA's) applied while interfacing with students “they perceived as not good enough to study quantitative methods” (Shaga) or be in Graduate Quantitative Methods Courses (GQMC). There was considerable evidence to suggest that GQMF and GTA self-selected students to support through assignments and understanding QM. Students understood teaching assistants were intended as a source of student support to facilitate a greater understanding of QMC. When they reached out for help on their assignments many students reported on their “struggles” (John) and “inability to get any assistance” (Lisa) from GTA's within some GQMC. For Bob, “the TA didn't want to help me a lot. I didn't find TA's as useful resources in my doctoral program because their level of engagement

with me was very poor. It's like they didn't even want me to ask them questions, but I saw how helpful they were to other students". This speaks to a form of selective helpfulness as one of the main gatekeeping strategies used to restrict who learns and who should not learn quantitative methods. Lini recalled how much:

They are not helpful because they're put into a position of authority and power they start to believe they are above their peers. When they don't want to help you, they talk around the question, and I have to refer back to the instructor. I don't like to reach out to TA's if I don't understand something, because the couple of times I did, they didn't know what and they didn't want to tell me.

Yan became frustrated with the push back she experienced every time she reached out to the Teaching Assistant (TA) within her advanced courses for assistance in troubleshooting issues using R studio:

I know he helped other students but my experience with the TA is really very bad. When I reached out he said find a peer first, if you and your peer cannot solve the problem, then come to me. I tried a peer, but he also struggled. I tried Slack but I'm not sure about what questions I should ask about my homework in that public place. Every time I sent the TA a direct message he pushed back and said why don't you send a message in the group. It's always I should seek help from somewhere else but not him. The pushback was stressful and really not very helpful. I was frustrated. The TA has so much influence on students' performance.

Angelica mentioned the discomfort she felt when interacting with TA's who did not want to answer her questions and were not willing to help her understand QM during one of her cognate courses:

Whenever I've asked the TA for help they said, 'ask the Professor'. I'm like okay but I'm also asking you. It was uncomfortable. My college pays for research and teaching assistants to help coach people and I am paying my tuition. I've seen them coach other students through their assignments but when I tried to use them a couple times I got bumped around without getting much help. It was very difficult and uncomfortable because I thought they were an opportunity for me to get help outside of class.

Susanna was adamant that teaching assistants communicated in ways which let students know they didn't belong because they couldn't understand quantitative methods:

It was not a good experience, so I didn't go back. They are very judgmental they will tell you oh, how come you don't know this, or know how to answer this question. I struggled with the way they spoke to you and how they perceived you. They were not very helpful for me.

Faculty gatekeeping also included being "blindsided" about students "potential" (Megan).

Shaga experienced gatekeeping as acts which locked him out of specialization courses.

He emotively stated:

I really wanted to do advanced topics, but I have to walk away from it because of how I felt in some of those classes, and how faculty saw me. I felt out of place, I

felt I didn't belong there, I didn't feel I had anything to offer. I questioned my own intellectual ability to the point where I felt this is not for me, even though my desire is there, my drive is there. When I looked it up and saw who is teaching the more advanced courses I knew it is not going to go well. I have to walk away because I don't want to have similar experiences with that faculty again.

Restricted Feedback

Some students experienced “non-existent” and/ or “general feedback” (Amy, Angelica, Jane, John, Lisa, Randolph, Shaga and Yan) which created feelings of being “disregarded” (Amy) when asking for and receiving very little direction from faculty. For some students feedback was also “frequently late” and also “destructive” when offered. Tom recalled “when I have to wait so many days to get a response that creates gaps in time which affects my ability to really understand the material”. Lisa shared that “for things I don't understand I am not receiving much feedback and in my (names course), we would get feedback months later. Honestly, I’m still not totally sure I was running some of those analyses correctly”. Angelica underscored specific ways that restricted feedback is a gatekeeping strategy which impeded her learning of quantitative methods:

They don't offer quality feedback. I need input on Part A so I can develop Part B. But if Part A feedback comes really late. How am I supposed to grow if I am not getting feedback in a timely way, or getting any feedback at all. Sometimes it's just points and that's a struggle. The feedback was way slow and late. This is an issue because I can't do correction before I get the feedback. Sometimes you get

feedback after the class ends and it has no impact whatsoever because I still don't know.

Restricted feedback emerged in the data to explain instances when:

Some faculty were always less available. There were some faculty where I had to schedule things weeks and sometimes months in advance and that felt like well, what's the point. It was so much like drinking from a fire hose because there was always a short amount of time to cover each topic (Mike).

When John asked one faculty member for assistance in understanding a very difficult concept based on his performance on one assignment:

The experience was hard. You know I could do some of the calculations but not all of them. When I turned to the TA for help he brushed me off. Then when I went to (names faculty) I was honest, I don't understand this, can you give me some tips to help me catch up. He didn't want to listen to everything I said he looked at my assignment and said my performance was very poor, and I should go back to the slides, everything is explained on the slides.

John's expose reveals a very important finding on the gatekeeping modality as the uncivil and demeaning ways in which faculty restricted or refused to give students feedback.

Shaga's experiences lends weight to this pedagogical modality because his description is in many ways painfully similar to John's when he shared:

At times I was struggling in one class, and I booked a meeting with a professor. He took one look at me and after I explained what I needed that professor made

me feel like nothing while he gave me a very quick explanation as though he wanted to just get rid of me. After I walked out of that office, I never went back to office hours again. After that I put on very thick skin to finish that course. When I shared my experiences with some of my colleagues they expressed to me the same way he made them feel horrible when they asked for help.

Noah's narrative is another source of evidence supportive of the restricted feedback modality as contributing to students frustration where:

When I would ask the question and the answer would always be it depends or with little explanation or I don't know Google it. This means you don't have any plans on how you're going to help me through the class and that added to my frustration a lot of times.

Learning from their mistakes was held by students as very important orientation for developing their own understanding of QM. This may exist as a reason why restricted feedback was perceived as a gatekeeping modality which denied some students access to the critical information which would help them become more competent. Angelica spoke about feedback in terms of sincerity and stated that although, "I need validation, but I do not like false encouragement. I don't need you say good job for following your outline, while you brush me off about the things I want to learn, that doesn't help me grow. I need genuine guidance". This raises serious concerns about whether gatekeeping is producing a group of winners and losers within GQMC. Most times when some students looked to

GQMF for support to improve their competency their agency were denied or ascribed very little value.

Deficit Ability Expectations

In the data several graduate students reported feeling “inadequate”, “lacking”, and “stupid” when GQMF responded to their questions, commented on their assignments and coursework. “It’s the subtle ways they let you know that when you don’t understand something, it’s your fault” (Susanna). Amy stated that “Some faculty made me feel stupid. I always had questions she thought were beneath her, stuff she did not want to answer”. Lini testified about experiences similar to Amy’s where:

We all learn differently but in my experiences some professors looked down on students while trying to assert that they know more. It always made me feel obviously inadequate and very stupid, and bit by bit I sometimes became less motivated by these experiences. I always felt if there was some difficulty I should be able to approach faculty. For quantitative people I’m like hey, I’m a person too, I’m a human being, even though I don’t know as much as you do.

Ines expressed some sadness about instances when “some faculty doubted my skills, especially when we started. Some of them would not believe I have those skills, belittle me or not believe my writing on my papers”. Sara underscored “instead of questions being perceived as something to learn it is perceived as how smart I am”. Jane argued “sometimes it’s where they (some students in her classes) don’t want to ask something stupid for fear faculty will think it’s stupid and then the faculty thinks that of them”.

When GQMF questioned some students abilities and attached a lower value to their questions, work and interpretation of QM this was perceived as a form of gatekeeping. Rather than engage with faculty to further understand QM these students opted out of learning or sought out healthier or more autonomous learning practices. Some GQMS were also perceived as being supportive of GQMF pedagogical socialization via deficit ability expectations especially those “students who had a lot of exposure to statistics and were very good at math” (Jessica). Angelica voiced support for a form of ability grouping within quantitative courses on the basis of not wanting to be:

Forced into groups if the group has people less capable than me that's a struggle. But if the groups have people just as capable as me or greater that helps me rise up. When my group has people that are struggling much more than me, I struggle to help them, and I struggle. There are people that are quant oriented you know, and then there are people that aren't. I think the level of ability and understanding differs between students in intro and advanced courses, its these two groups and I don't think there's a lot of thoughtful adjustment around that.

Deficit ability explanations were often perceived as being applied to whole communities (Sara, Jessica, Tiffany, Simple, Susanna, Shaga, Yan, Megan and Noah). Students of different demographic backgrounds felt they were subjected to deficit ability expectations which communicated they “always lacked something” (Tiffany), “didn’t have the right mindset” (Lisa) or were “missing something” (Susanna and Simple). Susanna pointed out the tendency to use deficit descriptions about groups within datasets which spoke to how

some faculty and students viewed communities and the students within quantitative methods courses who identified with these communities:

Some of the data sets we would use in the classroom the results always presented students of color as having lower test scores and White students as having higher test scores. Nowhere in the class, have you covered why those students have lower test scores. Some of the white students in the class would approach it like well you know these students of color it's because of their backgrounds or because they're not that smart. Then you start to think because they believe they're not smart, you're not smart. As a person of color, it begins to feel like this classroom is such a destructive space that I'm in.

Lisa experienced deficit ability expectations within QM syllabi and course content which she interpreted as promoting:

Math and statistics courses to affirm bias and determine how intelligence has been defined. While mathematically things may look very clean there is a lot of bias in the methods and how people are included in those studies. By taking these courses and interacting with some faculty in these areas I saw how math is used to reproduce bias. When they taught quantitative methods, some faculty made sure only certain members of certain groups were familiar with the content or the methods used to standardize scores.

These experiences also showed up as an overwhelming focus on the “poor performance in particularly math for black students” (Sara). Jessica described how:

Being a black woman when you work in groups you don't want to be the dumb one. I was battling my past experiences with math which were horrible. Being a black woman in this space meant I needed to hold myself up to make sure I do well in these statistics classes. You never want to reinforce what some people may already be thinking like you're lacking, or you're lazy or, it's taking you longer to grasp the concepts than other people.

Stereotype threats emerged as an *in vivo* code participants used to describe their socialization experiences via transactional pedagogical modalities. Where stereotype threats showed up as some faculty's assumptions about some students as having lower QM ability. Jessica, Sara's Megan, Noah, Rose, and Shaga's experiences added a lot of weight to the data supportive of stereotype threats being ascribed to some students of color within some GQMC.

Being technologically deficient was an expectation of GQMS who were older than most of the students in the class (John and Rose). For Shaga, faculty held "race stereotypes at different levels and I was always perceived as belonging to a group outside the realm of quantitative methods". White, Latinx, Asian heritage and Black female students were exposed to "mansplaining where occasionally guys would make comments to show they know more than the women in the class" (Kimberly). "Just because I am a woman" (Isabelle) there was the constant "stepping in of White males to explain things they thought I couldn't understand" (Jane). There were male students who "loved talking over female faculty while teaching" (Jessica). Kimberly also recalled one instance "when

a male student was getting overly assertive and critical of the female professor in front of students, and she just shut it down”. All these properties combined sums up that “being female creates its own challenges and struggles” (Stephanie) within GQMC.

Megan and Isabelle spoke about being “underestimated” because they were “very feminine”. Megan described her feelings of resilience and determination:

“When some faculty members were like oh let me treat her like a little girl, I’m like hey do whatever you think you need to do because I knew my purpose and it was to take these courses and learn, that’s how I dealt with that”.

At times it felt as though quantitative methods courses are a “space designed for males to succeed and lead” (Stephanie). (Amy) provided a very telling description of the vulnerability and low estimation she experienced because of some faculty and students deficit ability expectations of her as a:

Blond haired, blue eyed, white female, because I met dominant culture standards of beauty some faculty played to my Eurocentric standard of look. The stereotypes of being a blond haired, blue eyed female in quantitative classes was reinforced by some of the things faculty said and did which affected my ability to learn quantitative methods. I was complimented by faculty several times on my clothing choices or on how I looked. I also had moments when male faculty looked at me in ways which were uncomfortable. One female faculty didn’t even know my name half the time. When she did call me she always used the wrong name Jennifer in a way which let me know she saw me as just a ditzzy blonde who

has had a lot of privilege in life and is just there to decorate herself more by getting a high-level degree.

Megan offered a very telling revelation about her experiences with stereotype threats about Black women within her quantitative methods courses where:

There were experiences of gaze, inter-race issues about being a type of Black and gender issues. Most of my courses are taught by a White male. When faculty made comments, I don't think they're malicious, I just don't think they think about it. I just assumed they're not knowledgeable about how much the things they said and did could be offensive.

In these instances, Megan's and Amy's pedagogical socialization experiences included being under the gaze of predominantly White male faculty in ways which subjected them to uncomfortable forms of gender based discrimination. Most female students also pointed to the need for White male faculty to adopt more respectful and feminist inspired pedagogical approaches when teaching students within their courses. Ines, Lisa, and Yan spoke about the "lowered expectations" (Ines) for completing GQM they experienced as the mothers of young children in some of their QM courses.

Cognitive Determinism

Some faculty were perceived as promoting cognitive determinism as "things they look for in students" (Zi) and their "look for's of intelligence" (Tiffany) among Graduate Quantitative Methods Students (GQMS). Cognitive determinism is a modality where faculty applied predetermined judgements about students reasoning skills when teaching

QM. These were perceived as the “fixed standards” (Ines and Tiffany) faculty developed over time to sift through new and incoming students. The cognitive determinism subcategory emerged in the data to define incidents when faculty, GTA’s and peers tried to “impose their expectations about my performance” (Lisa) or “for me to accept their perception” (Susanna) about “who belongs and who does not belong” (Shaga) within GQMC. Most of the data supportive of this cognitive determinism subcategory emerged as the ideal quant or math brain, fast processing speeds, recall and retention.

Ideal Quant or Math Brain

For Amy whenever GQMF teach QMC they focused on the students who demonstrated what they perceived as an ideal “quant brain”. This emerged as an invivo code in the data. This ideal quant brain is able to “process quickly” (Kimberly) and “retain large volumes of information” (Yan) “recall on demand” (Jane), “recall when prompted” (Amy) be “math oriented” (all students) or whether “you’re a student who can expand on faculty’s quantitative expertise” (Ramsey). During teaching it was clear to Lisa that “professors only connected with students whose brain they believed were on their level”. This created different groups of students who received dedicated attention from faculty and those that did not.

The negative attitude orientations students experienced when they were perceived as “not on their (faculty’s) level” (Amy) is a crucial dynamic of the transactional pedagogical modality. Amy experienced many challenges within one of her classes with a male faculty member who was “hard to deal with because every time you tried to ask a

question, he always spoke about himself or the students he favored. He always spoke about how smart they were and made it clear that I was never at their level”. Jane specified that because she was not perceived as having the quant brain one faculty wanted he “ kept shutting me down the entire time. It was hard because I saw how responsive he was to the students he thought were smart”. Susanna understood for the most part this was based on:

Having a language others didn't have. I was not fluent in speaking about quantitative methods or processes so that high level language that quantitative people use, if you talk to an everyday person who's not really had those classes they automatically think that it's above and beyond them for some reason. There's a stereotype that goes with quantitative people or quantitative classes that they are just at a different level, they're on another planet talking in their own language and they really like that.

Amy lamented:

I didn't do anything that wowed my professors for them to hold me up as the ideal quant brain, that only happened for a select few. I wasn't sure if my questions irritated her or if she just didn't perceive me as your typical student. Faculty had their favorites in classes of who was their amazing quant brain and oftentimes she let me know I wasn't.

Some GQMS also found that faculty's deterministic orientation also reinforced many of their peers beliefs about their own ability and the othering of "those who do not think like they do" (Jessica).

Students like Rose described themselves as performing extremely well within their GQMC, "I've always been into data analysis and quantitative methods since high school that's the way my brain works it wasn't hard I just learned it. It's about accuracy, finding a correct answer and following the correct steps to get it". Ines noted "It is easy for me, more natural. Some may struggle with QM but for me, it's easier, it's natural, it agrees with my way of thinking". While these students narratives are not a transactional modality, some perceived that it contributed to the othering of students who were described as not having a natural aptitude for QM. For Lisa this resulted in "some of the white women in class having a superiority complex" because of the tendency to project White students as ideal students within GQMC.

Zi, John, Tiffany and Yan all spoke about the cognitive determinism as a socially constructed ideal where being Asian meant they were perceived as inherently having a "math brain" (Yan) "people should learn from" (Tiffany) by most GQMF and students. As Zi candidly explained:

Just because I'm an Asian or I'm a Chinese I am supposed to like math or statistics is in my brain when I was born. But it's actually not, I just work hard so that's why I'm good, not just because I'm an Asian. I'm not special because of my race. This kind of physical identity so that's where they take my mind all the time.

Yan also described her understanding of what it meant to be labelled as a model minority in all of her GQMC:

Some people had an impression about Asian researchers, or Chinese researchers to say their math should be good or your statistics is always great. They tend to have a very high expectation for the Asian researchers. It feels like I am representing all the Asian researchers and I should work even harder because if someone thinks Asian research is very good then I am a special one. It's not a negative influence it gave me motivation to work even harder because I have that so called title.

Bob shared additional perspectives on being perceived as a model minority within his quantitative courses where:

Being an international student gave me two advantages in my courses. As a non-English native speaker, it helped me to get away with some basic mistakes that's not expected from a native speaker. It also gave me that stigma as being good in math, computers, a workaholic or smarter than average. Faculty responded to me more technically and I'll say sharp.

Zi's experiences as an English Language Learner (ELL) is in sharp contrast to Bob's where he believed that:

Being an ELL negatively influenced my performance and experience in all of the QMC. My English-speaking ability set some barriers for me when sharing in group projects because I'm not very confident speaking English. The international

students tend to be in the same groups because sometimes it is hard to be in the American student groups.

Shaga's experiences and those of a few students of color stand in stark contrast to the narratives of students of Asian heritage. He faced dual pressures on the basis of being a Black African American male student and someone faculty implied were not suited for studying QM:

It is intimidating for someone who is coming from backgrounds faculty do not value to get into it. It is always like how I am going to do this, like fear they may not see me as being smart or I may not do well. When taking quantitative classes, faculty are always questioning my brain, questioning my potential, questioning my skills, my ability to understand. These are some things I constantly experienced. Now when I think about quantitative methods I think there is only a certain type of student who faculty believes can do this.

This is also consistent with additional experiences reported by some Black and Latinx students. Amy expressed some anxiety over the pervasiveness of cognitive determinism within her QM classes where not being perceived as a quant brain was "intimidating" while for Sara it was "draining" based on the need to demonstrate "sheer intellect and cognitive capacity" (Nora) to "think in very specific pre-defined ways about quantitative methods" (Tiffany). All evidence gives rich insight into the quant brain some GQMF and GQMS deem necessary for participating in GQMC. The quant brain category was also

racialized in ways which communicated its prevalence within specific students and groups and absence in others.

For John “all faculty expects you should be good at math” and “across the board there tends to be a very formulaic approach for being good at math” (Kimberly). This emerged in the data as one of the most socially explicit indicators of students cognitive ability within GQMC. Strong QM skills and performance standards are expected despite the “gaps in faculty’s ability to explain the relevance of math” (Kimberly) or it’s “relevance for everyday understanding”(Randolf). Mike summed up that most of his quantitative methods courses were “driven by mathematics and writing formulas while working on problems”. Zi echoed that “faculty recognized my math skills was always pretty good so that helped me choose more advanced quantitative courses”. Jane spoke about the tendency of her (names course) faculty to project mathematics as everything within her classes:

When we learned about optimization the professor explained the math behind it, he didn't spend too much time because we were expected to read chapters about in-depth math or go deep into the theory, I get lost with those pieces because it's so abstract. A professor and textbook talking to me about concepts, theorems and all the math behind it, that's important for them because they believe that's what you need for learning quantitative methods. But for me it's not everything.

Processing Speed

Faculty taught a wide range of quantitative topics using fast paced pedagogical strategies and required students to have “computational skills to produce with a short turnaround” (John). Jessica acknowledged her inability to keep pace with this “speed expectation” because “I’m a slow processor, my biggest fear being in the QM classroom setting is experiencing how people expected you to move fast given a limited amount of time”. Amy articulated a major limitation in:

The pacing of some of the courses, its super-fast, too fast. Just doing anything that required speed, the pace didn't work for me. When (names faculty) said, okay, do this problem, and lets discuss it 10 minutes later I was never finished with it, my group members were sometimes annoyed so that did not work for me. When the instructor came back a short time later for answers I was never able to respond because my brain just does not work in that way. Some faculty did not appreciate those differences. For the students who could respond as quicky as they wanted to you could see how much they were valued.

Lily perceived the fast-processing time was especially so “faculty can cover as much of the syllabus as possible”. Jessica felt that “this only led to a feeling of always being rushed through topics where they should give us more time to understand. Just because I cannot do things quickly it doesn’t mean I am not competent or capable”.

Sara, Megan, Mike and Rebecca also spoke about their disappointment at having to complete timed quizzes as an indicator of ability. Isabelle described how most of her

timed quizzes were administered online or for Rebecca in class “on a limited amount of time that involves answering questions about chapters of the textbook” in ways which were “not the best metric of my ability” (Bob). Megan remarked quizzes were “so off putting to me at this level” while for Amy “it was just so wrong to take these quizzes and be treated like high school students”. Isabelle stated that “timed quizzes did not make me feel like a doctoral student”. Mike argued quizzes “did not offer any opportunity to explore and apply things that were relevant to me. Quizzes are for tracking students’ performance in a traditional manner”. Rebecca was adamant that:

Quizzes are silly because all it can measure is repetition or reiteration of what's in a textbook. Yet at the doctoral level if faculty are not invested enough to design engaging materials, you probably shouldn't be teaching in a doctoral program. I feel that quizzes are appropriate type of assessment at the high school level, even the undergraduate level, but not at the graduate level.

Timed quizzes also emerged as a gatekeeping mechanism to prevent faculty from acknowledging graduate students as colleagues but as students. This served to keep that hierarchical positioning of faculty, GTA’s and students in place which is consistent within “traditional top-down” (Amy and Susanna) pedagogical approaches.

Recall and Retention

The ability to recall “large amounts of relevant information when prompted” (Lisa) was projected upon GQMS as an ideal cognitive orientation. John mentioned this specifically because “its automatic processing, we use the software so much that

sometimes it feels like faculty expect us to be just like it and recall the ridiculous number of concepts that we covered”. Nora acknowledged herself as “a student who was not good at recall. I am one of these students who need to rely on my notes to teach myself. I also need constant review to memorize and understand”. While for Sara: it goes back to the sense of “I gave you this information, you should be able to understand me as soon as it is presented”.

Lily added a completely different perspective on the importance faculty attached to students memory and recall as an indicator of who can also become GQMF:

I feel like they're very smart, much smarter than I am that's the first thing that comes to my mind. I don't think that one day I'll be a statistics teacher...I can't do that to stand and teach from memory all that information. People teaching quantitative methods are very knowledgeable because they are able to recall all those terms, numbers, equations and the technical part of statistical techniques.

Since faculty were perceived as experts who can process information quickly students suggested they carried the expectation that students should also demonstrate fast QM processing skills. Amy specified that her slower processing ability occurred on account of faculty's lecture focused teaching:

Very few faculty used teaching styles that showed me an image of how something works in real life to help me understand. I didn't want to always sit and listen and that's not how I learned. To this day there are many concepts I cannot explain which were taught by faculty using fast-paced strategies.

Susanna echoed Amy's assertion while supporting the notion that graduate students pedagogical socialization via transactional pedagogical modalities are based on beliefs that there are few and highly specified ways to learn QM. Since Susanna could not conform to these standards she lamented, "That's what I blame for not understanding. I'm not mastering the content because I just needed to regurgitate whatever script they taught me. Once I did that it just left my brain because I didn't actually have the here's why".

Cognitive determinism modalities can be perceived as the attitudes and values faculty used to support transactional pedagogical approaches. Since quantitative methods was presented in a static and unchanging way only the students who understood faculty's teaching style were perceived as having the ability to understand quantitative methods. This has serious implications for students who learn in diverse ways and who are also in need of differentiated activities to learn and understand quantitative methods.

Pedagogical Gaps

Pedagogical gaps emerged in the data as teaching strategies "missing the mark" (Randolph) or strategies faculty "overlooked or ignored" (Angelica) which were important for students learning and understanding of QM. For Amy these were "blind spots" faculty needed to fill to facilitate student QM competency via the development of more "welcoming classroom climates". The data which led to the emergence of this final category includes poor presentation skills, no teacher training, avoidance and poor classroom culture.

Ineffective Presentation Skills

For Ramsey, “faculty should re-design these courses and communicate their content better. In our program they didn't use a lot of modern content or strategies to communicate content”. Amy cited her years of experience as a “trained high school teacher” as her preface to voice how:

Topics discussed were extraordinarily dry. It was lecture style and PowerPoints which had no context or stories or visualizations, or any other way to see it other than symbols and numbers and high vocabulary. Faculty were unable to structure their lectures in a way that's engaging.

Nora expressed “class could be a little frustrating at times when faculty did not use much visualization for applied applications”. Marie confirmed, “The way faculty lectured were not that useful for me personally most times I couldn’t understand how information was presented so I did a lot of extra digging”. Simple mentioned that “a visual image would’ve helped me understand it better, when practicing problems on software” to “appeal to my visual brain that needed to see images” (Susanna). Like her co-participants Lini’s quotation emerged as data supportive of this property especially since she “ needed more visual than auditory learning to keep track of things while trying to understand content”.

Randolph’s quotation provides evidence about his perception that:

The PPT slides were poorly executed and jumbled so there’s no way you can remember all that information. I’ve seen slideshows where it’s just literally text,

nothing else. Sometimes just seeing black and white was really tough to deal with especially when you're sitting there for three hours. There's no way you can pay attention the entire time.

Comfortable and Uncomfortable Avoidance

Some Black, Latinx and White GQMS who identified as having strong social justice backgrounds (Amy, Marie and Jane) social work training (Tom), curriculum and educational policy (Angelica and Simple), higher education and student affairs (Jessica, Lisa, Mike, Shaga, Stephanie, Sara, Susanna and Tiffany) evaluation (Rebecca and Randolph), finance and political science (Shaga). Jane mentioned comfortable avoidance in the way QM faculty expended minimal effort to diversify group activities:

Faculty doesn't do a good job of mixing the students, so everyone that knows each other tend to be in their own groups with people that have a similar background or resemble or similar characteristics so there's not a lot of moving and you know just going into an established group and so students tend to be in their comfort zone.

For Lisa some faculty avoided discussing different issues because they were afraid of their inability to address linkages between race and the use and misuse of quantitative methods within their courses:

There is a fear to discuss topics like race. It's not as comfortable as numbers and statistical significance but they use statistics to say which groups are always behind or have gaps and which groups are unable to catch up. But there is never

any discussion or any context around that. I don't think they give responses to questions that make me feel they truly addressed my concerns about QM. When I raise issues, faculty believe are unimportant for their agenda, I am brushed off and then there is an uncomfortable avoidance between us. It's also whenever I try to bring up some of the limitations, they treat QM as something that is infallible. Shaga voiced being “shut down” every time he wanted to engage faculty in discussions about race and how statistics affected different populations. Tiffany expressed feeling uncomfortable about faculty's “comfortable avoidance” of issues they believed have no place within GQMC”.

Tiffany's perspective is similar to what Lisa and Susanna shared. She offered:

The way it's taught does not help paint a broader picture of what's going on specifically in higher education and looking at institutional structures and how people of color navigate. institutional structures. Conversations about the limitations of QM are very short. QM can help highlight where systems fail students, instead of showing students as always having a large gap. Quantitative research should give an idea of the structure of the environment students are required to work with.

Noah, specified how much pedagogical gaps increased students workload and created a feeling of being disregarded by faculty:

Where there is that lack of alignment or that disconnect, it's incumbent on us as individual students to figure out how to fill in those gaps. But in order to do that,

we have to be aware that those gaps exist but if you're not helping us, then that's comfortable avoidance that benefits you and not the student.

Jessica underscored the need for reckoning and reform of the ways Black populations are treated by some quantitative researchers who receive most of their training within courses like those she pursued at her institution where she oftentimes:

Think about how black populations are treated in QM research and ways that could be improved. These are discussions avoided by faculty but that would open the door to black students feeling more comfortable in these spaces, acknowledging a lot of the feelings we have towards math. We have heard as black students we're not good at math. You're dealing not only with being black but that women aren't good at math, and not good at STEM related fields.

Quantitative Faculty are not Trained Teachers

GQMF demonstrated little awareness about the scholarship of teaching and learning or what Amy defined as “their own pedagogical craft”. Her experiences as a teacher allowed her to see that faculty:

Are not teachers by trade. I did not see my GQMF as teachers. One in particular she is a statistician, a numbers person, all of her degrees were in mathematics or statistics and none of her stuff was in teaching. She is not a teacher because she found it hard to break down concepts in a way people could learn it and build upon things.

Marie shared her thoughts that “some of the faculty were really good at QM but bad at teaching it. Some were just not that great at course design or teaching content in a way that’s engaging”. Mike also emphasized his teaching background to share his beliefs that:

Most of the quantitative faculty I’ve met cannot really deliver a message, make it interesting and contextualize it in a way that captivated learners. None of the professors wowed me as far as their pedagogical skills. Linear thinking was held up as the standard. This was the pattern, it was how we were expected to learn in class, and I know that doesn’t work for everybody.

Yan was adamant that “you could be really good at quantitative methods and be bad at teaching it”. Megan, Bob, Noah, Yan and Ramsey described instances when faculty were not acquainted with the subject matter and as a result there were pedagogical gaps which proved difficult for them to overcome in order to understand content. For Bob and Ramsey these gaps emerged because adjunct faculty were more suited to industry rather than academia. Megan described instances when she:

Felt the instructor was (air quotes) winging it. They were not prepared for the class. So that was alarming to me and there was a lack of preparedness. An uneasy feeling persisted throughout those courses with those unstructured instructors that wasn't helpful in my learning process. So that was challenging for me. The winging it was surprising, and it was mainly full-time faculty.

Pedagogical gaps is a transactional modality where students felt that faculty did not demonstrate strong interest in helping them learn and understand QM. It is also a

modality where faculty had very little knowledge of pedagogical theory or responsive and innovative pedagogical strategies to facilitate students learning, understanding and mastery of QM content.

Poor Classroom Culture

Some GQMF used “a totally impersonal teaching style” (Lini) which was reflected in the limited effort they expended to improve the QM classroom culture. Students who were mostly on the receiving end of transactional pedagogical modalities found that GQMF “let the classroom climate sort itself out naturally” (Ramsey). For (Megan) “faculty should definitely focus on the classroom climate” to recognize how their transactional pedagogical modalities contributed to an environment students described as a “struggle” that was “tension filled”, “uncertain”, “not welcoming”, “cold” and “uncomfortable”. Ramsey understood these gaps in some of his GQMC classroom climate when he compared it with courses he took while building his cognate:

They jump into the content immediately and spend very little time building student relationships or a classroom culture. I took some non-quantitative education and counselling courses and their faculty tried to build a classroom culture before jumping to the content. For the quantitative courses the first day it's the first chapter, you have to know something, you have assignments, and the teacher just jumps right to the content. The first thing they elaborate on is the syllabus and then the software.

Some students perceived that the importance of setting a comfortable classroom culture based on classroom composition was ignored because similar to Ramsey, Jane shared:

The biggest thing is the syllabus. Faculty doesn't do a good job of mixing the students. There are a lot of cliques and groups in those courses. Everyone that knows each other tend to be in their own groups with people that have a similar background, who have similar characteristics so there's not a lot of a friendly atmosphere in my classes. They let students establish their own group and so students tend to always be in their comfort zone.

Amy, Ines, Noah and Shaga mentioned favoritism as a definite dynamic which added some strain within some of her QM classes where for Noah:

There's definitely favoritism. Some faculty try to hide it, others don't but it is so obvious. You can tell because there are those personal exchanges or inside jokes you know like don't forget you're supposed to bring this to dinner, or he'll say I need to talk to you later on about this project we're working on. I would appreciate it if they did not to say that in front of the other students because I know how I feel, and students should not be made to feel that way. When you do this you create a culture of competitiveness which is what I experienced from the newer students who gravitated towards the faculty favorite.

Megan opined “there is some bonding that needs to take place. We need to do better at my school at not feeling so competitive with one another. Because there are so few of us, so few black people in this field, we really need to stick together to look out for each

other”. This viewpoint was also supported by Noah which pointed to a pedagogical culture formed around having very few underrepresented minorities participating and excelling within GQMC while being supportive of each other.

Summary

The data suggests that a significant proportion of participants were disappointed with transactional pedagogical modalities as creating groups of winners and losers within their GQMC. All students experienced difficulties with hands off instruction, rigidity, and pedagogical gaps. The layers of gatekeeping and cognitive determinism were selectively applied to students based on faculty perception of their ability. Overall students were opposed to large class sizes, heavy reliance on the textbook and PowerPoint, rigid course design and poor presentation skills for teaching and learning QM. These transactional modalities also pointed to the interaction effects of various structural, institutional and personal dynamics. When comparing the data against the sample characteristics, some White and students of color who identified as social justice and racially conscious reported on experiencing most of the deleterious effects of pedagogical socialization via transactional modalities.

Transformational Pedagogical Modalities

Transformational pedagogical modalities created positive socialization experiences for some GQMS whenever faculty used growth mindsets, hands on approaches and invested support within quantitative methods courses to socialize students

into contextualized content knowledge for learning and doing QM within a collaborative community of supportive scholars (Figure 8).

Figure 8. Transformational Pedagogical Modalities

➤ Main Theme	➤ Core Categories	▽ Subcategories
➤ Transformational Pedagogical Modalities	➤ Hands On	▽ Guided Practice ▽ Memorable Application Moments ▽ Technological Content Knowledge
	➤ Invested support	▽ Expansive Feedback ▽ Mentorship
	➤ Contextual Content Knowledge	▽ Numerical Storytelling ▽ Justice, Equity, Diversity and Inclusion
	➤ Growth Mindset	▽ Creating Space ▽ Transitioning from introductory to specialization competencies
	➤ Collaborative Community	▽ Thought Partners ▽ Differentiated Learning

My second theme transformative pedagogical modalities emerged to describe any attitude, strategy or resource that Graduate Quantitative Methods Faculty (GQMF) enacted while teaching which built students capacity for understanding Quantitative Methods (QM) and acquiring applied technological skills. Transformation suggests that these were the modalities that GQMF intentionally used to improve students “applied

capabilities” (Kimberly), “competence and confidence” (Nora) while participating within Graduate Quantitative Methods Courses (GQMC). Students perceived this modality as used by GQMF who are “supportive” “encouraging”, “potential building” and “receptive” (Isabelle, Jane, Kimberly, Lily, Michael, Noah, Nora, Megan, Stephanie, Ramsey, Rose, Tom and Zi). Students perceived that faculty used transformational pedagogical modalities with the long-term goal of socializing them to become very proficient QM students and future professionals.

In many students estimation faculty applied transformative pedagogical modalities to “push you more, so you get more out of your learning experiences” (Jane). Yan summed up the transformative teaching strategies she enjoyed as those intended to “shift students direction and activate their thinking”. Transformational modalities were perceived as being enacted by “the professors who were really good teachers. They teach you, inspire you and push you to learn how to master the software” (Shaga).

Hands on Activities

Hands on activities were “super helpful” (Simple), “beneficial”(Nora) and “extremely useful” (Megan) modalities for “merging theory and practice while using software” (Michael). Labs and in-class activities using data analysis software emerged as the main activities faculty enacted while demonstrating this pedagogical modality. The data clearly indicated in class labs provided students with vital “hands on experiences” which “gave us opportunities to practically apply what we’re learning while having access to a professor to ask questions when any challenges occur” (Kimberly). Lab

activities afforded students opportunities to “use software to implement all the things I learned” (Lily). Megan described hands on activities as one of the modalities where faculty taught her the most about quantitative methods because “some instructors are very hands on, we did everything together, that’s when learning quantitative methods becomes interesting”. For Lily “the courses where you learn the most tends to be very hands on”.

Ramsey echoed Lily’s perspective when he shared for, “courses with the most hands on I can recall everything I’ve learned like I have a very fresh mind and I can talk a couple of hours about what I learned. I didn’t just learn, I also practiced”. This “merging of theory and practice” is one reasons why Marie stated she “always enjoyed more hands-on learning”. Most students enjoyed when “the entire course was comprised of lab activities” (John) and “using software where we would watch and do at the same time with our professor” (Bob). Shaga who reported challenging experiences with transactional pedagogical modalities changed gears when he said, “the hands-on parts are great, some faculty really walk you through the software. There was one faculty I appreciated who just broke it down in more understandable ways”. In the next sections I provide additional theoretical explanations on guided practice, application moments and technological knowledge subcategories within the hands on category.

Guided Practice

Guided practice was defined as continuous “knowledge checks” by Tom and Simple to define instances when faculty took the time to “walk through with you” (Rose) and “walk you through the software step by step for any statistical technique they spoke

about during the lectures” (Stephanie). During guided practice “you can tell faculty had good intentions in wanting to help you to become proficient” (Angelica). Stephanie continued:

There's a lot of hands-on components through in class labs where we walk through an example together. It includes doing the underlying mathematical part during the lecture and then running it in a program like Statistical Product and Service Solutions (SPSS) where we are actually seeing and doing step by step.

Faculty is always there showing us how to interpret the different information.

Guided practice is an exemplary modality where faculty helped students “develop expertise step by step with their assistance” (Jessica). Guided practice is based on “tactile learning” (Tom) and “practical application rather than purely listening to lectures and focusing on lectures and textbooks” (Mike). This guided practice property is based on strong and consistent patterns in the data on “walking you through” (Jane). This was also taken to mean when students “progressively use the software” (Nora) “one step at a time for compounding learning” (Michael) “incrementally over time” (Mike).

Students stressed on the importance of hands-on activities when “faculty paid attention to students” (Shaga) to “fill in teaching gaps” (Angelica). This brought students in closer contact with the “skills transfer” (John) role they ascribed to faculty. Michael expressed great happiness when he mentioned that in his program, hands on approaches were especially beneficial for problem solving:

There's a lot of hands-on components through in class labs which gives an understanding about concepts and what it looks like in practice. We start with the lecture and things you need to know to dive into a topic, just to make sure that we are on the same page, and we've got a good start. Faculty will talk about a particular kind of analysis and how it's helpful. Hands on exposed us to the concepts, different problems, and how technology helps us solve them.

Jane was very satisfied about the transformative influence of faculty's guided practice during labs, she reported on hands on activities "as intensifying over time because in each lab while interacting with faculty they show you how to get that expertise with the software. Then I begin to feel I can take on independent work, and do stuff on my own".

Like Jane, Simple was completely satisfied with the transformative effects of guided practice because "midway through the semester I was able to understand certain concepts and definitely see the evidence of that every time I used SPSS". For Jessica "faculty used different types of step-by-step activities to make sure I understood things during the labs". Jessica also described guided practice as all the times faculty was "just checking in to make sure I understood the activities we were all going over inside class to link content to the software". Sara who confessed to being a bit shy around her instructors valued guided practice as an opportunity to "talk through the steps with the faculty one on one".

Memorable Application Moments

Participants pointed to memorable application moments with some GQMF as the most impactful experiences connected to the hands-on pedagogical modality. Rose

recalled some of her most memorable application moments while learning Structural Equation Modelling (SEM) during her hands on lab activities:

After the lecture, we all performed a Confirmatory Factor Analysis (CFA) step by step, then (names faculty) immediately pulled a really great article from (names online module) that utilizes CFA. She waked us through our in-class activity, through the assumptions of a CFA but also the results and we critiqued it together. For Yan, “in-depth practical experience with linear modelling took me on a growth trip to give me very useful knowledge I will use in my future. The faculty was very good, and the labs showed us so much about using R for data modelling”. Isabelle recalled a transformative moment after experiencing “how patient (names faculty) was with creating moments with different data for us to see these deeper connections. She broke all the different pieces down from the lecture while we were using the software so we would have a deeper understanding of what those words and the notations actually meant”.

Amy was exuberant while explaining her favorite application moments when faculty:

Could deliver a message and make it interesting and contextualize it in a way that captivated learners. When she used her hybrid model to break down data structures it was a beautiful thing to watch. To this day I still have a lot of vivid images of her presentations and the hands-on activities in her labs. She was the best at her pedagogy and brought out the best in us within our learning environment.

Noah recalled when she was afforded some “freedom to be creative” (Rebecca) to design her own assignment to demonstrate her understanding of Chi-square within one of her seminar classes which:

Allowed us to be creative. He just said state how you would make the case based on this data set. That class was very engaging. I wrote it as a campaign manager. I created a whole story with a fake name (laughing). I was able to be creative and faculty made it fun and engaging. People take quantitative methods very seriously and give the impression that this takes away from being accurate, thorough and technical. Math doesn't have to be scary you can tell a story with numbers.

In the data students described “unforgettable moments when their eyes opened up to the possibilities of using numbers for social change” (Simple). Rose’s most memorable moments occurred when faculty and students “worked together on course design” or when faculty created “positive memories which prepared us to be faculty in our own right”. Memorable learning moments also contributed to “discovering things you’d never know about statistics with only the lectures” (Stephanie). For Lini its those “concrete Aha moments of oh my God I just discovered something!” when participating in hands on projects with her faculty mentor.

Technological Knowledge

Technological knowledge emerged as a very important property of the hands-on teaching and learning modality of GQMC. All students viewed technological knowledge as transformative because it was “useful for handling data” (Jessica) to “generate and

represent information in ways which required merging conceptual and procedural knowledge” (Marie). Technological knowledge is data driven and for Sara this was exemplified in:

The way they taught us technology is just an extension of the methods. In our labs the TA and faculty walked us through STATA, what that would that look like in the data? How would that impact? How would the data change? And what results we would see?

Technological knowledge represented “merging theory” within the lectures, textbooks, and PowerPoints “with practice” (All participants). Bob expressed his appreciation when faculty provided opportunities to “utilize the different software. We understood to use formulas in real time to analyze data”. All students reported acquiring “very valuable technological skills” (Mike) on how to use different open-source analysis software such as R, SQL and Python and proprietary software such as Winsteps, Statistical Analysis System (SAS), SPSS, STATA, Matrix Laboratory (MATLAB) and Mplus. Gaining technological knowledge skills emerged as a modality that for Megan was:

Absolutely huge to learn Rasch using Winsteps which was a part of our coursework, and for assignments. SPSS and SAS were a big part of our program, and then we started to integrate R. That’s when I really fell in love with what we were doing, it was exciting and interesting working with the different data and

analyzing it using the various software. It really just brought this practical side to quantitative research.

Noah expressed her appreciation for hands on experiences to develop her applied competencies using code driven software for applied problems:

We'll start thinking, talking through and coming up with our game plan. (Names faculty) will model writing the syntax with us, we'll share the screen, we'll write the syntax, talk through the syntax and he'll ask us questions about the logic of what we're trying to accomplish. Then we run the analysis in both SPSS and SAS to compare the output and then we'll talk about how to write it up. I got at least 10 or 11 weeks of hands-on experience, where each week I'm building a syntax library. These hands-on activities give us the space to create our own template for our future work and that's helpful.

In a similar vein Amy vouched for hands on activities as guided “step by step practice and those moments which help me become a stronger student in Mplus” or for Jane “stronger in Python and SQL”. Ines expressed that she:

Appreciated all the hands-on assignments where you use software like R and Mplus. Trying with real data and using technology to understand patterns in your results was most important. I appreciated faculty with a computing background because they also spoke about the algorithm behind what the software is doing when generating the results. (Names faculty) always let you know a little bit about what is happening behind everything.

Michael shared how much students and faculty “both enjoyed the hands-on components much more than lectures” while Stephanie “valued their enthusiasm while teaching the practical aspects of running and understanding the analysis. It’s like they came alive during those moments than while lecturing”.

Invested Support

Invested support is a teaching and learning modality which emerged as the “coaching strategies” (Lily) faculty used to enable some students to “thrive and succeed” within GQMC. Invested support are the different forms of “backing and encouragement” (Bob) students received while learning QM content or software which ranged from being “extremely flexible and receptive” (Mike) “to just listening to my ideas” (Tom). Simple used the words “care and consideration” and “dedicated effort to support us” to describe how the GQMF in her introductory course was “invested in encouraging her through the course”. Amy received invested support from one female faculty role model because:

She valued me, and I had the things that she valued so it worked out well together.

She actually made me feel I could do a quantitative dissertation. This was impactful since I and some of the faculty in my program was convinced I couldn’t do it.

This clearly illustrates that invested support is an encouraging modality faculty used to socialize some GQMS to grow beyond what they ever thought possible. Novice students like Isabelle appreciated faculty’s patience and willingness to meet her inquiry-based needs:

The instructor responded very positively when I asked for additional support. If I asked a question she was very receptive to answering it and was very encouraging of me to ask questions. I didn't seek support outside of the class ever because she always responded very positively.

Kimberly reported on experiences similar to Isabelle's of finding faculty invested in her success as a student:

I've always had faculty answer my question or break it down. I've gone to office hours. I've stayed after class to ask a clarifying question and they've always been responsive. I liked all of the quantitative methods faculty I have taken courses with, and I liked a few of the folks cool demeanor and patience. I was kind of nervous about quantitative methods and they calmed me. I also think of them as being really, really smart. I'm kind of in awe of how much they know about quantitative research.

Open office hours and open-door policies were cited as an indicator of some faculty's willingness to invest in student's development. Lini gushed while she described one female faculty with whom she "had mostly wonderful experiences with office hours. She was always available, very open, personable, understanding and eager to help me". Mike described how widely available faculty were during his experiences with the invested support modality:

I was able to either chat with him before or after class or go into a meeting. He had an open-door policy, instead of having to schedule. I think that supported my

learning much better. They did not make me feel as much of an imposition. It was something the faculty wanted to do.

Ramsey gave an instance when faculty were invested his success by helping him enroll in courses outside of his program:

Some faculty are very helpful. One time I wanted to take a program out of our program. The faculty helped me to reach out to the instructor, because they know if I'm sending emails by myself as just a student my email may be ignored.

Faculty always helped me to connect with course instructors outside the program and helped me to enroll in those courses. I think they are doing a very active job here and I definitely appreciate those moments.

Stephanie valued experiencing “quality support, helping students in ways which suggested they cared” while for Marie faculty demonstrated their “willingness to mobilize genuine effort to connect with students while guiding us through content”. Nora viewed invested support as a modality intended to “help students to be persistent despite experiencing difficulty”. Lily gave a meaningful description of an instance where one faculty:

Really helped me through. I knew she was there to support me through it. In terms of answering questions, faculty treated me as a human being. They were always very good, very friendly, very welcoming, very understanding. I've never felt like I wasn't respected. They were very understanding they provided all the support that I needed most of the time.

Invested support is driven by the faculty “prioritizing is student success, and understanding what's important to individual students” (Michael). Ramsey spoke about invested support as the:

Planning you do with faculty who try their best to inspire students and motivate us to achieve as we go along. They give valuable suggestions to say you need to adjust your goals. I am willing to help you plan to help you to achieve that goal.

Expansive Feedback

The data revealed that expansive feedback before and after assignments was one method which helped students learn and understand quantitative methods. Students appreciated when “faculty responded to me when I asked for feedback in a way that I would say is very sincere” (Jessica). This sincerity was felt by Amy when, “(Names faculty) didn't get annoyed when she gave me feedback, and she would tell me whenever I did well, and gave me a lot of constructive feedback for my next assignment”. Rose spoke about expansive feedback as “frequent and patient ways”:

Faculty is always checking in on us to know if we need more support to understand the students understand the concepts. When they read my research papers they reached out pretty quickly to identify where I've explained certain concepts well, where it's lacking information, or may be poor writing in terms of scholarship.

Tom defined expansive feedback as having responsive and in-depth conversations with faculty while running through lab related assignments:

It's not just the analysis and the writing, it's also our informal conversations. There were a few Professors who were very open when I asked for advice on how I should structure my analysis or what should I do when I'm running into problems. I was able to carry on conversations with my professors that let them know how much I was working through concepts and applying them. They knew I was able to use it.

Michael capitalized on the dedicated feedback he received early on from his QM advisor:

I've started to work with my dissertation director to talk about things I'm interested in, the problems I'm thinking about, and she was very supportive of that. She understood and is also actually attached to the things that are important to me. She encouraged me to think critically in an affirming way about where I am. I could always feel her interest. She took the time to make connections into possible research topics or professional opportunities that I just didn't consider.

Kimberly credited faculty's "instrumental encouragement" as facilitating her transitioning from introductory to more advanced courses. While Mike shared how much:

Faculty was extremely helpful and flexible. I felt like they had a lot of confidence in me. When coaching me through assignments they just kind of expected me to be able to do it and because of that I was able to do it. Most of my professors were pretty helpful and encouraging.

Sara reported on instances when her visits to the TA were instrumental for providing the invested support she need to fully understand quantitative methods. For her the “GTA went out of her way” to:

Help me feel comfortable all the time. She constantly told me if you have questions, if you need anything, you can always reach out I’m there to help. The TA helped my performance being the one that I would go to first to say how do I write this? I valued her experience, because I knew they knew what the Professor would want, because they're working with them directly. I felt this sense of ease of going to them first. She provided a sense of ease, which helped with my performance.

Zi described how beneficial TA’s were for supporting him through his GQMC:

The TA was great resource to ask for help and getting different types of support for the software, for assignments and really knowing what faculty expect on our assignments. They were always very nice and also helpful during their office hours and via email as well.

Ines pointed to how much one TA’s expansive feedback during labs and hands on activities because:

The TA’s have contributed a lot because they are the ones that lead the labs. They showed me how to run the syntax for the data and how to interpret the results.

When I had any doubt this is not working, and then he will say okay, here is what

you are doing right and or pointing out what you're doing wrong or why the program is not running.

Rose received expansive feedback from faculty at least twice per month on her progress:

I connected with faculty twice a month to assess my progress. They assured me they saw me as capable. I'm lucky because they gave me individualized attention and walked me through. They helped build my own confidence because they knew numbers and data are a part of who I am and a strength of mine. Whenever I went into office hours to discuss assignments they walked me through the content and gave me guidance to know if I was on the right path and that helped build my own confidence to conduct research eventually without their supervision.

Expansive feedback is perceived by students as very "positive" and "constructive" modality by all GQMS. Kimberly confidently stated:

I received positive comments and feedback on all assignments. I like constructive feedback which lets me know how I could improve. All of the faculty were responsive to my questions on the assignments or just on the material in some of the higher-level classes when I had to run complex models and they wouldn't run correctly. Faculty answered promptly and were really responsive to my emails. They also encouraged me to see them during their office hours and that helped my performance.

Isabelle also maintained these descriptions of expansive feedback as a predominantly positive experience where:

The instructor responded very positively when I asked for additional support or if I asked a question she was very receptive to answering it and was very encouraging of students to ask questions. I didn't seek support outside of the class ever...but there were times when I did ask for clarification of questions in class and she responded very positively.

Marie like her colleagues mentioned consistency as one of the key properties of expansive feedback where:

All the faculty are very open to answering questions. I've never encountered any professor or teacher who was not open about answering specific questions I had about content or my assignments. Professors have been very good and open during office hours when I needed help with understanding something.

Tom attributed his being perceived as “hard-working student” (Tom and Lini) as one reason for being on the receiving end of expansive feedback. Tom’s experience lends support for this finding because he recognized “She was very receptive because I had already done the work. So, then it was okay, I want to support you, because I see you’re putting in the work”. Expansive feedback made students know their efforts were visible, “known and valued by faculty”(Michael).

Mentorship

This is the final property supportive of the invested support subcategory. It is defined as instances when faculty “willingly devoted time” to grant students access to

their experiential expertise inside and outside of the classroom. For Rebecca this showed up every time:

One senior Professor was very supportive in helping us understand for each method and what requirements would be needed when we were writing a journal article. It's a great when faculty take the time to share their applied expertise you couldn't get from a textbook.

Lini, Noah, Megan, Michael, Megan, John, Tom and Ramsey reported on several transformational socialization experiences while enacting their teaching and research roles while being mentored by GQMF. Lini described how valuable it was when:

We came up with ideas that are out of the box. I was able to work on a scale validation that he pushed my way which was amazingly powerful. I am lucky enough to have gotten into this team and we're working on projects and writing articles out of my comfort zone. I'm trying to expand on creativity in my work with my mentor which produced studies with phenomenal results.

Ramsey mentioned mentorship as the close ties he developed with faculty:

You become a collaborator and very close friends much beyond the teacher and student relationship. You work on things together and learn about your strengths and become useful. Although faculty have their expertise they don't know every part of the content. If the faculty just don't have to have time to find the new content, I will do that work. This will not just benefit me it also benefits the

project we are working on together. We're working together and learning new things.

He also mentioned gaining access to "special opportunities within the department" where "several faculty expressed their eagerness to work with me, in fact many times they asked me to fill positions before it was advertised for all the other students".

For many students being mentored by female faculty is an important part of their GQM training. Amy, Isabelle, Kimberly, Rose, and Yan underscored the importance of having female faculty members as "role models" and "mentors" within quantitative methods as "a male dominated field". Isabelle's direct quote sums up how she was influenced by her female mentor who taught her how to navigate her personal and professional life:

Having a female mentor made me feel more confident as a female to pursue quantitative methods and feel less intimidated. She had a couple kids and as someone going on to be a researcher who uses quantitative methods and also have a family, it was inspiring to have her as my role model who is able to balance both worlds and be intelligent and competent. She was very nurturing and that really helped my perception of my ability.

Amy strongly identified with her female faculty mentor and perceived her as:

An ultimate example of a faculty who allowed me to feel competent and confident in quantitative methods because she had the demeanor that worked with my personality, but I liked her demeanor, I liked her patience. I also looked up to her

as a woman in the field who was very intelligent and knew her stuff. I wanted to be able to speak like she did one day about quantitative methods because she had a great delivery style.

Kimberly's perception about her ability to excel at QM was impacted by strong mentorship and modelling by female faculty:

Most of my classes were taught by women. I found this to be inspiring and it made me feel I could be competent in quantitative methods as a male dominated area of research. These women are just so amazing and smart and if they can do it, then I can do it to. They had a positive impact on my perception while mentoring my ability to pursue quantitative methods. One faculty that had that very calming sort of Zen like personality that made me feel I can do this and be calm because it's not that big of a deal.

Tom was extremely "thrilled" about the advantages he gained while being mentored by GQMF. The data below provides valuable evidence on the benefits of:

Being mentored as a research assistant is the applied part of my training because of the chances to do research collaborations with faculty. I know this occurs only if you have similar interests or a close relationship with faculty because for them they are investing their time mentoring you on those projects.

Mentorship is a transformational modality which gave students actionable career guidance to increase their "professional competency" (Kimberly). Rose summed up her extensive experiences with faculty mentoring, "as I said I know I'm lucky, its paramount

and hugely important to me”. Gaining access to faculty’s experiential expertise is a socialization process described by Noah where:

(Names faculty) also works as an independent consultant with for profit and not for profit clients to develop proprietary instruments. I’m paid to work with him and so there are a lot of times where I have to write an IRB or go through similar processes. When he is mentoring me, I learn things I didn’t know because he’ll sit down and say this is how it’s supposed to go, this is what it needs to look like, you try it and then come back to me. He’s very thorough about things even down to my writing style, word choices during item development and reporting to clients

In the absence of mentorship opportunities within their departments, John and Megan sought out quantitative mentorship from faculty outside of their programs. John stated that when external faculty:

Mentored me he always had a plan to help me with my goals, what I should do right now and what I should do in the next stage. When I first started out I just don’t have any idea about how I can be a data scientist. He taught me that just having a doctoral degree is not enough you need a lot of practical experience.

Megan sought out external mentorship because the faculty in her program did not have experiential expertise in her areas of interest. Michael also declared that:

There are faculty in my department playing a role to help me to understand the other aspects of being a statistician. It’s an interesting process where you have someone

who has the same interests as you and you also work with those folks, and they give you tips on the skills they think I should have for my future career.

Contextualized Content Knowledge

Contextualizing “content knowledge” and “contextualizing data” are *invivo* phrases participants used to define this transformational pedagogical modality. Tiffany captured her perception of quantitative contextualization as:

Creative opportunities to help students understand there is a lot of breadth using quantitative methods. Its allowing you to find all the variables which can possibly have an impact on students learning. It’s when they provide enough context so you can look at so many different things.

This statement explains the importance of “meaningful interpretation” (Rose) for understanding and appreciating the “real world nuances” (Simple) connected to numbers and statistical output. Lini described contextualized content knowledge as “the discussions, providing that deeper environmental perspectives and storytelling. It is talking to me and to the class not to the slide. It was the most beneficial and useful teaching method for me because I can connect to reality”. For Lisa, “I appreciated when they actually contextualized the research questions as real world problems first before we chose the methods to answer them. It’s not about just isolating and choosing the methods but its saying here's the value to it”. The faculty who were “intentional about contextualization socialized students to look at statistics as applied problem solving using

quantitative methods” (Rebecca). Lini provided another scenario when working with one GQMF with real world data led to her contextualization of content knowledge:

When I found patterns and meaning out of a jumble of complex numbers? One of the most exciting things I experienced is the lab when I have all my data and it's just a sea of numbers, and you can't see anything then I apply certain statistics on it, all of a sudden patterns emerge and then we worked together as a group to put these patterns into context, and that is exciting for me to find. It's finding the essence or meaning under the numbers.

The essence or meaning of numbers is a key characteristic of the transformational pedagogical modality which is in sharp contrast to the rigidity of the textbook and PowerPoint focused transactional modality. Lini's use of the word 'essence' suggests she was guided to contextualization as the deeper meaning of QM. Amy described her experiences with “contextualized teaching” in glowing terms because her:

Experiences with the teaching strategies which provided the story behind the context and the context behind the data. I felt successful and confident when teaching strategies included contextualizing data were part of learning a new statistical or whatever concept quantitative concept. My experience gave me confidence, increased my understanding, and gave me new ideas of something to do with that concept. My mind started to imagine how I could use that in my field, so those teaching strategies were good for me.

Ines appreciated how much her program laid the foundation for contextual content knowledge before students were exposed to QM techniques and applications:

I valued learning about the philosophy of science and scientific inquiry and, how do we come to know any truth about the world? and, can we ever know for certain are there definitive truths in the first place? and that can be proven through the scientific process. We went through philosophical discussions that forced me to think about my own scientific pursuits it was a nice compliment to the very hard and fast formulaic nature of statistics. The more philosophical discussion that was another aspect of the teaching that provided contextual knowledge I appreciated.

Numerical Storytelling

Amy rated the transformational effects of numerical storytelling as “phenomenal” when:

We used an early childhood data set to contextualize things during hands on activities. It resonated with me because I’m an educator. That’s how I understood Hierarchical Linear Modelling (HLM). You have kids nested in classrooms, nested in schools, nested in school districts. I can understand why you would want to see if there are correlations based on the different experiences students had in each context. I created a story of what it could do for impact with visual images to help me and my stakeholders understand it better on the software. I was like wow! Now I know what I needed to see.

Jessica appreciated the way one GQMF in her program knew “students needed to be taught in a way that incorporated numbers into real life stories”. For Simple “it was a big deal the way she gave us the stories behind the numbers”. Sara described exposure to contextualized teaching and how it brought about the pivotal realization that she struggled through her undergraduate quantitative methods courses because:

You need a story to help you learn quantitative methods. What do you mean when we're talking about t- tests or ANOVA? Giving students the story behind those techniques got us to think about people instead of just thinking about where they land in your computer output. These techniques provided to a particular story that's what I realized.

For Megan and Noah numerical storytelling is based on “adding the history” (Noah) or a “historical perspective” (Megan) for “analysts to contextualize data” (Megan). Jessica also touched on the importance of having faculty explain “the historical components, so how did this develop, why did it develop in relation to other techniques, where does it improve upon and where is the work going”. Noah also shared:

My best experiences is having an instructor very focused on knowing the history. He would let us know the foundation, talking about how our field developed has been very helpful for me. He was very centered on understanding the evolution, history and context. Before we even begin to learn how, we have to learn the who, and the what and the why it came about in order to get to the present day, and how we use it.

Michael appreciated how some instructors spoke about the history of the methods to provide additional context for each technique:

I've always enjoyed the most when our learning is grounded in context, both in terms of the history of statistics and analysis and potential applications. The history is just very interesting, looking back from, say, the early 20th century to date and just learning about all the connections.

Justice, Equity, Diversity and Inclusion (JEDI)

JEDI is a transformational modality where “there's a greater contextualization of learning as something that is not solely white, solely male, solely within the United States that's been very nice” (Stephanie). Isabelle spoke about the impactful ways one faculty included Diversity, Equity and Inclusion (DEI) perspectives within her courses. This lent itself to the contextualization of datasets for a greater understanding of representation where:

Readings that talked about how quantitative methods don't always capture or apply to different identities and how questionnaires developed in psychology are geared towards primarily white, cisgender, hetero normative populations. As a predominantly white, cisgender, heteronormative group of students, we are forced to read those aspects of our identity and about how we might shape the field and apply different methods to make the fields more inclusive and diverse. Learning about diversity helped us be a little uncomfortable with the way the field is currently and how we can change to make it more inclusive.

Ramsey described contextualization as instrumental for understanding how to:

Pair my quantitative methods training with diversity issues in school or educational settings. These are not pure quantitative topics, but it has emphasis on quantitative outcomes. It's very helpful courses outside our department to build awareness and understand critical educational topics and issues.

Tiffany described the benefits of meaningfully interrogating datasets with a Diversity equity and Inclusion (DEI) lens when:

One instructor brought in student engagement data sets which were meaningful and more in line with my interests. This faculty took time to look at quantitative methods through an equity perspective which was helpful because as a person of color I really went in with all these biases and prejudices against quantitative methods because of the way it has been used to harm communities. Especially as an Asian American where oftentimes the numbers are not representative of the diversity in our racial group.

Michael described contextualization using a diversity lens as instrumental for his development into a DEI focused QM scholar:

We read the articles and data sets we're working in ways which often draw from broad social science, research studies so they may be focused on children they may be focused on low-income families, they looked at older people. Different gender and sexual orientations, I see a variety of identities reflected and many I personally connect to my background as a first-generation college student. But

then it also exposes me to other identities or experiences that I may not have considered or personally relate to.

He mentioned being mentored by one DEI faculty helped to provide an important lens for contextualizing data and results during his applied practice with higher education data.

DEI perspectives emerged as a crucial transformative pedagogical modality some GQMF used to empower students to develop an understanding of racialized statistics in educational research and praxis. Lisa and Susanna took it a step further when they referenced how much learning about the racialized history of statistics provided essential context on statistics and some of their experiences in statistics classes. Lisa described a pivotal moment when she learned about the importance of contextualizing statistics for social justice:

Both in terms of the history of statistics and analysis and potential applications.

The history is just very interesting, looking back from, say, the early 20th century to date and just learning about all the connections between theorists and practitioners and how this world overlaps in ways that you wouldn't think about and, and how that informs the development of the techniques we're using.

Diversity and inclusion perspectives helped us to learn about what's happening in the world today, and how these kinds of techniques can help us answer certain kinds of questions of who is always shown as having gaps, lacking or inferior in certain studies.

Tom's past background in social work, Michael, Lisa, Tom, Stephanie, Mike, Kimberly and Susanna's experiences within higher education and policy courses and Isabelle and Ramsey's participation in some psychology courses were instrumental for shaping their consciousness by:

Providing the context for the students that are privileged to understand why they're getting these scores, because they usually attend lower funded schools with the high teacher turnover, high administrative turnover usually these classrooms have 35 students in a class with one teacher and experiences in undergrad when the instructor fed into those stereotypes (Susanna).

Mike described one instance when faculty presented Black as a large mega category and used his diversity and inclusive excellence lens to understand that:

Black does not always mean African American; Black does not always mean Black African. There's a lot more diversity there. I think my experience seeing these patterns it's because I started off in (names program) which has a huge social justice and inclusive excellence component. Because of that lens I could look at a quantitative measure and say you have a binary male and female, or if you have White are you talking White South African, White European or White Latin American. So being able to critically contextualize quantitative results that is an important skill.

For him "it's been interesting to see my quickness of being able to recognize some kinds of marginalization when I think it through with real life examples". Rose specified how

much her “Diversity, Equity and Inclusion (DEI)” inspired QM coursework proved pivotal for her professional practice:

In my actual quantitative work capacities in a women’s organization as their DEI consultant and developed a climate survey measure to gather better data on how to serve their diverse clients. I actually worked with a group of individuals on establishing predictive analytic tools particularly logistic regression and multiple regression models around student retention rates. I’ve been able to contextualize DEI perspectives and contribute to those spaces.

Growth Mindset

A growth mindset captures the attitudes, beliefs, approaches and convictions of GQMF that each student has the “potential” (Kimberly, Marie, Megan, Noah, Jessica, and Sara) and “talent” (Bob, Ines, Michael, Tom, Lini and Ramsey) for QM. Tom was very happy that he found faculty invested in “seeing he has what it takes” and can be “motivated and encouraged to work hard” (Michael) to master QM. Students strongly believed that socialization by this transformational pedagogical modality also encouraged them to develop a growth mindset for understanding QM. Ines exposure to hands on approaches led to her to adopt the “perspective that quantitative methods is based on learning by practice. You have to do it a lot, practice, practice, practice until you become better at doing it”. Randolph mentioned how much exposure to coaching from adjunct faculty contributed towards:

A growth process for myself. I began in the evaluation track but participating in the (names courses) outside my program made me interact with adjunct professors to develop a practitioner way of thinking and talking about things. I had a lot of conversations with adjunct faculty in industry which really helped grow my perspective away from the theory focus of tenure track professors.

For Megan transformational pedagogical strategies helped students overcome and exceed any doubts they had about their potential. There was one faculty who during each class encouraged her to dream big:

He would constantly say, I'm not training you to work at Educational Testing Services (ETS). I'm teaching you to build your own ETS. He was invested in really building you up as an expert so you can stand on your own, that was really cool. So that developmental mindsets to inspire us to grow in and out of our programs and apply to our own research was really impactful.

Transitioning From Introductory to Cognate and Specialization Students

A few participants began their programs with no solid background in quantitative methods. These students started out in introductory GQMC and were mentored and strongly encouraged by faculty to pursue intermediate and advanced GQMC. This represents a growth mindset that stretched students beyond their expectations. Mike described:

I switched programs and would not be in my quantitative focused program without faculty support. I was strongly encouraged by one female professor. She

really was you should be doing this because you can. I went into advanced classes thinking this is going to be a real struggle because I'm not a math person. As time went on I found that quantitative methods isn't really all about the math it's about learning how to apply concepts, interpret the computer output, think logically about what's going in and coming out and what does that tell me. Having that one-on-one time with faculty, flexibility and encouragement to switch programs was crucial for my success in more advanced courses.

Simple identified as someone for whom faculty's growth mindset was a source of encouragement despite the fact that she had:

Bare minimum knowledge coming into my program. Faculty did a pretty good job of laying a good foundation for me because I didn't have any experience and then building off of that as time went on. It helped when faculty explained things and took the time to coach me. I felt I was growing all the time. I'm glad I found faculty who were willing to do that in my program. It's much less reading on your own, it's about receiving information from someone who knows it really well and knows how to translate it into something that would make sense. I appreciated that about faculty.

Nora's happiness provided empirical backing for transformational pedagogical modalities as strategies which progressed some students from an introductory to advanced QM trajectory. Nora "started off with no background knowledge in analytics and I am sure I am leaving my course being proficient in advanced topics because of the faculty". Jessica

noted that the QM faculty in her program “was impactful in helping me develop positive views about my potential and ability because I had no background in quantitative methods”. This modality helped Sara “resolve a lot of those negative experiences, I wasn’t going to do my dissertation using quantitative methods within my own area because I only saw myself as a qualitative researcher, but now I am going to do a quantitative dissertation”.

Creating Spaces

Graduate students appreciated what they called “making spaces” (Simple) as the intentional strategies faculty used to socialize students into “creative thinking while openly sharing their thoughts about quantitative methods” (Rose). Faculty created “safe spaces” (Jessica) for students to reason out loud about statistics and interpret computer output. The importance of “creating space” (Randolph) supportive of a growth mindset was captured by Ramsey:

I value the space faculty left to the students to do their own thing, share and explore their own research interests and choose a topic. They do a mini research within our classes to leave the space to students to choose what I valued the most within those classes that leaves a choice to the students to explore a little bit.

Rebecca expressively appreciated space as “vocal moments” especially since some GQMF rarely valued the instances when she came to voice about her discouraging experiences with transactional pedagogical modalities. For some students creating space was viewed as a protective factor for sharing their mistakes and misconceptions about

QM content “without judgement or ridicule” (Shaga). Jessica’s quote added to the strength of this finding when she shared:

Working in groups on math can either be really encouraging, challenging, or intimidating. When you hear the word stats, when you hear math, how do you feel and ask people straight up, Are you nervous? things of that nature. She said things to help let me know I’m not alone in that feeling. Her approach to teaching was very warm and acknowledging. She created that space no matter what background or skill set you're coming from you will be okay, you would be able to do well and understand the software and concepts.

Isabelle stated that “even though it was a virtual space, she was very accommodating”.

For Marie faculty exemplified openness and adaptability when they “let classrooms be a space where truly everybody’s skill level could be appreciated and accepted. I valued the faculty who were very good at that”. Sara and Susanna valued the ways this transformational modality gave them the “freedom” to overcome their negative impressions and anxiety about past GQMC, “It wasn't this isolated space where I was afraid to be wrong, I could be right, I don't know, I need to know, and can you help me? It was more of an encouraging, open space” (Sara). Jessica opened up about her experiences with this modality by repeating the “caveats” faculty used when addressing that students should be comfortable within courses because no one is “all knowing” about QM. This created the space for students to seek help in understanding challenging

concepts. Mike stated how much having “applied space” was beneficial for his pursuits outside of this department:

I realized how much faculty’s strategies helped with application in this field. I actually ended up getting invited to present at a small conference on how we apply psychometrics to education. Having that space to explore was definitely the most helpful.

Creating space was important to students because it provided them with the “flexibility to pursue topics which were of interest to me” (Zi). Ramsey valued:

“Unregimented seminar classes where faculty provided the space for us to learn the things we are more interested in. I was able to narrow down my future interests specifically within those courses with those faculty and identify additional interests to explore in the future”.

Collaborative Community

The three lines of evidence supportive of this final subcategory of GQMF transformational pedagogical modalities included differentiated learning, cohort development and thought partners. For Amy the GQMF this included the faculty who used “strategies and projects to create a sense of community amongst my peers in the classes contributed to my learning, it wasn't a competitive environment, it was a collaborative community”. A collaborative community modality was encouraged as spaces where each student felt their “individual thoughts were valued” (Jessica), and their

work is “valued and visible” (Rose) in ways which contributed to “shared feelings” (Simple) of inclusivity and “acceptance within the larger class climate” (Amy).

Susanna recalled her experiences with one faculty who taught students to contextualize data where “even from the first day of class her approach was very communal”. For Jessica “everyone could participate in the discussions without judgement” also “the ones who were strong in quantitative methods but also those with a more qualitative background who may not have a lot of experience with quantitative methods beyond these courses” (Sara). These were the moments when faculty were willing to give students the chance to share their ideas outside of the lecture structure. Cohort development was also viewed as a transformative strategy faculty applied to build collaborative community. John mentioned how much he valued the strategies faculty used to emphasize working with:

My cohort peers were important and finding collaborators who have close research interests with you. We were able to talk about a lot of projects together. In some of our seminar classes where we worked together it led to conference proposals, and papers for a publication together.

Zi mentioned how much he appreciated projects which encouraged him to:

Value my peers and classmates as important for my learning experience. I cannot imagine if I'm learning everything by myself they helped me with things. It's also really fun to have so many people to work with, instead of doing everything by yourself in the program. Our program has a relatively large student body with US

and international students which brings good aspects. The good aspect is we were able to be a real network and also we are able to have a sense of community for learning and studying together. People really came together to help each other. Jessica revealed the extent her cohort became a protective factor within her QM courses against the perceptions imposed on her as a Black woman conducting predominantly qualitative research:

I could not have gotten through the program without my cohort. I know most of them would say the same thing. It's our sense of community what got me through when we worked as a group or on our more difficult assignments. I knew nobody was going to let me fail.

Differentiated Learning

Including students from different disciplines within GQMC was a welcomed quality which created a sense of collective community for most participants. Evidence supportive of this finding include Bob's reasoning that:

I love that we have students from school of social science or from other schools, they have very different research topics than us, so their expertise is beneficial when they share their work within our courses. It was always a little bit different from my work even if we completed the same quantitative courses.

Michael spoke about the importance of differentiated learning in a collaborative community as when faculty:

Tried to connect students and create community in terms of similar interests for content or application or in different courses. A lot of our courses are service courses for other programs so faculty used a variety of applications and examples for individual students. I enjoyed the final presentations which gave everyone to present the results of their own mini- research in their own fields.

Stephanie's personal narratives support QMS perception of differentiated learning as a modality that facilitated broad applications of QM for students within diverse disciplines:

Faculty connected with students, both individually and as a class in interesting ways that speak to their professional or academic interests whether its social work or counselling students. The curriculum and final assignments were designed with different students in mind, so I appreciated the courses are very diverse in terms of the content that they cover for the students coming into the program with different backgrounds.

Differentiated learning contributed towards "greater acceptance of students who learned QM differently" (Sara) when professors took the time to:

Establish community in the class to normalize that people are coming into this space with varying knowledge and abilities. Normalizing that allowing us to ask questions on how we can really make the most of quantitative methods in our different fields made me feel more empowered to learn quantitative methods using sort of a dialogue (Lisa).

Interacting with community building teaching strategies meant students were able to “come together organically to support each other. Taking quantitative methods courses as allowed us to keep our cohort groups together especially when most of our QM courses were offered outside our program” (Jessica). For Zi, cohort development emerged as an important modality for building collaborative community because:

My classmates are very important to my learning experience. It's also really fun to have different students to work with instead of doing everything by yourself in the program. We were able to form a real network and a sense of community for learning and studying together. People were very friendly and really tried to help each other. Our courses are extremely diverse because we have students from everywhere. We are able to work together frequently to get through the courses. So that made my learning easier.

Kimberly gave a very in-depth description of the valuable and varied strategies some faculty used for teaching and learning QM:

There tends to be a mix of different kinds of activities and assignments. There might be exams or quizzes, there might be papers that have to be written and every instructor has their own preference or their own focus. There were seminar discussions, more theory focused courses or those where you're learning about the application where you choose a topic of interest or do article reviews things like that. Faculty used different strategies to engage learners at different levels as a way to focus on understanding concepts in action.

concepts in action emerged as an important invivo code to explain one of the reasons why exposure to differentiated learning as a means for students to activate different learning styles emerged as a strategy connected to the transformational pedagogical modality.

Thought Partners

Overall participants appreciated transformational pedagogical modalities which provided students with “opportunities to partner together” (Stephanie) as “thought partners” (Angelica and Simple). Participants references to GQMC as “thought spaces” (Stephanie, Shaga, Rose, Simple) introduced another dimension about the pedagogical socialization process of GQMS GQMC. A thought space was described as discourse that “guides me into different interpretations of what the numbers say” (Simple) or “what I know the numbers are showing me based on my experiences and non-traditional aspects of QM training” (Shaga). For Angelica this modality contributed towards her ability to process QM topics and address misconceptions with peers “rather than being in isolation”.

When GQMF transformed their classrooms into thought spaces, Rose personally felt it “enabled me to transform my research agenda and goals into something I can do using data and QM”. Thought spaces were encouraging because it communicated “let's talk more and do QM together” (Stephanie). Some students also mentioned how much thought partner modalities were valued as a form of collaborative community. Noah shed further light on this subcategory:

Because most of us either work or volunteer in the lab, there's more camaraderie, there's more of an onus on us to help each other out. It just simply comes down to hey did you figure this out and then we share it with each and grow in that moment. It's better to be collaborative with the people you see face to face, day in and day out, working in the same space.

Jane valued how much faculty became thought partners with students. For her understanding QM became much easier when:

Some faculty were more willing to collaborate and share ideas with you. It's a two-way street, it's not just one way. I'm sure they learn from us too, so it's a partnership. In some courses faculty also listen to our ideas and focus on understanding it more. I tend to do better in courses where faculty give us the chance to talk about our group projects in class and use case studies for us to figure out how we can apply the methods we were discussing.

Lini echoed Jane in advancing the reciprocal nature of having faculty and students as collaborative peers within thought spaces:

I valued classes when there was more of a dialogue, an opportunity to ask questions and be collaborative. In those moments we shared what we're reading in different articles rather than have faculty summarize or talk about topics as a kind of uni-directional lecturing. These faculty would intentionally build in time to engage us in conversations. It was more reciprocal in that way; the pedagogy was more reciprocal.

Ramsey also brought in a culturally relevant outlook on the reciprocal relationships between QM faculty and students he experienced with his faculty mentor within his program:

In China there's a very old saying from Confucius about teaching and learning, it's helping each other. Teachers grow when teaching students, but teachers also grow when they are well aware that students teach them also. I appreciated when teachers found a better way to help students understand everything by including them during their process.

Students also valued the GQMF who encouraged fellow GQMS to see their peers as thought partners and not “competitors” (Angelica, Ines, Noah, Megan, Jessica, Simple, Tiffany and Yan). Jessica laid out some of the teaching strategies GQMS did to encourage collaborative thought within group activities to:

Ask questions, share our main takeaways, ask about challenging things, share articles and resources which broke down statistics for important topics in our fields. We did things that appealed to different learning styles. When you work with others and share ideas, it's not a competitive process it's a space where we encourage one another to grow. I felt more confident, and this is really what quantitative research should look like.

Angelica stated “it was so much easier for me to wade through everything with thought partners. I really valued thought partners”. Amy experienced a form of liberation from

deficit ability expectations and stereotype threats when completing projects within diverse groups:

I felt a sense of escape from that ditzy, blond hair, blue eyes identity. We were all in the class together and that bound us together, we were all students, and we came together to do projects. (Names 5 students) all identified socially in completely different ways. It was a beautiful thing, we had one thing we had to do and that was put our brains together. I identified with my intellect, and they truly saw me for my brain and those were the very first times that happened to me. If I can help figure this out then the next time when I needed help you figured something out. I was able to forget about how I looked.

Summary

The transformational pedagogical modalities theme captures the socialization process which enabled students to actualize their identities as GQMS. All graduate students spoke about the growth and affirmation they experienced as an outcome of transformational practices such as hands on teaching, guided practice with data analysis software, memorable application moments and invested support from encouraging faculty. Students were able to describe how much contextualized content knowledge enabled them to overcome challenges understanding statistics. Inclusion of a JEDI to interpret numbers played a pivotal role in creating spaces for students to recognize deficit interpretations of themselves and their communities. The GQMF who encouraged collaborative community building within their GQMC helped students feel valued,

affirmed and encouraged as their came to voice about the issues they considered important for their development into highly skilled QM professionals in their different areas of interest.

Ontological Understanding

The four core categories in (Figure 9.) emerged to define GQMS ontological understanding of their pedagogical socialization experiences with transactional and/ or transformational pedagogical modalities included, empowerment, letter grades, identity politics and resolving paradigmatic tensions.

Figure 9. Ontological Understanding of Quantitative Methods

➤ Main Theme	➤ Core Categories	▽ Subcategories
➤ Ontological Understanding of QM, GQMF and GQMC	➤ Empowerment	▽ Autonomous Empowerment ▽ Faculty Driven Empowerment
	➤ Letter Grades	▽ Performance or Substantive learning
	➤ Identity Politics	▽ Neutrality ▽ Suppression ▽ Salience
	➤ Resolving paradigmatic tension	▽ Qualitative ▽ Critical Quantitative ▽ Mixed Methods ▽ Evaluation

Ontological understanding is my third and final theme which emerged from my data which captures the theory of being in social research and inquiry (Lincoln, Lynham,

& Guba, 2018). The categories, subcategories and properties supportive of this theme overwhelmingly indicated that Graduate Quantitative Methods Students (GQMS) did not exist as passive recipients of transactional and transformational pedagogical socialization modalities. GQMS developed their own ontological understanding of their pedagogical socialization process while being exposed to transactional and transformational learning modalities.

Students developed a personalized understanding of how each pedagogical modality enabled and constrained their learning of Quantitative Methods (QM), and Graduate Quantitative Methods Courses (GQMC) as an ontological thought space where students develop their own “way of thinking” (Ines) about QM. All GQMS valued QM and being within GQMC to learn and understand QM as a “necessary investment in their future” (Rose). Ontology is a paradigmatic tenet of applied research which holds that the subjectivities of the mind are used to create a world of physical objects and social interaction that students consider important (Jacquette, 2002; Freire, 1970). It is also the subjectivities that students used to frame how they will use the quantitative research paradigms to understand the natural world and the underlying dynamics of human existence they believe should be explained in quantitative research (Lincoln et al. 2018).

The evidence suggests GQMS developed their ontological understanding of GQMC as thought spaces based on their exposure to either transactional or transformational modalities. Ontologically most students understood that faculty’s social perception of their identities, demographic backgrounds and dispositions guided the

socialization process they experienced within their GQMC. This in turn influenced how students interpreted QM, saw GQMC as part of their social world and how they should think about and apply QM inside and outside of these courses. Students ontological positioning within these spaces were based on their consideration of what it means to exist within GQMC as: a woman, member of a racially minoritized group, Black, Asian, Latinx, Native American, Saudi Arabian, an International student, a woman, an evaluator, student affairs, a psychometrician, qualitative researcher, applied researcher, government statistician or psychologist, a member of a dominant group, racially and/ or critically conscious, a valued or marginalized GQMS. Students also developed aspirational professional identities which took precedence over all other identities and faculty's perception of their identities.

Exposure to transactional and transformational pedagogical modalities impacted upon how GQMS defined reality and used QM to study that reality. Students who were predominantly exposed to transactional socialization processes perceived GQMC as a rigid space defined by poor pedagogical practices, unequal power dynamics, racialized and oppressive hierarchical structures. These students also became invested in needing to learn quantitative methods to illustrate the obvious and hidden ways their experiences are enacted and perpetuated within different social structures. Students who received the most pedagogical socialization via transformational pedagogical modalities tended to view GQMF as open and welcoming spaces where they thrived and received invested support to reach their full potential. These students developed an ontological

understanding of working in some of the top federal and state agencies and prestigious institutions in the private sector.

In many instances the pedagogical socialization process students received via transactional and transformational modalities were at odds with the value all students attached to their agency, abilities and their role within GQMC. Oftentimes transactional modalities devalued students agency in ways which prompted students to resist and reject this overwhelmingly negative socialization process. This is in sharp contrast to the transformative pedagogical socialization process which not only reinforced but also increased students confidence and high estimation of themselves and their QM abilities.

Empowerment

This empowerment category defined students ontological understanding of how they can become successful and competent GQMS. There were instances when students exposed to the transactional modality reasoned how they would “dedicate all of my effort” (Lisa) to “make the most of every opportunity” (Angelica), experience or resource to ensure that they persisted and also thrived within their GQMC.

Autonomous-Empowerment

Students who received abundant exposure to transactional pedagogical modalities developed positionalities that they needed to navigate the GQMC environment independently. Rebecca described her personal form of empowerment as “self-encouragement to do some self-teaching, self-exploration, and investigation on the topic”. John described it as “I also have a brain which allows me to understand QM even

under poor conditions”. These were some of the protective orientations the students developed to counter the negative effects of their transactional socialization process.

Lisa who identified as a Chicana, first-generation student with intersections as a mother and scholar put a positive spin on her experiences with benign neglect, deficit ability expectations and restricted feedback because she decided:

I feel a sense of autonomy and self- efficacy understanding it is up to me to learn and that does not always mean asking faculty for help because of their personalities. I’ve come to depend on external resources like YouTube for demonstrations and this allowed me to trust just because I don't understand something the first time or faculty turns me away I can still work through it and stretch my brain rather than feeling defeat. So that's why I'm still taking quantitative courses although I don't have to.

Lini a White female, European, international student experienced a combination of transactional and predominantly transformational pedagogical socialization within her GQMC. She voiced her preference for autonomous learning to maintain her posture as a very knowledgeable student with “strong skills” where:

I don't ask for additional support. I go to YouTube, I read up on things. To be hundred percent honest I’m very embarrassed to admit that I don't understand something. On the positive side, I did develop the skill of being able to look things up, though it might take me longer, but then I know I understood it. Because I’m looking for the information myself and there's plenty available.

Rebecca possessed a strong practitioner identity, and this compelled her to pursue autonomous self-empowerment to actualize her career goals because:

There's an element of self- teaching that's going to happen when you don't get the material or when you don't have support learning the software. There are a lot of online resources you can use to help and support yourself. Most faculty are very theoretical, so this definitely had challenging implications for being a practitioner and what I'm actually going to do in the real world.

Noah experienced varying levels of transactional and transformational pedagogical socialization on account of her identity as a Black woman with a strong professional identity and a “faculty favorite” in her program. She also developed the autonomous belief that:

You have to make it fun for yourself and not rely on faculty to meet your learning style because graduate degrees are very much an independent enterprise. We're doing it because we want to, not because somebody is forcing us, because who would continue to go to school if they didn't have to. Why would you keep doing this to yourself? it's because you really have a passion for quantitative methods.

Megan's reported on her social understanding that she needed to empower herself through graduate school because the:

Doctoral experience is an independent enterprise that we choose, so it is not up to the Professor nor does the responsibility lie with instructors to make things do or be anything other than themselves. I chose this because I want it and I need to

work for it. I've encountered personalities but I can't allow myself to fail or be mediocre because I don't mesh with my professor. I have to figure out a way of making it work for myself and that's how I reconcile everything.

Megan also furthered that she wants to leave graduate school as an “expert” and reached out to external collaborators and resources to help her achieve her personal goals:

I came into the program working on an outside grant. I don't believe my faculty has contributed to this at all. All of my publications are outside of my program. I did all of my formal academic conferences, papers, book chapters outside of my program. The current people leading our program don't have either a strong interest my research areas of interest, so I went with people that do more of that work.

Yan is a female Chinese international student is a mother to a young toddler. Despite living through the positive stereotype of being a model minority, she also faced micro aggressions and gatekeeping from GTA's which led her to develop her own understanding of autonomous empowerment within her GQMC:

Sometimes I want to say I don't want to do this but because I've had that experience of overcoming difficult concepts I understand my own learning is believing that an outcome has more to do with my efforts. If I try harder to understand something then the more likely it is that I will truly understand it. Throughout my quantitative courses I have very much internalized that

expectation of myself despite the challenges that prevents me from asking for help. If I don't understand it's up to me to figure it out.

For Ines and Jane their autonomous learning strategies “paid off” (Jane) because of the applied competencies Ines demonstrated as a research assistant where:

It's been good teaching and learning for myself. I've been able to apply my knowledge to answer the research questions I've been working on in my research teams by applying quantitative methods. I feel good I've been able to transform the research question and goal of the Principal Investigator (PI) into something I can prove through the data set. I get to practice and become better at my skills because I have to do everything from zero and build my research from what I learnt during courses.

Lily felt empowered because her self-driven efforts enabled her to perform well in all her courses:

I don't like the teaching, but I got A's in all of my courses. My performance was very good because most of it was due to my self-learning. If I don't understand something I would go to the book and read, I would go to YouTube Videos and of course Mr. Google (laughing).

Lini expressed her feeling of autonomy as having consistently high performance which is not dependent on whether GQMF teaches well or poorly:

I'm getting A's in all my classes, regardless of how they teach. I'm having a hard time conforming to (male faculty) reading strategy because I'm not him. Their

teaching style doesn't have an effect on my academic performance but maybe in the long term, it might have an effect on my Dissertation. If my performance is based on grades, presentations and publications the teaching strategies didn't contribute.

Lisa pointed out that she empowered herself to learn QM so she could teach others who “faced but cannot overcome” transactional pedagogical modalities:

When I got to a place where I understood a method. I would work with my peers experiencing similar challenges to help them understand, so we understand together. I learned really well because I had to learn them on my own but then also know them well enough to try to show someone and demonstrate it

Noah mentioned similar aspirations of empowering herself so she could act as a “role model for students of color”. This emerged as a “self-motivating” form of “collective advocacy” (Tiffany) and “self-advocacy” (Lisa) that racially minoritized students used to persist through their GQMC.

Autonomous empowerment is connected to the ontological understanding students developed on account of the commodification of graduate education. Noah stated:

I do value my education and the money I’m paying for it I go Google it and then come back and say, I found A, B and C and ask which one makes the most sense and why normally that's pretty well received by (names hands of faculty). I’m

sure their eyes rolls, when I constantly asked questions, but I have to because at the end of the day I want this degree.

Amy shared that when she reflected on all the answers she gave to interview questions left her “wonder if I was focusing more on the faculty perspective for my learning as opposed to my own perspective as a student”. This is a poignant ontological question which captured how much many of the students who were exposed to transactional pedagogical modalities needed to develop their ontological understanding of themselves as GQMS to counter deficit ability expectations.

Faculty Driven Empowerment

Students who experienced predominantly transformational pedagogical modalities attributed their success to faculty driven empowerment within their programs. Some students who interfaced frequently with modalities such as hands on approaches, invested support, guided practice and mentorship viewed faculty involvement as a key contributor to the empowerment they experienced on account of their professional pursuits outside of their GQMC. Invivo codes such as “grateful”, “inspired”, and “competent” emerged which provide evidence supportive of this category. For Kimberly interfacing with transformational pedagogical modalities compelled her to voice:

I am grateful faculty provided me with a solid background in quantitative methods. After taking enough classes I started to feel I have a high level of competency. I've received A's in all my courses and my performance has been good because the quality of teaching did contribute to my learning process. One

thing about our program is that it's applied. When I compare myself to some statisticians I come across I think don't they know very much about really applying quantitative methods. The program, coursework and faculty is strong and so I became a strong student so much that I did have the chance to teach a class in my program.

Lini expressed gratitude for mentorship which blossomed into strong collegial relationships with faculty:

I am very grateful for the instructors who see me as a colleague not just as a student. They provide possible avenues for me specifically to see myself as a teaching so becoming a professor or working in industry developing tests and measurements. Many people in the program do not have the same opportunities so I am happy.

Jessica was very grateful for the feelings she experienced when she acquired significant levels of competency. She attributed her triumphs to faculty's invested support and inspirational teaching of QM:

Faculty were instrumental in getting through to me in saying I can do this! and having a positive outlook of my skills and abilities. I took two quantitative methods courses, and I actually retained a lot of the information because faculty took the time to walk us through the content and using the software. I never thought I'd be able to say this, but I would like to use quantitative methods one

day while consulting. I got through a lot of my fears and now I have an open mind about being positive and not letting past math experiences get to me.

Noah and Jane experienced faculty driven empowerment due to the taxing and challenging way faculty brought out the best in them during their training. For Noah:

Names faculty is very encouraging, and only hard because he expects a lot of you. He will tell you that he believes in your ability to get it right. He is hard but also encouraging, and patient. I joined the program because of him.

Jane experienced autonomous empowerment on her job because she attributed her ability to solve problems and build data dashboards to the “hard” faculty who taught specific GQMC:

Tough, toughness they're really tough. It's frustrating when I'm seeking the faculty's help to complete an assignment, or a project and they shut me down or told me to go figure it out sometimes it's because they wanted us to really learn the material. For the toughest faculty in the hardest classes I worked harder to understand the material. If it weren't for them I would not be so practiced and skilled.

Tom, Mike and Michael attributed much of their success within their assistantships and employment outside of their program as due to the skills learnt from their GQMF.

Comprehensively both subcategories autonomous and faculty driven empowerment exist as two ontological understandings students developed on account of the vast differences

between their socialization experiences via transactional and/ or transformational pedagogical modalities.

Letter Grades

Letter grades emerged as a strong core category within the data supported by one subcategory, performance versus substantive learning. Students representing a wide range of identities within different programs expressed concern about the quality of grading and assessment within their GQMC. Students who experienced transactional modalities expressed mistrust about the value of grades based on their experiences with poor course design, pedagogy and assessment strategies and pervasive faculty bias. While some students who participated in transformational pedagogical strategies trusted faculty implicitly that their classroom assignments were designed to facilitate substantial learning and understanding of QM and the transfer of essential technological skills.

Performance Versus Substantive Learning

For the most part all participants spoke about achieving “all A’s” , “good grades”, or “performing well” during and at the end of their GQMC. Rose expressed deep happiness when she provided evidence to support her impressions about the grades she earned after participating in her GQMC, “I felt good, I felt so good about it (laughs) I got A’s”. Her strong sentiments were shared by Ines who shared “in terms of grades I've always been good”. Nora expressed a deep sense of accomplishment when sharing “for me two of the most important things connected to a grade is, one it’s great to have great

grades and two my ability to put these methods into practice”. Lily shared how much final papers contributed to her process of gaining knowledge on QM:

Yes I performed well but for me it was how the grades were generated. Grades were based on how you did on lab assignments. All of our quantitative methods classes had a mid-term and then a final project that was always your own practical application of the content in the class. I felt particularly on final papers that if I was able to use all the knowledge I gained throughout the Semester and apply it to my own research studies that signifies I got the content and was able to apply it.

These narratives illustrate that some students accepted grades as an indicator of performance while some students gauged the value of their letter grade based on their ability to apply skills learnt within their GQMC. Ines and Rose gave examples of substantive successful applied practice outside of the classroom and credited faculty’s invested support and their exposure to classroom content as contributing factors.

Noah, Lisa, Marie and Megan all added support for this performance versus substantive learning subcategory in similar and unique ways . Noah provided empirical backing when she stated, “I’m great because I make A's but that's just a letter. As far as learning, I feel like I’ve learned something when I’m able to apply it successfully”. Lisa attached deeper significance to her letter grade in her statements that “I've had A’s in my courses and for what it's worth performance is different for me. I don't know if those grades really reflect complete learning, understanding and application”. Marie was resolute in her explanation that:

If you asked me how I perform in a course, I'm going to think about my grade but arguably this is not the best way to think about how you perform for a course. Did they assess understanding and being able to apply it to your work?

Megan described her nuanced perception of her grades earned within her quantitative methods courses:

I didn't learn everything I needed to be skilled because courses were based on limited learning options. Sometimes the teaching strategy made me question my performance. For me the quality of my performance were strongly indicated by the research opportunities I received from some professors and others following those courses. After getting my grade they saw something they were interested in building.

Amy shared:

Getting an A is a nice thing. It took everything in me to meet the expectations outlined in the syllabus for what I was supposed to be able to demonstrate as a learner. I didn't do anything that wowed my professors in terms of above and beyond or thinking of new quantitative methods or applications that popped into my brain that really didn't happen very much.

Megan's and Amy's recounting of their experiences allowed for linkages to be made between strong performance and exceeding faculty's expectations within GQMC as contributing to faculty's positive estimation of students abilities. Ines expressed a similar sentiment about being underestimated until faculty:

Eventually learned that my methodological skills were more developed than my classmates because I did a Masters in (names specialized statistics degree). So, in that sense when that happened I no longer had any issues of faculty not believing in my skills.

Michael spoke about letter grades as a temporal and incremental process of skill acquisition over time:

I did not enjoy when we're doing exercises for the sake of having a grade and I know this for myself, and I've heard similar experiences from other students. The further along I got in my academic career, I developed a pretty strong idea about what I wanted to focus on and where I want to put my energy. I tapped into that more when I had valuable one on one time with faculty. I've gotten an A in almost every class, two of them I've had a B plus. So that's just the grading side of it, the performance side of things. For me it's mostly what I feel like I've taken away. But I still feel like I've been very successful.

Rebecca posited the temporal aspect of building grades based on her ability to perform all the activities stated within her syllabus:

I received an A for all of my courses. I was very engaged because the reason I was taking these courses is specifically for advancing my skills in (names field). I met all the criteria, I had very high engagement, I attended all my classes, I asked a question if I didn't understand, I did all of the homework assignments in addition to doing any supplemental assignments including the practice exercises.

Faculty noticed and appropriately assessed me as meeting all requirements for fulfilling the courses, so I performed very well in all of my quantitative courses. However, I learned the most when I investigated additional information on my own to be able to build my understanding of the topic.

Rebecca constantly expressed how much “self-directed learning” contributed towards her understanding of QM and future practice. Yan mentioned her letter grade comparatively with the males in her courses in terms of the fact that she was one of the few females within her advanced QM courses who would:

Spend a lot of time alone on statistics and I would get very good grades. In reality a lot of my males classmates can do a very wonderful job with the software's, R and they're doing all the fancy things we are not taught in class. Good grades is very nice but overall, I don't feel very confident in this field because of my female identity and skills when I compare myself to males.

Simple expressly stated that she does not:

Evaluate my work based on a grade, although my transcript is important an A or B is nothing unless the course is really useful and the skills I learned is helpful for my research. I grade my performance on how much can I remember, understand and apply.

John appraised his performance in terms of the differential effort he carried out in classes where there were mostly transactional and hands off strategies where he expended the most personal effort to learn and understand QM versus courses with predominantly

transformational modalities where things were “very smooth” not only did he focus on the “content but also the skills and new things connected to the content”. Bob voiced similar deductions when he shared his:

Feelings some of the classes were challenging in a way that I learned a lot but there was so much chaos and stress in my life from figuring out what's needed or how to interpret the output from that class. I don't think my results reflects learning in those classes. I had high scores in all my quantitative courses. My were almost the same but that doesn't reflect the huge effort I put in especially for the poorly structured ones.

Many students viewed take home tests as an indicator of their ability where they were exposed to content in a way that did not “trigger their anxiety” (Jessica) or “make them feel nervous” (Sara). Isabelle provided a different viewpoint about connecting grades to take home assignments rather than traditional in class midterms and tests:

An A was not the best metric of ability, even though my performance would indicate that I feel very confident in performing quantitative research. I am not as competent as my grade would suggest or don't feel as proficient as my performance would suggest. Assessments conducted in person that doesn't allow students to use their notes would be a better indication of this actual ability. I am a good note taker and so if I am able to use my notes for an assessment, then I don't necessarily internalize the material to the same extent that I would, if I were not

allowed to use my notes. My performance is a better indication of my note taking ability than of my quantitative abilities.

Susanna's social understanding of her grades after experiencing considerable socialization via transactional modalities concluded:

They evaluated my performance not my mastery of the content because I got good grades in the classes. What they were grading was my ability to follow the syllabus, do the assignments and the final paper. If they graded me on mastery I would have failed the classes. So, they were grading my performance not my ability. They gave us a lot of work a lot of the time but was that work necessarily meaningful.

Identity Politics

Strong evidence emerged to support students ontological understanding of the pedagogical socialization process connected to their identities and identity development within GQMC. Identity politics is a main theme which captures GQMF perceptions about GQMS dispositions, backgrounds and identities and how it influenced the pedagogical socialization process they directed towards different students within the QM learning environment. The identity politics connected to transactional pedagogical socialization were implicit and explicit, hierarchical, power driven, oppressive and racialized. For Shaga "I do believe it is racialized. I do believe that's the way it has been". It forced students to interact with stereotype threats and deficit ability expectations from faculty and students within GQMC. The students who were socialized primarily by

transformational pedagogical modalities tended to view GQMF as extremely accommodating, supportive and accessible to students. I developed the identity politics core category using the identity neutrality, identity salience and identity erasure subcategories.

Identity Neutrality

Bob reported experienced mostly transformational pedagogical socialization identified as a male, Saudi Arabian international student and model minority noted that:

It was a very healthy and anti-discriminatory environment for me. All were welcomed, there was no discrimination between gender or background. This may not be so for some students for me nothing stands up very negative about how faculty perceived me. I met a lot of lovely students who were very nice, and I love the experience. It's a female dominant environment, which is a game changer for me because this added a very different perspective.

Lily a female international student who experienced predominantly transformational pedagogical modalities such as guided practice and invested support voiced that faculty:

Treated us as human beings. They were always very good, very friendly, very welcoming, very understanding. I've never felt like they were racist, or I was discriminated against, or I wasn't respected. They were very understanding and provided all the support that they were able to provide so I was not negatively impacted.

Kimberly who reported being socialized by transformational pedagogical modalities throughout her time within her GQMC stated “I don't feel they responded to anyone in a bad way. They treated students in an equitable way”. Michael who identified as a first generation GQMS with a well-established career in QM was also exposed to predominantly transformational pedagogical modalities expressed:

Within my quantitative methods courses I have the expectation that while you're being challenged by faculty they are criticizing and pushing you to defend your work, this shouldn't be seen as a personal attack or slander it's more about what you need to be a scholar and a practitioner.

Rose identified as a Black women, part time student with an innate ability for QM experienced predominantly transformational pedagogical modalities. She was adamant while communicating:

My treatment was consistent to how they treated other folks. I would say to just being transparent, in this degree, at the school, at our institution it's almost 50-50, those who identified as White and those who identified as Students of Color, so it was a different space. I personally have not experienced people treating me differently or inconsistently with how they treated others.

Some graduate students developed their ontological understanding of quantitative methods based on varying levels of acceptance or rejection of the perception of numbers and mathematical formulae as objective, or representative of a neutral stance in quantitative research. Similar to the contextual content knowledge modality some

students rejected an identity neutral framing to GQMS pedagogical strategies, QM syllabi, textbooks mathematical procedures, numerical content and research ethics. Stephanie who identified as a biracial part time student and student affairs professional was adamant that instead of “constantly reading supposedly neutral textbooks the syllabus should have included a lot more diverse voices”. Jane as an international student expressed similar sentiments about faculty’s assumptions that their syllabi and assignments were neutral:

The syllabus does not do a good job addressing diversity or all the supports that students need. There is a lot of diversity, when it comes to when we're talking about students with disability or students of color or gender, but these are things that are accepted and well known. But I don't think the lectures or syllabus addresses specifically how assignments are presented as pretty neutral, so it doesn't affect the dominant groups. They don't talk about race I am not sure if they valued the word diversity in my analytics courses. The biggest thing that was not neutral for sure is the syllabus.

But then Jane in response to one question about whether her identities were important while participating in GQMC responded in sharp contrast below to what she shared in the preceding quote on the importance of having students identities reflected in GQM course design:

I don’t think some faculty see the difference, which is awesome because when you're a student, in my opinion you're a student, who cares what your color is or

how you look like. In my opinion, we're all the same, we shouldn't be discriminated because of that. My identity wasn't really a part of any of that, the only identity I brought into the class was being an educator

Simple provided key insight on her ontological understanding of identity neutrality within her GQMC:

Statistics texts discussed race and gender in what was supposed to be a neutral way or in ways that represented people as a piece of data that are not neutral and that permeates the entire research process. People of color are represented only within the confines of survey ethics where we speak about how we've been harmed or negatively framed with quantitative research.

There were students who believed that when identities such as race and gender were added to statistical models it was perceived as a neutral activity which would bring about neutral results. Noah opined her discernment that the instrument development process was not neutral but the statistical techniques she used to analyze the data arising from her instruments were:

It makes me think about a book that I'm reading on project evaluation, critical race and social justice. None of that is present in my quantitative methods courses because they're technical and theoretically you know measurement is supposed to be neutral, but it isn't but as far as the mathematical procedures go it is. Identities come up in research projects or instruments but not in methods.

John, an international masters student who experienced various forms of ability expectations and ageism within his GQMC expressed support for identity neutrality when he shared “I would say the assignments they're pretty neutral, so is data science. Identities doesn't affect when we're talking about numbers or the math”. All evidence unites to suggest that students pedagogical socialization process greatly influenced their perception of the identity neutral politics within GQMC. Isabelle noticed that “I don't know if there was ever any explicit discussion or acknowledgement of my identity in the class, it definitely implicitly influenced most of the interactions we had”.

Identity Salience

This subcategory emerged to describe the identities which strongly factored into whether students experienced transactional or transformational pedagogical socialization. Identity salience emerged because of the consistency in which students made connections to their identity based lived experiences, pedagogical socialization process and their aspirational professional pursuits post-graduation. Lisa summed up identity salience in the context of GQMC:

Because I'm one of the few non-white people my identities related to race or gender were more salient because I don't see my identities in quantitative methods courses. There were always instances of having to prove myself. My former advisor didn't believe me when I said I knew how to use SPSS since undergrad. Some faculty don't necessarily expect I know what I'm talking about or that I can do certain things. I have to show them I can be more than what they

expect. It was disappointing with White faculty but also people that have the same identities as me of having to prove myself.

Lisa believed that some GQMF targeted her on the basis of her identities using their transactional pedagogical socialization modalities. Lisa identified being one of the only Latinx student and constantly having to prove herself against the expectations imposed on her Chicana identities and as someone faculty didn't expect to be competent using SPSS. Although these experiences served as a strong motivating factor to perform well in her classes, Lisa experienced an underlying and unacknowledged mental burden. Susanna voiced similar experiences based on her most salient identity as a Latina and qualitative scholar.

Being White was acknowledged as a salient identity for some students but not others. Amy, Marie and Mike described how being White affected their pedagogical socialization experiences within their GQMC. Amy experienced significant stress from sexism and discrimination within her GQMC and also on account of her rejection of the privilege male faculty and students wanted to bestow on her on account of being “a White female with blond hair and blue eyes”. She experienced a lot of difficulty because her physical features were not her most salient identity and her refusal to “play towards faculty expectations connected to her looks”. Female students perceived “White male professors as so pompous and so arrogant in their own White male privilege” and the “intimidation factor that sometimes accompanied it” (Amy).

Amy also expressed feeling “particularly bothered I could not talk with White female faculty despite our similarities in terms of being White” on account of the way she looked. All of these experiences provides some insight into the reasons why Amy was so grateful for the Asian female faculty that mentored her within her GQMC. Amy’s experiences with transactional pedagogical modalities also gave her an awareness which led to her ontological development of her identity as a “social justice advocate in her current and future work”.

Marie mentioned her identity as a White woman as salient but connected to additional identities:

I identify as a white cisgender woman and a passionate social justice advocate. I went into research to provide evidence to really improve this country, the world and life for marginalized minorities and people who have less than I do. I see myself as having some form of white privilege and I try to recognize my privileges as a white woman. I also recognize myself as a woman and that is also seen as a disadvantage more in statistical analysis because I see a lot more men in those fields.

Mike emerged as the only White male participant to provide context on his White male identity in statistics:

It's been hard to put myself into some situations because race and gender-based marginalization is not a part of my white male experience. In the US some of my white identity is the dominant culture because it is always represented, and

considered the cultural norm. White male is considered the default, but if you add in disability status or queerness, it really isn't represented. I think about how that might impact others in the data.

Several references were made about the identity salience of White men predominantly by female/ women GQMS. For Angelica, "Most of the QM faculty were older and White and the readings are all White male focused". Marie added some context about one White male professor who highlighted that most quantitative methods were created and developed by White men:

One of my professors would bring up, it's another white guy that we're learning a concept from so he would recognize that. It's a lot of White men that discovered and created a lot of those statistical concepts that we learned. There was not a whole lot of diversity in the readings that we do.

No other student who identified as White within the Participant Information Survey considered being White within GQMC as affecting their pursuit of QM or future aspirations within GQMC.

Students of color perceived being White as a very salient identity for White students with implications for their pedagogical socialization within GQMC. For Lisa this shows up in:

The history and how a lot of methods and statistical procedures have been normed around white wealthy men and the way these methods have been used to recycle hegemony. It's mostly Pearson and other white contributors to statistics we're

introduced to and that's it. When they say that study is generalizable it's because participants are primarily white, primarily men and primarily heterosexual, so dominant groups are always represented in the data.

Ines and Jessica both spoke about their stereotypical impression of GQMF. Ines opined “my stereotypical impression of a QM faculty member is unfortunately male and someone who is older, White and very serious”. Jessica perceived GQMF as:

White, male, hard to read, perceived as cold and the opposite of classes and programs I’m used. The faculty for my more advanced quantitative methods classes was a middle-aged white woman who was surprisingly very receptive, very accommodating, very much aware of the reality of what was going on with the world.

Noah stated that when she thinks of White faculty:

I envision an older White male who is the guardian of all things quantitative. But I attend an HBCU and so I’m blessed to have an older Black male, who is the guardian of all things quantitative. I feel safe, I feel supported in this HBCU environment to prepare me as best as their resources allow to compete with White students from Traditionally White Institutions (TWI’s). One professor is Black and the one White professor views himself as a minority so that is something I take into consideration. But we have not had rapport building conversations where we would get to know each other on a more personal level.

Both Noah and Megan spoke about the levels of support they received within their HBCU's in contrast to their experiences within TWI's at their undergraduate and master's levels. It is also interesting that Noah felt that she was competing with White students and also the students of color enrolled within QM programs at TWI's. Noah also demonstrated a gendered perception of males faculty as the guardians of quantitative methods.

Gender is a very salient identity for female and male GQMS and GQMF. Kimberly alluded to feeling “a little intimidated with the statistics courses as a gender issue not being dealt with appropriately”. Marie noted that her female identity was strongly salient because of being mentored by a female QM professional outside her program. Gender is a salient identity for Noah especially as a Black woman in psychometrics:

When I attend the National Council on Measurement in Education (NCME) graduate student meetings with their brown bag sessions, I don't see very many black people and with the way measures are so pervasive in society, we need to make sure that the people developing those measures are representative or represent the people taking those measures to let diverse communities have input into how it's developed, disseminated and how the scores are interpreted.

Nora appreciated also “teaching strategies that supported my identity as an introvert”.

Students social understanding of identity salience was also tied to the hiring and visibility of diverse faculty. This perspective was voiced by Lisa, and Angelica for black

faculty who also tended to be adjunct professors with large course loads and mostly black male QM faculty (Marie, Noah, Jessica and Megan). Megan noted that although she attended an HBCU most of her faculty were predominantly White, male with mostly White students enrolled in her advanced GQMC. She also noted that interestingly, “as a Black female in quantitative methods I’ve never in my life had a Black female instructor, I’ve never had Black female instructors throughout the duration of any courses in particular. I didn't see that representation”.

Identity Suppression

Sara identified as a Black doctoral higher education student at a traditionally White private R1 institution spoke about linking QM to her Black identity for the first time:

There are no moments where there were black quantitative methods scholars or People of Color. I didn’t see myself reflected as black and female within the curriculum or when even thinking about the assignments. Just looking through the syllabus right now (slowly flips through syllabus), no I or my communities wasn't really represented. I didn’t even think about that since I did not expect to have those experiences. It makes me think about the history of quantitative methods, are there black female quantitative readings or articles? Are we even reflected in quantitative methods history?

Susanna communicated that for the most part “my identities were not relevant, so it was not reflected in the syllabus”. For Jessica:

I don't even think the topic of my identity ever was a basis of a conversation within my quantitative courses which is vastly different than the program I am in. In my program we're very identity driven and identity heavy. We're in a field where we talk about our identities constantly all the time. Now you're in spaces where we're not talking about identity because we're talking about math, talking about equations and they assume there is no identity development connected to that so my identity as a Black woman never came up.

Lisa mentioned that in her early GQMC she suppressed her identity because:

Even though they treated me differently faculty never acknowledged my identities and early on it made me feel like I could sort of just blend in. It sometimes felt like an erasure so as time passed I understood that my identities mattered in these spaces because I am a minority especially when speaking about measuring intelligence.

Noah mentioned as a matter of strategy that she suppressed her Black identity to:

Focus on learning quantitative methods and getting her doctoral degree because it's not what I am now but it's my purpose in the future. Because I attend an HBCU I don't concern myself with the concept of being Black or African American, because that is who my peers are in this environment now. My identity has more or less importance depending on the context. Ultimately once I have those three letters behind my name then that will give me access to those

discussions and those platforms, so what I'm doing today is an investment for my future.

Angelica who expressed a lot of pride in her multi-racial identity added a very interesting dimension to the evidence supportive of identity suppression among GQMS when she shared:

I've never felt any issue or discrimination or oppression because of my identities.

I've never felt any recognition or discussion of them either which I'm okay with I don't need them picking apart my identity to say 'oh she is black let's...' I don't need that either, I just need good content, good learning and good teaching.

Resolving Paradigmatic Tension

The final core category supportive of students ontological understanding of their GQMC as a space to resolve tension between qualitative, quantitative, mixed methods and evaluation research paradigms. In this category all four research paradigms are framed within the context of students pedagogical socialization process within GQMC by faculty. Students expressed either moving away from one paradigm to another, realizing different areas of convergence for two approaches or adherence to only one research paradigm.

Qualitative Research

Students recognized paradigmatic tension between qualitative and quantitative researchers where both paradigms were perceived as polarized opposites and were ranked in ways which positioned qualitative research as having lesser value than quantitative

research. These sentiments gained traction on account of comments from Angelica who stated that although she “valued qualitative data, she had a perception that the world and scientists valued quantitative methodologies more”. This was reinforced by Ines who shared that “qualitative is not something that comes to me naturally. Quantitative research is more valued than qualitative research and you need quantitative knowledge more”. Both Yan and Zi spoke about their preference for math as the reason why they are more inclined to pursue QM training rather than qualitative. For Yan, “although my program really valued qualitative methods it's very important for me to learn how to use quantitative methods especially because I want to have that math background”. Although Zi appreciated both:

Quantitative and qualitative research methods are very powerful tools for our future research. But when I compare with qualitative research methods, I feel more passionate about quantitative so that's why I'm choosing the more quantitative research methods than qualitative. My math is also pretty good, and it is not a challenge for me so that will help me choose more quantitative than qualitative research methods.

Lini spoke about switching her emphases to quantitative methods after having a heavy focus on qualitative research during their master's training. For her, “I started being more a qualitative person, I could not understand people as well anymore. I found solace in numbers, in knowing what is black and white to know that I'm right or wrong. QM, give

me stricter boundaries, than qualitative research in general”. Stephanie expressed happiness at making the crossover from qualitative to quantitative research where for her:

The faculty have been very encouraging and have presented quantitative methods as something to not be frightened of or just another tool within the toolbox or another color of paint in the palette we can use as researchers and educators. That has been very empowering and very reassuring, I had originally enrolled in my grad program thinking I would primarily focus on qualitative approaches.

Tom shared “I always leaned heavily on qualitative because I’ve taken qualitative courses from undergrad to my master's program. Now in my doctoral studies I wanted to reinforce quantitative analysis in my skill set”. Students in the quantitative track like Tom, Lini and Stephanie who experienced significant forms of transactional pedagogical socialization each received significant support from faculty to make the transition from qualitative research to quantitative. All recognized the benefits in terms of adding new skills or ultimately seeking in employment in “larger institutions like the CDC, USAID or any other quantitative based organizations as one of the reasons why I pursued a quantitative focus in my doctoral studies and because there is a gap in my knowledge within that field” (Tom).

Students like Jessica, Susanna and Shaga reported struggling within their GQMC because of their strong qualitative research identities, the negative perception of qualitative research by quantitative students and faculty and the weak relational orientations of quantitative faculty. Jessica expressed her hope:

I can look at quantitative data and phrase it into a qualitative question that's beneficial. I appreciated faculty not making people who studied qualitative research feel lesser than in a quantitative methods space. She did not have these long philosophical debates for people to take the opportunity to say qual is not real research and qual people be like you know quantitative researchers think they're objective, but you're not. She let it be a space where everybody's skill level could be appreciated and accepted. I'm fortunate, our working group was all women, and we didn't want to be seen as dumb qualitative researchers. We're just trying to get through this with no judgment in that aspect.

Shaga expressed:

I've taken quantitative classes because I'm interested in doing it although my program leans more towards qualitative studies. The expectation is different, even the lecture approach is different, the in-class conversations are different, and you can make a humanizing contrast to qualitative studies.

Susanna professed having a strong qualitative background and identity and was a bit angry about some GQMF openly expressing their low estimation of qualitative research and qualitative researchers. Susanna shared, "some faculty made disparaging remarks towards qualitative research, and I said you can't denounce qualitative research because you're a quantitative researcher". Simple and Tiffany always experienced difficulty with the ways quantitative researchers framed the experiences of different groups so they

applied their extensive knowledge in qualitative methods in their quantitative classes.

Tiffany's approach gained unexpected recognition from quantitative faculty:

I had a survey assignment where I looked at faculty of color tenure rates compared to white faculty. When I was writing the limitations, I wrote in a very qualitative way from my qualitative mindset and the instructor really liked it. I think in academics spheres people do not think about me because I am Asian American that I do qualitative work primarily. I do have strengths as a qualitative researcher.

While for Simple who expressed no intention of leaving the qualitative track found value in using her qualitative skills to tell a more contextualized story of native students within her quantitative results:

I know quantitative research is valuable to know what is published and how native students or natives in general are represented in the numbers. The numbers definitely told a certain story, and I think about collecting larger amounts of data and different methods of analyzing data to find relationships and trends in ways that can be represented as it relates to qualitative approaches and context in an in-depth way.

Critical Quantitative

Critical Quantitative (CritQuant) research is a frame of reference for education scholars who challenge quantitative research framed within the positivist tradition (Tabron and Thomas forthcoming). It is an approach to quantitative research that

contextualizes numbers using Justice Equity, Diversity and Inclusion (JEDI) approaches to “question the models, measures and analytic practices of quantitative research” to develop quantitative techniques and practices “that better describe the experiences of those who have not been adequately represented” (Wells and Stage, 2015, p.103-104).

Kimberly used a diversity perspective to define:

CritQuant where it's critical race theory applied to quantitative research or having those identities like race, ethnicity, gender, different identities informing the way that we do statistics, but that really was never something that was covered in any of our courses, and I wondered why? I took some classes and I learned about it from readings in those classes. I don't know if maybe they don't cover it in (names program) because they assume people that are interested in that will pursue that on their own or what, but I wondered why it's never been considered as something to bring into the curriculum.

She lamented the absence of a similar course within her quant heavy doctoral program.

Lisa added some valuable insight into why CritQuant is a subfield within the quantitative methods paradigm which would accommodate the positionalities she developed on account of her transactional pedagogical socialization process within her GQMC:

Knowing the history of Pearson or Spearman that's helpful knowledge because that caused me to question the hegemony in quantitative methods, but I don't use that history in the analysis. I'm hoping to utilize the promise of critical

quantitative methods in trying to learn methods to apply it to Critical Race Theory (CRT) and empowerment theories that challenge racial hegemony.

Michael mentioned his growing interest and:

Focus on Critical Quantitative in DEI initiatives on racial equity in education, access and how we understand student success. My interest with CritQuant developed over the last couple of years because some individuals I've been able to work with who does a lot of critical race theory. I've had a number of experiences in my professional life, where I've seen quantitative methods very badly misused especially in the world of racial equity.

Developing a CritQuant identity has been crucial for students to reconcile the paradigmatic tension of engaging in quantitative research as a site of oppression and marginalization for diverse groups and individuals with diverse backgrounds. Tom spoke about the development of his critical identity as a quantitative scholar after being exposed to a combination of DEI courses, personal experiences and quantitative training:

The syllabus doesn't reflect any of my personal identities there is no critical quantitative information purely methodological. There is no methodological content in the syllabus that reflects critical quantitative studies that would talk about gender or anything like that. A critical identity for me as an identity that is critical of institutions systems and norms, assumptions, cognitive schemas whatever at social, cultural, academic and that, for me, is a social justice identity. Criticism comes from non- representative traditions and non- representative

practices so to me the social justice identity is part of the critical identity. There is no interrogation of how we can interpret different information on different populations.

Mixed Methods Research

Students enrolled in specialization quantitative methods programs lamented the weak emphasis of GQMF on the power and utility of mixed methods research for professional and applied practice. Randolph recognized the utility of using qualitative and quantitative methods in evaluation research:

When using qualitative and quantitative research you can go either way and it can be both, but it's not necessarily that one is better than the other. We're supposed to blend quantitative with qualitative. We have two different paradigms of data collection and analysis. You want to make sure you're using the best tools for a given situation in terms of how you're collecting data. You want to make sure you have all of the tools that means it's more 50/50 share to get the answers you're seeking?

Tiffany spoke about needing unity between both approaches in education research and did not:

Appreciate anything that pitted quantitative and qualitative work as dichotomies.. Because there is also mixed methods I also don't think we talk about often about that. I am interested in learning how quantitative methods informed mixed

methods. I don't like the dichotomy. I think we do quant because it's been told we need to at least understand quant. But we choose to do qualitative research.

Amy addressed the issue of being equivalent but different when addressing paradigmatic issues in mixed methods research saying “we need to look at qualitative and quantitative more equally. I felt like quantitative would add some punch to my social justice and get the attention or approval from those who might not be willing to look at my work if I did qualitative”. This also provides evidence to support the mono method bias that exists for qualitative research as a standalone method among quantitative researchers.

Michael shared his interest in mixed methods for professional identity development and untapped potential for conducting DEI research:

I tend to work in the quantitative world and increasingly my academic interests have been in a mixed realm which tends to focus on DEI initiatives. There's obviously a lot we can learn and study using mixed method as the start of the conversation with quantitative analysis paired with the qualitative.

Megan, who is enrolled in a heavily quantitative program considers it her personal responsibility to ensure her competence in mixed methods. This is crucial for her development into a highly skilled researcher since:

I have a responsibility that I am reporting the correct information that I'm doing the right analyses that I'm holding up the integrity of my data. So having a good understanding of qualitative methods and standards is required for me as a good

mixed methods researcher. All the work I'm doing is related to quantitative and qualitative measures.

Susanna's poignant quotation brings a with fresh perspective that "for me you need both, they are not mutually exclusive, they're interdependent the data only tells half the story because without people's stories you're missing the whole context of the situation". While for Tom mixed methods research is a great way for "creating a diverse portfolio of skills especially when considering the matter of how you're going to apply them or how to deal with the non-linearity of real-world applications".

Evaluation

After taking her evaluation class Marie expressed, "I still don't know if evaluation research is quantitative, but I guess you could do quantitative methods within evaluation research". Randolph who has considerable training in evaluation sought to resolve the paradigmatic tension of situating quantitative methods within evaluation research:

I have a solid background on making everything happen within evaluation, setting up you logic model, you plan how are you going to do it? set up your evaluation, plan, do all of that. I would say we didn't necessarily dive heavily into how quantitative methods would inform that. It became a bigger priority to be a practitioner than the program itself. I feel like my program is very heavy on academia because I often felt like they weren't necessarily tying it to a practitioner focus basically it's the tools you use to give your stakeholders your responses.

Randolph spoke about resolving the tension he experienced about evaluation in his quantitative courses with prioritizing a practitioner and stakeholder engagement foci. He emphasized a strong component of evaluation research which differentiates it as a paradigm with a different focus than solely an academic mastery of quantitative techniques. Rebecca mentioned the use value she expected to derive from learning advanced statistics to increase her ability to manage the complexity of evaluations mandate for stakeholder responsiveness:

My interest is program evaluation where we use all types of advanced statistical methods, very commonly now in program evaluation, propensity score analysis and HLM. So having those courses under my belt and understanding them was something that was desirable for me to be competitive in my field. But because my program is so academic focused I have to constantly translate the stats heavy stuff to a practitioner focus.

Like Randolph, Rebecca reconciled the paradigmatic tensions she experienced with the pedagogical socialization process within her evaluation courses with a lot of self-teaching to “translate” content into applied practice.

Summary

Graduate Quantitative Methods Students (GQMS) described pedagogical socialization as the connection between intent and impact. They looked at the stated and the implied attitudes, values, norms, and expectations of faculty used to inform the pedagogical modalities used to teach students QM and the contradictions between them.

Autonomous empowerment was enacted by students who experienced transactional pedagogical socialization as a response to being denied access to institutional and faculty-based support. All graduate students set their own personal goals for achieving competency in quantitative methods using autonomous strategies such as self-teaching, self-determination self-coaching and self-advocacy to avoid the harmful and often traumatic experiences interfacing with uncivil, discriminatory and racialized teaching practices. This is in sharp contrast to some students who experienced significant levels of transformative faculty driven empowerment who had unrestricted, welcoming and open access to faculty backing, mentorship and opportunities to advance their student role and professional pursuits.

Most students developed an ontological understanding of identity politics and paradigmatic tensions based on their perception of Graduate Quantitative Methods Courses (GQMC) existing as a contested thought space. Students also interpreted and added meaning to their experiences with quantitative methods based on the opportunities it afforded them to make deeper connections with qualitative, mixed methods and evaluation research paradigms. There is a definite tendency to focus on the students methodological socialization and training within graduate quantitative courses. My research clearly demonstrates the need for a dedicated shift towards teaching and learning within GQMC based on students ontological understanding of the world and their experiences within it.

Chapter Summary

Transactional and transformational pedagogical modalities and students ontological understanding emerged as the three main themes which underlie graduate students pedagogical socialization process within GQMC. Each theme is supported by well-developed subcategories, properties and propositions which provide a holistic representation of the pedagogical socialization experiences of the 31 GQMS who participated in my study. Participants verbatim quotations from saturated data sources within NVivo v. 12 were weaved into theoretical explanations to provide a rich and descriptive process theory of pedagogical socialization. It was impossible to ignore how much the GQMS who persisted through their GQMC rejected the deficit unidirectional socialization of the transactional pedagogical modality. The data also illustrated how much transformational pedagogical modalities are crucial for students persisting, innovating and advancing through their GQMC. GQMS ontological understandings of QM were based on the ways students dealt with issues related to their perception of their socialization process within GQMC, their roles as GQMS and its relationship to the nature of reality they intended to capture using quantitative research.

CHAPTER FIVE

Discussion of Findings

The purpose of my grounded theory inquiry was to explore with a sample of doctoral and masters students, their perceptions about their pedagogical socialization experiences within their graduate quantitative methods courses. In the first section of this Chapter I restate my research questions to reiterate my reasons for conducting my study. Next I provide answers to all three research questions based on relevant patterns which emerged from my data. Since theoretical sensitivity and credibility are based on the depth of engagement between my findings and the existing literature (Corbin & Strauss, 2008; Glaser, 1978; Morse, 2018) I also discuss the contributions of my pedagogical socialization theory in relation to graduate education scholarship and pedagogical theory, research and praxis.

Restated Inquiry

I conducted my grounded theory inquiry to collect and analyze graduate students narratives to study:

1. How do graduate students describe and understand the process of pedagogical socialization they experienced within their graduate quantitative methods courses?

2. What are graduate students' perceptions about the recurring patterns of interaction between themselves and graduate quantitative methods faculty?
3. What are the underlying dimensions of a theory which captures graduate students' pedagogical socialization experiences within graduate quantitative methods courses?

Presenting an interrelated theoretical explanation of my findings is sufficient for answering my research questions and providing a holistic representation of graduate students lived experiences with pedagogical socialization as it occurred within their quantitative courses over time (Glaser & Strauss, 1967; Glaser, 1978; Strauss & Corbin, 1998).

Students descriptions of their Graduate Quantitative Methods Courses (GQMC) led to a deeper understanding that there is much pedagogical and experiential variability connected to faculty's teaching approaches within advanced methodological courses (Nind & Lewthwaite, 2018). My findings revealed much of the historical, socio- cultural, interpersonal and structural factors contributing towards this variability. Although enrolling within GQMC is a common experience for all the students in my sample, most did not experience constructive and engaging pedagogical socialization. Pedagogical socialization within GQMC is enacted differently for different students based on faculty's teaching strategies and their perception of student's group membership, dispositions, and abilities.

For students experiencing socialization via transactional pedagogical modalities courses were perceived as oppressive, rigid, stagnant, unwelcoming, racialized and gendered spaces. Some students were subjected to a range of debilitating norms, values and role expectations which stymied their learning and understanding of quantitative methods and more specifically higher level applications of quantitative research. These dynamics have been linked to increasing student perceptions about the poor quality of their academic experiences within graduate classrooms over time (Gaggero & Haile, 2019). This is in sharp contrast to the students who experienced pedagogical socialization via transformational modalities. These students reported on their quantitative courses as welcoming, capacity building, progressive, growth oriented, supportive, inclusive, and identity affirming spaces. They also reported that their role as QMS and future professionals who apply QM were their most salient identities which were upheld, promoted and valued by faculty. In the next section I revisit the critical incidents and experiences comprising QMS pedagogical socialization process and their ontological understanding about their experiences with both modalities. I will also explain instances when my theory converged, added new elements or refuted already existing scholarship.

The Process of Pedagogical Socialization

Deficient Classroom Culture

Classroom climate is used in the literature to define the day to day atmosphere students experience within classrooms (Golbeck & Molgaard, 2021). However, the term classroom culture is better suited to describe the meanings, symbols and patterns of

behavior shared among individuals that guides organizational activities (Chen, & Zhao, 2015; Back et al., 2012; Tierney, 1997). Culture influences behaviors and assessments of behaviors of others within the organization (Golbeck & Molgaard, 2021). Based on the data classroom culture has stronger applicability than classroom climate when explaining the learning environment within GQMC. Culture is distinct from climate. Students used the term classroom culture to communicate the ways in which transactional pedagogical modalities were deeply entrenched within their classroom socialization process (Peden & Carroll, 2010). Transactional and transformational pedagogical modalities were recurring cultural activities which occurred and became solidified over time within GQMC. Hence the reason why graduate students defined GQMC as spaces reified by unwelcoming and non-supportive pedagogical norms, values and role expectations.

“Loose teaching”, “winging it”, a “strong theoretical focus”, “shutting down” students voice, having faculty “just talk”, or say “Google it” when students ask questions were described as some of the faculty driven setbacks attached to the deficient pedagogical culture within GQMC. I use the term setbacks to capture how much students felt that these modalities inhibited their learning and understanding of QM. Uni-directional lecturing and a strong textbook and PowerPoint orientation were noted by all students as activities incapable of facilitating their creativity (Johnson & Dasgupta 2015; Aguilera, Perales & Palacios, 2020). While some students valued the presentation of content using these modalities, they did not appreciate the absence of creative engagement during the teaching and learning of QM.

Despite differences in graduate students' demographic, social, academic, and professional trajectory, many faculty remained discriminatory and oftentimes indifferent to student's backgrounds and expressed needs based on their personal history. Penultimately these predicaments stem from faculty's inability, reluctance or refusal to reconcile their pedagogical practices in ways which affirms all students as important stakeholders within GQMC (Singer et al. 2020).

There is significant convergence between the evidence presented in my findings and Kilburn et al. (2014); Garner et al. (2009) work which found that students tend to be socialized by a deficient pedagogical culture within advanced research methods courses. Faculty's use of transactional and transformational pedagogical socialization strategies helps to produce and reproduce the deficient culture of some GQMC. Student socialization via transactional pedagogical modalities were demonstrated by faculty who held on to traditional worldviews (Daniel, 2018) rooted in the banking system of education (Freire, 1970). When applying these modalities faculty attempted to socialize students as objects who listen in silence and obey instructions, who also do not question being led by the textbook and or deficit ability expectations.

The use of transactional pedagogical modalities socialized students into a deficient pedagogical culture which compelled them to feel disconnected, disengaged and de-motivated from quantitative content. Instead of presenting content in ways which facilitated students understanding and mastery of QM, this deficient pedagogical culture

led some students to expend considerable energy to fill in the gaps produced by ineffective teaching and classroom management strategies.

Students ontologically understood the need for significant improvements to classroom culture through effective teaching (Freire, 1970). Better teaching will stimulate the mastery and innovation that graduate students need to activate their agency to update many of the classical and dated strategies being taught within some GQMC. Most students who experienced socialization via this deficient pedagogical culture reported feelings of detachment from quantitative content because of the limited opportunities to complete quantitative assignments that matter (Daniel, 2018). Students recognized that most classical quantitative techniques and faculty's focus on abstract content are not necessarily the skills they needed to adequately explain the social realities connected to their lived experiences within institutions and in their communities.

Large Class Sizes

Large class sizes emerged as a well noted factor which prompted some students to feel commodified within their GQMC (Bok, 2009; Zacharakis & Holloway, 2016). The neo-liberal and market driven side of graduate education is based on the cost efficiency of large class enrollments and commodification of graduate education (Zacharakis & Holloway, 2016; Cash et al. 2017). This commodification of graduate education is defined as the exploitative shifts which have occurred within degree granting institutions to extract as much income as possible from students. The monetized supply side of graduate education is needed to upkeep bureaucracies, pay salaries and provide the most

accessible opportunities for consumers to acquire credentials (Zacharakis & Holloway, 2016).

For a subject as “technical as quantitative methods” (Tom) most students felt that smaller classes should be a definite departmental policy to ensure that they received adequate support to learn and understand QM. Students within large introductory and cognate courses reported experiencing high levels of hands off approaches, impersonal interaction, isolation and anonymity during classroom teaching, short times for individual consultations and exposure to one size fits all lectures and assessment strategies (Cash, Letargo, Graether & Jacobs, 2017). Students also recognized that the pervasive use of hands off approaches within courses with a large student body were not suited to their learning style or how they needed to engage with faculty to grasp QM content.

Students also described the predominant presence of hands off modalities in large classes as instances when they reached out to faculty for help, and they were “left” to struggle through understanding the material. Large classes were also implicated as perpetuating faculty’s benign neglect of students learning needs in favor of easier teaching and learning strategies. Participants also recognized that large student enrollment significantly increased faculty’s course load which impacted upon their ability to provide in-depth attention, support and feedback. However, students also noted the ways faculty used transactional and transformational modalities to create stark differences in their pedagogical socialization process. Some students also pointed out that within large classes particular faculty dedicated their limited course time for meeting the

needs of the students they tended to socialize via transformational pedagogical modalities. These dynamics were all cited as some of the faculty related challenges which adversely influenced student learning within their GQMC, (Tishkovskaya & Lancaster, 2012).

Rigidity

The rigid nature of faculty's transactional pedagogical socialization practices was expressed through their fixed emphasis on the textbook and PowerPoint as the "end all and be all" for teaching quantitative methods. This socialized students into believing that they should predominantly consume but not contribute to quantitative methods as a discipline (Singer et al. 2020). Faculty placed minimal emphasis on presenting models, formulae and techniques in flexible and more easily understandable ways for students. This is similar to what the National Council of Teachers of Mathematics (NCTM) (2014) defined as increasing the procedural fluency of quantitatively oriented teaching as "the ability to apply procedures accurately, efficiently and flexibly to different problems and contexts; to build or modify procedures" (para. 1).

Additionally, pedagogical socialization via rigid replication was understood as a process in keeping with the positivist orientation of QM. This contributed towards students feelings that faculty projected linear and predetermined ways of thinking as the only way to learn and master QM. These dynamics led students to perceive their GQMC as following a rigid course structure which made them feel like robots or as if faculty

expected them to code and program themselves like data analysis software to follow their directives.

Students re-telling of their experiences with the rigid nature of their GQMC is similar to what la paperson (2017) termed as scyborging where some faculty expected them to actualize and reproduce performance expectations of instant recall and the storage and retrieval of large amounts of information. For Freire (1970) this serves to alienate students from their own learning process by treating them as objects. Further to this scyborging within GQMC is a form of rigid programmatic structure where the “self” is promoted as an extension of technology and technological capacity. When students agency within GQMC were bound to faculty’s ability expectations for speed and processing it was consistent with la paperson’s “roses in concrete” analogy because their growth and true creative potential were stifled under the weight of a deficient socialization process which acknowledges a narrow range of modalities and pathways for learning, understanding and mastering QM.

Static Content Knowledge

Although the study of content knowledge has rarely been utilized within the graduate education scholarship it emerged as a definite part of graduate students QM pedagogical socialization process. Content knowledge is faculty’s conceptual understanding of their academic subject matter which formed their “knowledge base for teaching” QM (Shulman 1987, p. 4). Graduate faculty are considered Subject Matter Experts (SME) of introductory, intermediate and advanced QM techniques. QM faculty’s

social role as content experts is crucial for their gatekeeping of which students can or should not be knowledgeable about QM.

Participants in the sample described some faculty's content knowledge in its presentation as static and abstract. Students were also socialized by dated slides which were reflective of the minimal time faculty spent updating materials with very little attention paid to trending topics. The pedagogy of QMF who teach statistics as a monolithic discipline was evaluated as repetitive and unresponsive (Daniel, 2018). In the study students referred to the content knowledge presented in GQMC as predominantly classical with very little updated materials. Students needed real world case studies and applied practice not abstract scenarios, formulae and equations to understand reality (ASA, 2016). Participants expressed disappointment about textbook content knowledge which were branded as outdated by more contemporary QM experts. Students received very little current application or teaching from faculty's own research or real life scenarios as a form of transactional pedagogical socialization. Faculty's perception that they provided sufficient knowledge for student learning was another way of advancing a static orientation to QM content.

Despite these challenges all students expected their content knowledge to evolve over time as a stimulus for their own growth into quantitative SME's in the social sciences. Based on their ontological understanding of their GQMC students applied a range of autonomous and collaborative strategies to counter the negative effects of having

static content knowledge as the predominant modality for teaching and learning QM content.

Gatekeeping

Gatekeeping within GQMC exists as the pedagogical attitude orientations, behaviors and modalities that QM faculty used to determine “the rate at which students’ progress(ed) to more advanced levels of study in the academic setting” (Greene 2007, p. 417). Gatekeeping emerged as the combination of pedagogical driven barriers which denied graduate students access to adequate support to learn and understand QM within their GQMC. Gatekeeping manifested during each instance when faculty denied students access to information or limited their participation within educational spaces, (Greene, 2007; Gasiewski, Eagan, Garcia, Hurtado & Chang, 2012).

Faculty were viewed as gatekeepers who directed modalities such as ignoring and disregarding students, unavailability and inaccessibility, restricted feedback and selective guidance to students they viewed as not worthy of their time. Socialization via gatekeeping involved shutting down students voices, and significant push back when students attempted to voice their concerns about the deficient culture attached to their pedagogical socialization process. Students described gatekeeping as a process which contributed towards their feelings of not belonging, feeling unworthy, marginalized and excluded within their GQMC because they were subjected to activities which obstructed their full actualization of their social role as GQMS (Gasiewski et al. 2012).

Swartz (2017) posited that gatekeeping within education institutions is an outcome of significant push back against the increased enrolment of diverse students. For The restructuring of the graduate admissions process also meant that many faculty lost control to determine who enrolls within different programs and who can participate within their classrooms (Posselt, 2016). Posselt (2016) gatekeeping increased over the last few decades based on concerted efforts by some faculty to preserve enrollment into specific disciplines as a “badge of honor” reserved for students perceived as having exceptional abilities.

Faculty’s experiential expertise are the skills, subject matter advanced proficiency and pedagogical content knowledge they accumulated over time about QM and the “hacks” or best strategies needed to master QM techniques for applied practice. Only students who were socialized via transformational pedagogical modalities were privy to faculty’s experiential expertise. Although all students successfully enrolled into GQMC and were able to access to course materials, gatekeeping modalities were applied whenever faculty denied students access to their experiential expertise.

Gatekeeping was also applied in ways that reified unequal power relations within GQMC classes. Out of the 14 students who complained about this modality only six Amy, Rebecca, Randolph, Susanna, Lisa and Shaga challenged gatekeeping while attempting to dialogue with faculty. These students also reported experiencing some of the strongest socialization via transactional pedagogical modalities. Conclusively gatekeeping as an element of transactional pedagogical modalities could be perceived as

a component of the pedagogy of the oppressed that distorts, denies and devalues students agency, (Freire, 1970).

Faculty Incivility

Faculty directed a wide range of incivil attitudes towards students while enacting transactional pedagogical modalities. Faculty incivility towards students includes judging, labelling, withholding instruction, “ long periods of silence”, “ being ignored”, “rude”, “not taken seriously”, being disparaged and the direction of demeaning critique towards student’s voice and agency (Holtz, 2016). It is argued that being ignored is an incivil attitude orientation that graduate faculty use to socialize some graduate students into independence and isolation as the normative culture of higher education (Carter & Kumar, 2017). However, my findings suggest there are deeper dynamics at play than these authors suggest.

Faculty civility was perceived by students as conscious or unconscious strategies intended to weed out students faculty deemed unsuitable for participating within GQMC (Chawla, 2020; McCoy, Luedke & Winkle- Wagner, 2017). Female students and Underrepresented Racial Minorities (URM) were most likely to be the receiving end of faculty incivility. Del Prato (2012) noted faculty incivility as a form of informal socialization into banking education and racialized teaching for URM in STEM. GQMS engaged in a process of seeking help from other professors, collaborating with peers, being silent, self-teaching and self-motivation to offset internalization of these forms of negative communication (Holtz, 2016).

Mental Taxation

An emotional tax is a “psychological burden where one has to use one’s mental resources to stay vigilant against bias, discrimination and exclusion” (Reed, 2021, para. 12). Students experienced mental taxation by faculty and peers for being “allowed” to occupy space they were deemed not suitable for (Reed, 2021). GQMS emotional tax manifested as isolation and marginalization, imposter syndrome, powerlessness, uncertainty, being worn out, tired, depressed and disappointed while interfacing with transactional pedagogical modalities (Reed, 2021). Faculty incivility was implicated as a factor which contributed to mental taxation because it was found to inhibit learning and decrease students’ academic self-esteem and self-confidence. Some female students, students of color and students perceived as having low ability were more likely to be perceived in a negative light and denied affirming, supportive and healthy communication. Students experiencing transactional modalities expended significant energy to learn QM more so than students socialized by transformational pedagogical modalities.

Fixed Mindsets and Cognitive Determinism

A fixed mindset was demonstrated whenever faculty applied pedagogical modalities based on their beliefs that a student’s intellect, personality, traits and abilities were set and could be changed or improved over time (Dweck, 2016). Cognitive determinism is the assumption that intelligence is fixed at birth and that natural IQ is a predictor of academic achievement and learning. However, much evidence within my

study suggests that GQMF either consciously or unconsciously tried to socialize some students using the mindset that their reasoning and thinking skills were fixed and they were not naturally inclined towards QM. Some GQMS consistently picked up on these cues while experiencing pedagogical socialization via transactional pedagogical modalities.

For many faculty learning quantitative methods and statistics is a predominantly cognitive endeavor dependent upon student's math ability (Chiesi & Primi, 2010; Johnson & Kuennen, 2006). Students also pointed out that GQMF focused on whether they possessed or displayed particular traits which were indicative of their math ability while teaching QM. This emerged in the data as faculty's look for's and indicators of intelligence such as fast processing speed, an ideal math or quant brain, retention, memorization, almost instantaneous recall and understanding of more advanced research applications.

Particularly in STEM, faculty's pedagogical strategies are most likely to be founded on deficit views based on ability grouping and selection of who faculty deems as the cognitively fittest student (Harper, 2010; Valencia 2010; Wagner & Okeke 2009). When students experienced biased signals about having low ability (Gardner 2009) hands off, gatekeeping modalities followed. This is in sharp contrast to the pedagogical socialization process of students perceived as high ability who were exposed to transformational modalities. Faculty will naturally select these students and mentor them through their classroom and professional aspirations because students perceived their

beliefs that innately brilliant students will naturally master the content and can innately progress to more advanced applications.

Students believed that faculty's fixed mindset beliefs were unconsciously or consciously communicated during teaching, and particularly when seeking feedback on their assignments. This emerged as a major hurdle marginalized students needed to overcome within their GQMC. Although cognitive determinism may not be the intent of some faculty, its deleterious impact was felt by many students. Throughout their experiences with faculty's transactional pedagogical modalities students reported experiencing "low motivation", worthlessness, "feelings of giving up", "despair", "anger" and "exasperation" in classes taught by fixed mindset faculty. Female, African American and Latinx students were most likely to report experiences with cognitive determinism and deficit ability expectations which they interpreted as a form of stereotype threat they constantly navigated and expended extra effort to overcome. This contributed to additional forms of mental taxation because each student sought to ensure that they did not meet GQMF deficit expectations which were uncomfortably reminiscent of similar experiences they encountered within quantitative focused classes throughout the p-20 pipeline (Sabnis, 2016).

Deficit Ability Expectations

Deficit ability expectations is the assignment of a lesser value to students achievement based on what teachers believe students are missing or lacking (Sabnis, 2016). Some characteristics of deficit thinking about student ability found in the data

includes students being subjected to incivil attitudes while asking questions and seeking clarification on assignments. In these moments faculty communicated deficit educability perceptions that some students are unable to understand QM (Valencia, 2010). This perception of deficit ability expectations contributed to students perception about one of the reasons why faculty presented static content knowledge within predominantly introductory and cognate GQMC. This was based on faculty's low estimation of students abilities and their perception that they have given students "everything they believe is sufficient for learning" QM.

Mike, Angelica, Susanna, Lisa and Tom reported on experiencing imposter syndrome within their GQMC as persistent feelings of self-doubt and low capability because of past experiences with faculty who steered them away from quantitative courses because they did not believe they possessed the ability to perform well (Bernard, Hoggard & Neblett, 2018). Deficit ability expectations are a pedagogical socialization modality predominantly used by faculty with fixed mindsets about QM ability that surfaced whenever they communicated their disbelief when some students came to voice about having high QM ability. Gatekeeping are educational practices that limited and stifled the potential of students perceived as having lower ability within GQMC. This also contributed to a re-triggering process which prompted students to relive similar negative experiences they encountered with quantitative methods teachers throughout the education sequence from high school to the masters and doctoral level (Sabnis, 2016).

Racialized Ability Expectations

Racialized ability expectations showed up as situational cues about low intelligence and limited ability during teaching which were directed towards students who identified as Under-Represented Minorities(URM) or those students whose dispositions faculty believed were not suitable for studying QM. There were a number of students who spoke about their experiences with racialized deficit thinking. Many students exposed to racialized ability expectations also expressed strong concern about being judged in terms of ability stereotypes and racial achievement gaps. Stereotype threat emerged as an invivo code participants used to describe their experiences and fear of actualizing racialized deficit thinking. Stereotype threat was coined by Steele and Aronson (1995) as racist stereotypes assigned to students of color in STEM classrooms as low ability, disengaged and underprepared achievers (Harper, 2010). Dweck (2016) also found that individuals who held on to deficit stereotypical notions of natural endowment also possessed fixed mindsets.

The QM higher education classroom culture is a well noted site for racial microaggressions about BIPOC student's achievement orientations (McGee, 2020; Vakil & Ayers, 2019). On top of micro- aggressions and racially charged mental taxation all URM placed the burden on themselves to perform at a higher standard than White male students and in their own way attempted to exist as model minorities within their GQMC (McGee, 2018). GQMF's fixed mindsets about racialized ability expectations also placed students in a position where they constantly have to prove themselves to GQMF (Dweck,

2016). This is especially taxing since these students were more likely to experience poor or nonexistent mentorship (Griffin, Perez, Holmes & Mayo, 2010) and pedagogical socialization via transformational pedagogical modalities. Racialized ability expectations also minimized the achievements of high performing racially minoritized students who earned good grades but were still perceived as always falling below the performance of White and Asian students (McGee, 2018). In instances when students of color outperformed their White counterparts they are ascribed a symbolic status and tokenized as outliers who exemplify the behaviors and value systems of the White dominant culture (McGee, 2020).

Students classroom experiences with racialized and sexist pedagogy also created intersectional effects from being female and a racialized minority within QM classrooms. This has historically been known to create “emotional layers of pedagogic experiences” (Burke 2015 p. 390) which incur trauma, mistrust, and apprehension among these students within their QMC (Henderson, Acquaye- Doyle, Waites, & Howard 2015). Students also reported on unexpressed research aspirations and very little adaptation of syllabi to reflect areas of inquiry important to their culture and communities (Tabron 2019; Tabron & Thomas, 2021). This was viewed as being detrimental to their professional identity of wanting to expand on the positive elements within their communities and find solutions to longstanding issues (Lalayants, 2012). Black and Latinx students described being in collaborative groups as a protective factor where their agency was valued and affirmed. It amounted to a form of racial identity politics because

students understood they are navigating structures and the implications include being subjected to lower or harsher performance standards, denied access to quality feedback and faculty's experiential expertise (Vakil & Ayers, 2019).

Model Minority. During transactional pedagogical socialization faculty espoused the model minority mindset that Asian students possessed innate intellectual abilities which made them naturally gifted in STEM. This model minority stereotype is used to describe students of Asian heritage studying or living in the United States as innately suited to above average effort, sacrifice, hard work and tenacity as characteristics led to the widespread acceptance of Asian heritage students as dominating STEM fields as scholars (Hartlep, 2021).

Research has shown the model minority label to be an American cultural stereotype intended to perpetuate structural racism (Hartlep, 2021) by promoting what McGee (2018) termed as a “stereotype lift” which promotes students of Asian heritage as quiet and reserved and therefore a more acceptable, teachable and unproblematic minority. The data also pointed to Asian heritage GQMS perception of the model minority label as a “badge of honor” or positive stereotype which motivated them to expend more effort at QM achievement (Hartlep, 2021).

Despite this stereotype or because of it Tiffany, John and Yan reported on experiencing microaggressions when interacting with some faculty, GTA's and peers within their GQMC. These students also personally rejected the tendency towards cognitive determinism and having a fixed or innate QM ability because of their race/

ethnicity. Model minority stereotypes also serve as a form of othering which typecasts American and international Asian heritage students and faculty as non-normative, or exotic (Lahman 2018) as Kimberly expressed her preference for the “Zen like quality and calmness” of her Chinese female faculty mentor. As demonstrated by the data this oftentimes exists in sharp contrast to the stereotype threats faced by racially minoritized Latinx and Black students within QM classrooms. These students openly reported on the different forms of explicit and implicit negation of their identities and abilities and also expressed the challenges experienced while attempting to focus on content while trying not to live up to racialized stereotype threats.

Racialized Statistics. BIPOC graduate students reported discomfort while interacting with GQMF who teach from a deficit standpoint about difference and continuously cited racialized statistics linking disparate and negative outcomes to students of color and marginalized communities. The datasets students encounter within their GQMC perpetuate gap gazing of achievement and educational attainment in ways which ascribe and racialize lower ability expectations upon racially minoritized groups who are perpetually unable to catch up to White students and White majority education institutions. Students recognized that the predominantly White male faculty who taught them racialized statistics using a restrictive outlook about different racial groups tended to minimize the importance of structural conditions in reproducing inequality in ways which protect the historical legacy of White superiority within GQMC (Haynes, 2017).

This racialization of statistics within the teaching, learning and interpretation of QM has its genesis in eugenics, social Darwinism and anthropometry to prove the genetic, cognitive and social inferiority of communities of color (Tabron, et al. 2020; Thomas & Tabron, forthcoming). The genetic pathology of racialized statistical thinking influenced US educational policies based on early quantitative research that posited BIPOC students IQ and educability as inherently inferior and White students as intellectually superior (McKenzie & Scheurich, 2004; Omni & Winant, 1994).

QM started out and continues to be driven by the work of a small but tight circle of like-minded men whose modern day racialized ability expectations perpetuate quantitative scholarship about the predisposition of some students towards lower levels of intelligence (Thebaud & Charles, 2018). Statistics and QM textbooks and resources tend to be authored by white middle class male faculty (Holleman, 2005) who also teach most and especially higher level GQMC. These White male faculty are also noted as actors who continue to racialize GQMC by perpetuating a restrictive pedagogical culture based on racialized statistics and deficit ability expectations attached to the performance of URM.

Gender Socialization. Female GQMS experienced strong socialization practices based on high levels of underrepresentation within GQMC and dominance by male faculty and students within their GQMC (Moss-Racusin et al., 2012; Thebaud & Charles, 2018). Females acknowledged doctoral student success in QM was stymied by patriarchal expectations about female students having a lesser capacity to conduct rigorous research

(O'Connell & McKinnon, 2021; Sallee, 2011). Even when females outnumbered males within GQMC, males outperformed females and were afforded higher levels of respect for the QM work they produced.

Amy, Isabelle, Kimberly, Jane, Megan and Linda were expected to uphold patriarchy by conforming to traditional gender roles within their departments (Connors & Franklin, 1999; Moss-Racusin et al. 2012). Findings illustrated that female GQMS experienced gendered ability expectations through “mansplaining” which amounted to being talked over because they were perceived as having less ability to explain complex applications in comparison to males. Female QM students also experienced being perceived by male as well as some female faculty and students that men held a monopoly over advanced numerical skills within their GQMC.

Yan, Isabelle, Megan and Amy felt that some male and female faculty sought to gatekeep female students out of more higher order QM skills. Amy resisted conformity to stereotypical perceptions of being a blond haired and blue eyed White female and as a result experienced significant levels of marginalization, shaming and retaliation. These forms of gender inequity is frequently reported as some of the main factors accounting for the high attrition rates among females within STEM focused graduate courses (Lott et al. 2009; Hurtado & Figueroa, 2013).

The historiography of QM in the social sciences provide additional support for the gender-based socialization process which contributes to the underrepresentation of females within GQMC. Men continue to dominate QM oriented disciplines as founders,

tenured chairs and professors who perpetuate patriarchy by passing down their positions and scholarship onto their male disciples most likely to continue their work (Stigler, 1986). Fewer females with masters and doctoral QM degrees mean fewer female faculty and mentors within GQMC (Table 3.). As female students developed their own ontological understanding of what it means to exist as a woman within a male dominated field like QM. Most female GQMS also confirmed that being feminine emerged as a salient identity as a form of resistance to the strong masculinity upheld within their GQMC.

Pedagogical Knowledge

Pedagogical knowledge is faculty's knowledge and expertise about the activities and practices needed to teach and facilitate students learning and understanding of quantitative methods (Koehler & Mishra, 2009). Students perceived faculty used textbooks and PowerPoints because of the absence of pedagogical knowledge and training. Nind, Kilburn & Luft (2015) found that although pedagogical knowledge is essential for "building and sustaining the methodological capacity of students to conduct research to decompose the effects of different phenomenon" many faculty were recruited without it. It is well documented that the majority of GQMF are not trained teachers of QM (Harris, 2007; Tishkovskaya & Lancaster, 2012). Since traditionally content knowledge is the focus of QM teaching and learning at the graduate level, there is the almost ubiquitous assumption that having a Ph.D. degree is sufficient to serve as GQMF and teach QM (Wagner & Okeke, 2009).

Nind et al. (2015 p. 455) underscored the importance of teacher training for research methods faculty to build capacity among students to “undertake sophisticated research tasks in response to current social challenges”. Students urgently needed faculty to consider how much “teaching requires knowledge, skills and other competencies to transform knowledge into practice” (Ulferts 2019, p. 8). Students noted there was little evidence of real-world applicability in the pedagogical practices of GQMC. This was something they needed to “self-teach” and “figure out on their own”.

Pedagogical Content Knowledge

Pedagogical Content Knowledge (PCK) is experiential teaching that integrates how much teachers know? with how well they communicate what they know to students (Shulman 1986; 1987). PCK blends content and pedagogy into an “understanding of how particular topics problems or issues are organized, represented and adapted to the diverse interests and abilities of learners”. PCK prompts teachers to maximize learning opportunities using the most accessible curriculum, teaching strategies and formative and summative assessment. Transactional pedagogical modalities provided evidence to suggest that GQMF possessed low levels of pedagogical content knowledge. Hands off approaches, heavy reliance on textbooks and PowerPoint, pedagogical gaps and poor classroom culture were noted as evidence of an absence of “pedagogical craft” among GQMF.

Faculty implementation of transactional pedagogical modalities were perceived by students as a lack of pedagogical content knowledge on how to transmit QM using

strategies more responsive to students perceptions of QM subject matter (Guerreiro 2017; Ulferts 2019). Some faculty demonstrated teaching and learning strategies which promoted optimal learning of QM such as hands on approaches, invested support, expansive feedback and guided practice. However, the data illustrated that some students perceived that some GQMF were very selective about the students who experienced transformational pedagogical socialization modalities.

Autonomy and Empowerment

Autonomous empowerment emerged as one form of ontological understanding students developed which included “self-teaching” to “fill in gaps” from ineffective teaching and incivil faculty attitudes towards teaching different students. Students spoke about having high levels of autonomy as a form of empowerment which helped them persist through GQMC. Students developed their own ability to direct their own learning. Empowered students “consider varied perspectives, negotiate with others, amend policies as needed s they can think independently make their own decisions thoughtfully and with reference to relevant information and action based on that knowledge” (Broom 2015, p. 81). Students interfacing with transactional modalities also reported on hiring tutors and taking short courses outside their programs to supplement pedagogical gaps leading to a better understanding of QM and mastery of data analysis software. However, this increased the financial burden of several graduate students who paid for these services in addition to their GQMC tuition.

Transformational Pedagogical Modalities

Transformational pedagogical modalities were perceived by students as an empowering modality which encouraged them to critically examine “their beliefs, values and knowledge with the goal of developing an appreciation for multiple perspectives and a sense of critical consciousness and agency”(Ukpokodu 2009, p. 43). Constructivism in statistics education emphasizes the role of the learner in constructing his or her own views or model of the material. The faculty utilizing transformational pedagogical modalities can be described as infusing constructivist principles into their teaching practices.

The instructors who used a variety of teaching styles were more likely to diversify course materials to increase student interest, learning and engagement (Lage, Platt & Treglia, 2000). The hands on approaches of GQMF were described as “memorable moments” “expansive feedback”, “thought provoking” “inspirational”, “rigorous”. Guided practice emerged as the “step by step”, “knowledge checks” faculty used to walk students through learning and understanding QM and its technical application via data analysis software. Faculty also openly communicated their intent to inspire students through an incremental growth progress leading to mastery of QM and applied skills. Conclusively transformational pedagogical modalities especially the modalities grounded in JEDI perspectives socialized GQMS to “develop their power to perceive critically the way they exist in the world with which and in which they find themselves they come to see the world not as a static reality, but as a reality in process, in transformation” (Freire,

1970, p. 83). This also found expressed when students developed their own ontological understanding of QM and their role as GQMS within their GQMC.

Hands On Approaches

This is a transformational socialization process which helps students to become competent at QM via learning by doing. Learning by doing and hands on approaches has been adopted into the QM teaching and learning reform movement (ASA, 2016). Hands on approaches gave students the confidence to analyze and apply empirical data for real world research using different data analysis software. For Lovett & Greenhouse (2000, p. 196) hands on approaches is a form of active learning for reforming statistics learning based on five tenets:

1. Students learn best when they practice and perform on their own
2. Knowledge tends to be specific to the context it was learned
3. Learning is more efficient when students receive real time feedback on errors
4. Learning involves integrating new knowledge with existing knowledge
5. Learning becomes less efficient as the mental load students carry increases

Each of these five tenets place students at the center of their learning experiences. All of these five major factors which promote the learning, understanding and mastery of QM emerged as crucial modalities connected to students transformational pedagogical socialization within some GQMC.

When demonstrating transformational modalities faculty provided constructive feedback, were polite and open to students potential and growth (Del Prato, 2012). At its

core transformational pedagogical modalities were used by faculty to transmit norms and values which differed from transactional pedagogical modalities in terms of faculty's expectations connected to student abilities, potential and agency. Faculty recognized that they were united with GQMS in their goals of gaining new skills. They also assumed personal responsibility for providing strong socialization to promote individual and collectively oriented goals of understanding QM.

Hands on approaches was perceived as a transformational modality that promoted procedural fluency each time faculty streamlined their teaching of the technological skills students needed to carry out QM procedures flexibly and resourcefully (Inayah, Septian & Suwarman, 2020). Most importantly the faculty that established respectful and connected relationships were seen as positive role models by all participants. As such, Amy perceived transactional pedagogical socialization as instances when GQMF “got it right”.

Faculty Driven Empowerment and Invested Support

The students who experienced transformational pedagogical modalities also complained about the ineffectiveness of the textbook and PowerPoint lecture. However, they received additional and unrestricted help from faculty to overcome the learning gaps they developed after interfacing with that modality. Students described the forms of faculty driven empowerment they encountered as “coaching” and faculty’s “flexibility”, “accessibility”, “considerable care and attention” and “dedicated effort” to help students understand their coursework materials. Students perceived a certain amount of

“closeness” between themselves and faculty and mentioned having “regularly scheduled times” and “in-depth conversations” on mutual topics of interest.

These forms of invested support socialized students to move beyond a superficial understanding of QM and into the realm of conducting applied research, jump starting their QM Dissertations and aligning coursework to reflect their professional interests post-graduation. Most students also openly acknowledged if they were not supported they would not have persisted through the program or overcome their anxiety and fear of quantitative methods. These students credited the extensive and comprehensive effort that faculty expended to empower them through their courses as the reasons for their success. Faculty driven empowerment was also based on the quality of interaction between faculty and students. Students who experienced greater levels of transactional pedagogical modalities acknowledged the long term benefits of their socialization process where those who bond closely with influential QM advisors and faculty tend to become well connected to secure additional teaching, research or industry related opportunities within the field of QM (Eliot et al., 2020; Gardner & Barnes, 2007).

Growth Mindsets

Faculty channeled growth mindsets while enacting transformational pedagogical modalities. Students perceived faculty’s growth mindsets as their belief that their potential and ability is adaptable mindset of becoming (Freire, 1978). Faculty and students with a growth mindset believe they can develop and hone their intellect incrementally over time (Vandewalle, 2012). Some of the faculty who utilized

transformational modalities tended to create a growth mindset environment for selected students to increase their chances of reaching long term QM career goals (Hochanadel & Finamore, 2015). Students were socialized to believe that they too can become competent in QM like faculty because their abilities can be developed through effort, affirming guidance and quality mentoring.

Socialization into a growth mindset was facilitated by open office hours, open consultations, hands on, differentiated learning and open task coursework activities. Students were given the freedom to demonstrate creativity by applying multiple methods to address different topics or the same problem (Blackwell et al. 2007). The faculty who demonstrated growth mindsets while teaching QM GQ also moved away from the problematic assessment culture of QM focused courses to focus on quizzes, closed tasks and one way solutions to understanding content and mastering problem solving. Students also were socialized to rethink academic achievement in terms of a grade and perceive substantive learning and applied competencies as evidence of understanding QM.

Technological Content Knowledge (TCK)

Technological Content Knowledge requires an understanding of how technology and QM content are interrelated. TCK is demonstrated within GQMC when faculty united their subject matter expertise with their technological skills of how quantitative analysis software can be best used and adapted to facilitate students learning and understanding of any QM topic (Koehler & Mishra, 2009). GQMC are laboratory focused courses based on the integration of technology into GQM curriculum as the primary

means for GQMS to learn software supportive of quantitative methods content knowledge (Cabillo & Farrell, 2001). GQMS were socialized to “not only know statistical methods but also be able to choose and apply them according to the tasks of research” (Paura & Arhipova, 2012, p. 9).

When comparing the TCK students gained within their courses most developed preference for the different software based on the quality of instruction received, ease of accomplishment of assignment tasks and the extent the software facilitated their understanding of quantitative methods. Findings highlighted the importance of statistical instructors possessing solid skills and knowledge of technology and analytics for effective skills transfer to GQMS. Technology emerged as a game changer for students experiencing both transactional and transformational modalities. For transactional modalities “Mr. Google” and YouTube emerged as important tools students used to circumvent poor pedagogical socialization practices. Students also recognized that technology is a knowledge system that can be programmed in ways which make some applications more suitable for certain tasks (Koehler et al. 2007). Just like the students in the sample, Hu (2003), Schenker (2007) and Sosa et al. (2011) found that graduate students who experienced high quality computer instruction consistently demonstrated higher levels of achievement within their GQMC.

Data visualization technology enables visualization of statistical concepts and processes demonstration of complex abstract ideas and provision of multiple examples to enhance learning (Chance et al. 2007). Technological content knowledge was described

by an operation by sequence format which students described as “walking through”, “step by step” the full sequence of operations connected to the statistical techniques they needed to perform using different software. Some of the TCK barriers cited by students included limited access to technology via inconvenient closing times attached to departmental computer labs and the high cost of software such as Mplus particularly for specialization GQMS (Zyad 2016; Meehan & Salmun 2016).

Contextual Content Knowledge

Students experienced transformational pedagogical socialization when faculty engaged in numerical storytelling and infused the QM data collection, analysis and interpretation process with a Justice, Equity, Diversity and Inclusion (JEDI) lens. Students also described how adding narrative storytelling to pedagogical practices led to their deeper understanding of QM. The faculty using these modalities taught students that numbers need a narrative. QM faculty socialized students to recognize the untapped potential of becoming skilled at quantitative storytelling as a way of effectively communicating effectively with individuals, communities, practitioners and policy makers (Tarran, 2021). Students used imagery such as putting together puzzle pieces, flowing water analogies, painting and color palettes and data clouds to describe socialization process via contextual content knowledge.

Context matters because it makes quantitative inquiry, critical thinking and applied practice easier for students to understand how they can use numbers to represent phenomenon and stakeholders experiential realities (Tarran, 2021). There is meaning in

numbers, but this meaning is connected to space, place, temporality, history, multidimensional phenomenon, and intersectional relationships between individuals, families and communities with public policies (Millen, 2021). Students recognized they made sense of the world through stories and experiences which convey a JEDI minded interpretation of data. When faculty utilized this transformational modality they engaged students with pedagogical strategies on terms similar to their lived experiences, current events and trending topics. When students were exposed to this pedagogical modality they were also socialized to appreciate qualitative research and mixed methods approaches. Students also reported on an ontological resolution to the longstanding tendency to perceive quantitative research as superior to all other forms of research.

Justice, Equity, Diversity and Inclusion (JEDI)

Dominant culture approaches to teaching QM inhibited a more representative view of the history and the use and misuse of QM in education and educational policies. Students were socialized into growth mindsets by faculty who taught statistics using JEDI focused modalities (Gray, 2021). Statisticians and faculty who taught QM using a JEDI lens tended to interpret numbers based on demographics, diversity, underrepresentation, racial categorizations, racial hierarchies, pay and performance equity. Students described diversity based teaching as a modality which includes non- normative ways of thinking which trained students to value the inclusion of different disciplines and multidisciplinary approaches and the existence and intersection of multiple identities (Golbeck & Molgaard, 2021). Infusing QM instruction with JEDI within some GQMC encouraged

students to embrace students and perspectives from diverse and marginalized backgrounds. In these courses faculty facilitated deep dialogic discussions (Tuitt, 2003) to challenge faculty's fixed mindsets and deficit ability expectations (Harper, 2010).

Being innately intelligent, highly practiced and skilled in QM was not an overarching rule of engagement for GQMF using JEDI focused teaching practices. Each student regardless of background were treated as a valuable and respected member of GQMC. This led GQMC to be perceived as thought spaces rather than courses to contribute to QM. When faculty infused JEDI in GQMC they were perceived by students as being intentional about creating environments where all GQMS are represented and heard, and students co-exist as collaborative thought partners for group discussions and even individual assignments. (Golbeck & Molgaard, 2021).

Racial Socialization

Racial socialization is the social knowledge URM students receive from actors which buffered against the microaggressions and racialized ability expectations they encountered within their GQMC (White- Johnson, 2015). Racial socialization is traditionally defined as the social knowledge that the parents of racialized minorities use to socialize their children about interacting with law enforcement agents. Racial socialization emerged as an important finding in the data which students attributed towards their exposure to JEDI focused teaching approaches and learning about the racialized history of statistics. This is a significant finding since most GQMF have rarely presented or even challenged the racist history of QM (Tabron, 2019; Tabron et al. 2020).

Students appreciated the faculty who provided this context as a transformational modality based upon radical honesty and truth-telling (Williams, 2016) about the structural racism that formed and continues to shape the use and misuse of QM. Students also mentioned that learning about Critical Race Theory (CRT) and CritQuant approaches also served as a buffer against deficit and racialized ability expectations, stereotype threats and cognitive determinism perpetuated by transactional pedagogical modalities.

Critical Race Theory (CRT)

Students mentioned having a knowledge of CRT was crucial for understanding and countering racialized deficit thinking within their GQMC. The tenets of CRT relevant to participants transformative socialization within their GQMC included discussions on structural racism, interest convergence and Whiteness as property. The incorporation of CRT into students pedagogical and methodological praxis entailed working backwards to “challenge the historicism and uni-disciplinary focus of most analyses of race and racism” (Teranishi 2007, p.39) while working forwards (Anthony, 1966) to “analyze the present and future implications of race and racial identities”, (Garcia Lopez & Velez 2018, p.153) on the educational outcomes of students of color.

Structural Racism. Racial formation in America is an organization of society and relationships to justify the domination and oppression of people of color (Omni & Winant, 1994). Some students perceived that the pedagogical socialization processes they experienced within their GQMC perpetuated the structural racism found with the wider socio-cultural, economic and political structure in which GQMS are embedded (McGee,

2020; McCoy et al. 2017). Racism is at the root of deficit and racialized ability expectations (Delgado & Stefanic, 2012). Some faculty attempted to socialize URM to believe they do not belong within GQMC because they belonged to a subordinate minority group (McGee, 2020). Gatekeeping, using predominantly transformational pedagogical socialization strategies, silencing and de-valuing of the intellect and agency of Black and Brown students are some of the ways that structural racism persisted within GQMC.

Colorblindness and Racial Erasure. On the surface color blindness is advanced as each student having equal access to their GQMC. However critical race theorists have called out color blindness and objective neutrality as strategies that “camouflages the self-interest” of White supremacy and the “institutional structure of racism” in America (Ladson- Billings & Tate 1995, p.2). Color blindness allows Whites to turn a blind eye to the systematic white privilege perpetuated via transactional and transformational pedagogical modalities and the persistence of disparate outcomes among students of color. It also allows Whites to discount the predominantly aversive stimuli such as mental taxation and racialized ability expectations that students of color experience within the American education system. Instead, the dominant narrative of white supremacy blames and shames students of color for not making the most of educational opportunities.

Racial erasure is “the sentimental idea that racism would cease to exist if everyone would just forget race and just see each other as human beings who are the same” (hooks, 1992, p. 12). Refusing to see color as a priority is a refusal to acknowledge

the plight of non- White students. Racial erasure is also based upon explicit and implicit communication on the forms of deferential behavior required for success (hooks, 2015). Socialization via racial erasure by GQMF was perceived by students during instances when faculty prioritized the development of students professional identities without considering the implications of their racial and ethnic identities and experiences (McKenzie & Scheurich, 2004). Students also noted how important it was for them to engage in identity suppression for professors to feel comfortable using transformational pedagogical modalities to socialize them into a deeper understanding of QM (Nealy, 2018).

CRT provided a framework for understanding the implications of the model minority stereotype is a means to reinforce a racial hierarchy among minority groups and as an instrument of White supremacy. For Zi there is an unseen and distressing burden attached to being perceived as a model minority where some White students continuously expected to receive unlimited assistance and tutoring from Asian students. For Tiffany it resulted in her identity as a qualitative researcher being marginalized. Yan described instances when she experienced microaggressions from uncooperative GTA's. Research has also shown that "the model minority stereotype reduced students to one group to reify success to cultural causes to maintain the status quo" (Hartlep, 2020). The model minority stereotype lift is a cornerstone of the neoliberal racial project to deny opportunities to historically marginalized Latinx and Black students (Chen & Buell,

2018) and re-distribute them among a racial group perceived as less threatening to White material interests.

Whiteness as Property. Ladson- Billings and Tate (1995) underscored the unfeasibility of understanding academic outcomes without consideration of the intersectionality of race and whiteness as property. Enslavement was a deliberately situated project that organized social structures around the denigration of dark bodies and the ability of Whites to own and enslave other races and determine their worth. The curriculum, classroom pedagogy and administrative functions within the education system are similarly patterned after these historical arrangements (Roithmayr, 1999). The value of having URM within GQMC seemed to be based upon the extent they can be used to advance the White interests. Some URM were allowed to actualize their potential and intellect within GQMC only if it did not exist as a threat to white property rights within the educational system (Ladson- Billings & Tate, 1995). Whiteness is a racialized system of dominant thinking which gave some White students and the students of color who reified Whiteness almost exclusive rights to a socialization process based upon transformational modalities.

Counternarratives and Resistance Positionalities. Students experiencing transactional pedagogical modalities developed counter norms and resistance positionalities as viable responses to the tensions experienced during graduate student socialization (Gonzalez, 2006; Anderson & Louis, 1994). This was based on narratives of self-empowerment, autonomy, resistance, persistence and strengths. McKenzie and

Scheurich (2004) define as counternarratives as a process of replacing stereotypes with strengths. Counternarratives were used to overturn historical and racialized deficits imposed on the agency of some students of color (Solórzano & Yosso, 2002). Many students responded to transactional pedagogical socialization as a deficit orientation using an assets based perspective which valued their minoritized identities and communities. These students developed an attitude of resistance, “I expect to get respect” (Shaga) or valuing of their feminine identities which helped them persist through GQMC.

Pedagogically there were also instances when (Simple, Megan, Sara, Jessica, Susanna, Linda and Tom) appreciated the courses where faculty cultivated their critical reflexivity in locating themselves within their methodological decision-making process (Lewthwaite & Nind, 2018; Tabron et al., 2020; Danowitz & Tuitt, 2011). By interfacing with JEDI perspectives students learned that rather than putting the problem on themselves for not understanding QM they should look to inflexible institutional dynamics and how faculty’s stigmatization of their identities and abilities. JEDI perspectives helped students to develop an awareness of the highly racialized and gendered pedagogical socialization directed towards themselves and additional students within their GQMC.

Many students who experienced transactional pedagogical modalities experienced transformational change because they developed counternarratives to reject faculty’s deficit ability expectations and put the spotlight on poor pedagogy and textbook orientations as disregarded areas of consideration. They also recognized that resilience,

adaptability and the tactics they developed over time to overcome poor pedagogy were unrecognized indicators of intelligence (Valencia, 2010; Greene, 2007).

Students experiences with contextual content knowledge and JEDI perspectives inside and outside of their GQMC gave them the language, training and assurance they needed to develop counter narratives to nullify the effects of their transactional pedagogical socialization process. Students also developed an oppositional stance against claims that QM is an objective and neutral discipline because the racist and patriarchal founding fathers who created QM methods were not objective, and the ways QM is taught to different groups within their GQMC are also not neutral. Students like Noah, Lisa and Isabelle developed a critical consciousness about the ways psychometricians created White normed and culturally and racially contingent items for educational testing (Teranishi, 2007).

Critical Quantitative Research. Students appreciated learning about Critical quantitative approaches from the faculty who infused Justice, Equity, Diversity and Inclusion (JEDI) into their work. Critical quantitative approaches were seen as an innovative variation to QM needed to advance students unaddressed research aspirations. Students like Lisa saw critical quantitative research as a space to re-imagine the agency denied to her within traditional statistics classes and to demonstrate that innovation can come from students of color within statistics. Tom, Lisa and Jessica expressed the desire to engage with critical QM not based on linear thinking but a more recursive logic with more feedback loops for understanding quantitative methods.

Oppression, inequity, discrimination, marginalization, structural and cultural racism is the lived reality some GQMS ontologically needed to explain. Critical quantitative research was perceived as a subfield of QM which could provide students with some of the methodological tools and training, they needed to achieve these goals. Transactional modalities were implicated as a system of oppression based on students lived experiences with racialized and deficit thinking, stereotype threats and gap gazing in research. Noah, Lisa, and Isabelle recognized in keeping with (Valencia 2010, p. 12; Teranishi, 2007) that “typically deficit thinkers base their study on (these) unsound assumptions, use psychometrically weak instruments and or collect data in flawed manners so not control important independent variables and do not consider rival hypotheses for the observed findings”. They like Michael noted this as the historical misuse of statistics.

In some statistics courses students were encouraged to adopt a non-conformist stance against traditional QM. Michael also saw critical quantitative approaches as crucial for infusing mixed methods approaches with diversity, equity, and inclusion to serve the access, persistence and success needs of minoritized students in higher education. This was regarded as an important transformational socialization process for URM students. It is also important to note that when these students tried to cross over these pedagogical modalities into more higher level statistics courses they experienced a lot of push back via transactional pedagogical modalities.

Equity Trap. Some White and international students who perceived themselves as model minorities perceived that there was no discrimination or racism during the teaching and learning of QM within their GQMC. They also perceived that courses were equitable learning environments. For Lily this involved being treated as a “human being and for Bob classrooms were an affirming environment for all students. Michael, Kimberly and Marie also reported on their GQMC being highly equitable spaces. Nora added that students identities were affirmed and there was freedom particularly for her as a highly introverted student to opt out of group work and complete more individual projects.

Based on theoretical and chain sampling strategies a few students of different demographic backgrounds pursued the same courses or were in different programs within the same institution. This gave me some vantage point as a researcher to look at the stark differences in the transactional and racialized experiences of URM students and transformational experiences of some White students or students. This is viewed by Valencia (2010) as an equity trap or form of sanctioned oppression where “those with power are frequently least aware or at least willing to acknowledge its existence” and “those with less power are often most aware of its existence to consider why different students are discriminated against” (Delpit 1995, p. 12).

Collaborative Community

Student reported on the benefits of having highly involved peers and faculty within their GQMC. Students described their experiences with transformational

modalities as instances when “their individual thoughts were valued” and GQMC existed as a safe “thought space” to share and also be vulnerable with incorrect responses. Students also valued instances of “reciprocal relationships” to openly dialogue with faculty and shared their triumphs and challenges with coursework.. Collaborative community was also defined as building connections with cohort members as colleagues and collaborators.

The drive to building graduate classrooms as collaborative community is not a new pedagogical modality where for (Bielaczyc & Collins, 1999, p. 272)

The defining quality of a learning community is that there is a culture of learning in which everyone is involved in a collective effort of understanding. There are four characteristics that such a culture must have (1) Diversity of expertise among members who are valued for their contributions and given support to develop, (2) A shared objective of continually advancing the collective knowledge and skills, (3) Emphasis on learning how to learn and (4) Mechanisms for sharing what is learned

All four factors were found to exist within this collaborative modality. Faculty designed GQMC, differentiated assignments and curriculum to recognize the different skills that GQMS brought into GQMC. Students were socialized to view their cohort members as collaborators and not competitors who worked together to creatively transform classroom presentations into publications and complete projects outside of their GQMC. Students also interdependently learned and acquired new skills and recognized the nexus between community and surviving through course work together.

Collaborative community is a protective factor crucial for building classroom climates supportive of all students learning and understanding QM. Collaborative

community also emerged as a space where students “knew their community would not let them fail”. For Amy collaborative community allowed her to escape from the marginalization she experienced from some male and female faculty on account of rejecting having blond hair and blue eyed female as her most salient identity.

The inclusion of DEI perspectives during the transformational modality included facilitating group discussions to explore QM using topics related to race, gender, equity and access within the higher education environments. This dialogic process allowed URM students to come to voice using the agency denied to them during socialization experiences with transactional pedagogical modalities. This dialogic process was important to

Allow students to personalize subject matter with examples from their own history can inhibit some students ability to make connections between the ideas learned in the classroom and those learned through life experiences. This point is extremely important for some students who possess a strong racial identity. For some students, their personal experiences can be- but are not always- “racial experiences” grounded in a racialized context. When a professor devalues the use of a student’s personal experience as a way of understanding the subject matter they potentially run the risk of creating for that student the perception that their experience is not valued because of their racial background (Tuitt 2003, p. 80).

Collaborative community development also resulted in a flatter hierarchical structure within GQMC. In this modality faculty shared their power with students in the knowledge creation and dissemination process. Everyone felt their voices were valued and that everyone contributed to the learning process (Tuitt, 2003; Tuitt, Haynes & Stewart, 2018) as the “pursuit of full humanity” (Freire 1978, p. 85) carried out in an environment of mutual respect and collective orientation.

Underlying Dimensions of a Substantive Process Theory of Pedagogical Socialization

Propositions are the final outcome of substantive coding, theoretical coding and constant comparison when the researcher further develops evidence which represent participants premises about the relations of their everyday life (Glaser, 1978; Glaser, 2005; Strauss & Corbin, 1998). Socialization via transformational pedagogical modalities is deficit oriented, limiting, restrictive, racialized and highly discriminatory. Socialization via transformational pedagogical modalities is growth oriented, inclusive, encouraging and affirming. Exposure to both modalities compelled GQMS to develop their own ontological understandings of QM, themselves as GQMS and GQMC as a thought space in ways which fostered the development of their aspirational QM professional identities. Pedagogical socialization is a process which is based on the extent GQMF attitudes, values and teaching strategies enable and/ or constrain GQMS contextual understanding and mastery of technological and content knowledge for QM applied practice and professional identity development.

Consistent with my study's findings I present five propositions comprising my theory of pedagogical socialization. My propositions are embedded in my theoretical discussions about my main findings (Strauss, 1987). Each proposition explains the behaviors which underlie the pedagogical socialization process within GQMC and the main concern among participants about how faculty's behavior contributes to their pedagogical socialization experiences via transactional or transformational pedagogical

modalities (Glaser, 2002). It is important that these propositions not be considered as “narrow, reductionist explanations” (Charmaz 2006, p. 126) but as statements which convey the most strongly communicated participant experiences which emerged from my data (Strauss, 1987; Corbin & Strauss, 2008).

Proposition 1. Most GQMF teach GQMC without adequate pedagogical training.

This proposition was explicitly derived from the data based on the transactional pedagogical modalities faculty applied within most GQMC. Evidence pointed to the absence of effective strategies to manage the teaching and learning process within large classes and stagnant content knowledge facilitated by a strong textbook and PowerPoint emphases. Pervasive pedagogical gaps developed on account of faculty’s minimal effort towards building an inclusive classroom culture, ineffective presentation skills, avoidance of JEDI focused discussions while using numbers and recommended readings which predominantly presented racialized interpretations of different groups and communities as lacking and lagging behind White groups.

Proposition 2. Underrepresented minorities experience higher levels of transactional pedagogical socialization.

Students who identified as underrepresented minorities comprised just about $n = 14$ or (45 %) of the total sample of 31 participants. The data illustrated that most students who identified as underrepresented minorities experienced higher levels of transactional pedagogical modalities within GQMC. The pedagogical socialization of underrepresented minorities via transactional pedagogical modalities were informed by racialized and

deficit ability expectations which devalued students agency and cognitive ability to learn and understand quantitative methods. Racialized and deficit ability expectations also compelled underrepresented minorities to experience significant forms of emotional and mental taxation within GQMC based on their desire to avoid actualizing negative stereotypes assigned to Black and Latinx students. The transactional modalities students consistently reported on experiencing included hands off approaches, benign neglect, minimal guidance, non-existent or restricted feedback, faculty incivility and being avoided by faculty. Underrepresented minorities are also more likely to experience transactional pedagogical modalities within higher level specialization and cognate quantitative courses rather than introductory courses.

Proposition 3. Female GQMS are more likely to experience lower ability expectations than male GQMS.

Female graduate quantitative methods students comprised $n = 21$ or (71%) of the sample of participants interviewed for my study. Lowered ability expectations emerged as a salient pedagogical socialization experience of female GQMS within GQMC. Most students reported having male faculty and White male faculty teaching their GQMC. Lowered ability expectations is a transactional modality experienced during pedagogical socialization when faculty opted to treat some female students like “little girls”, while others were subjected to “experiences of gaze” and type casted into feminine roles which met faculty’s expectations. Amy reported experiencing lower ability expectations on account of being perceived as a “dumb blonde” by male faculty, peers and even female

faculty. Jessica and Sara as Black women within GQMS reported on not wanting to be perceived as the “dumb one” who were only capable of being “qualitative researchers”.

Female students also reported on instances of mansplaining as talking over and even challenging female faculty publicly in front of the entire class. Female students also experienced mansplaining as the tendency of male GQMS to talk over them while speaking. This was perceived as occurring on account of the assumption that they were unable to explain highly technical concepts or as Yan believed lower numeracy skills and advanced proficiency with quantitative data analysis software.

Proposition 4. Justice Equity Diversity and Inclusion (JEDI) frameworks within GQMC are necessary for contextualizing QM content knowledge within GQMC.

One string finding which emerged from students perspectives is that the presence of JEDI within GQMC addressed the unfair treatment of different groups and the recognition that students representing a wide range of identities and backgrounds should have access to the resources and opportunities which enable them to thrive on equal footing (Perez, Robbins, Harris & Montgomery, 2020). Infusing JEDI within QM programmatic elements such as classroom composition, syllabi, curriculum, pedagogical strategies and classroom culture was important for most participants. Most students also reported that the inclusion of JEDI perspectives within their GQMC contributed towards contextualization of QM content knowledge and datasets. They described this process as extremely beneficial for capturing the historical events and structural conditions which produced and reproduced the structural racism and marginalized experiences of students

and whole communities. This was deemed crucial for negating stereotype threats and the racialized expectations particularly for URM and their communities.

Proposition 5. Growth-oriented teaching modalities can contribute to a reduction in deficit ability expectations within GQMC

A growth mindset offsets racialized and deficit ability expectations by focusing on helping students develop strategies to overcome challenges they may have learning and understanding QM. Faculty who invest time and effort to apply growth oriented teaching modalities tend to value the effort and work of all students within GQMC. Faculty applied growth oriented ability expectations to the students they socialized using transformational pedagogical modalities.

Limitations

Throughout my dissertation I addressed the limitations connected to each step of my research process reflexively as they occurred over time. Firstly, I addressed the use of the term quantitative methods as a concept which is inclusive of graduate statistics, analytics and data sciences courses within the social sciences. For some this may be an all-encompassing generalization of quantitative methods. I also used the term GQMC to include introductory, cognate and specialization students into my sample. It can be perceived as a lumping together of students into an undifferentiated mass of students more amenable for analysis rather than meeting the unique needs of each group. I intend to address this concern in my future research.

Since I pursued a specialization doctoral degree in QM this meant that I possessed a common identity with most of the students comprising the sample and also had similar experiences with pedagogical socialization via transformational and transformational pedagogical modalities. I am also an international doctoral student who besides travelling to and from the US prior to enrollment in my doctoral program lived and studied in the US for three years and carried an additional identity as a ‘legally resident alien’. For some I may not be able to speak to these issues based on my identity as an international student who spent limited time within GQMC in the US. The sample of GQMS who participated in my study is comprised of only two White males. Since White men were consistently perceived as a dominant group within GQMC it would have been analytically important to collect their narratives about their experiences within GQMC and how they perceived their socialization process within their GQMC and how they perceived faculty and peers.

Conclusion

At its kernel the evidence that emerged from my inquiry challenges the longstanding cultural classification of QM as being harder and more rigorous than all other subjects within the social sciences. Faculty pedagogy and the pedagogical socialization process emerged as the strongest factor influencing students ability to learn, understand and master graduate quantitative methods. By focusing on the pedagogical socialization process within these courses my research clearly indicates that much of the ‘hard’ cultural classification of QM stems from the difficulties students experience when

trying to navigate the deleterious effects of deficient classroom culture and transactional modalities. There is a strong need to transition from transactional pedagogical modalities as the pedagogy of the oppressed (Freire, 1970) to more emancipatory pedagogy that is inclusive, affirming and culturally engaging for all students. Transformational pedagogical modalities should not be viewed as an exemplar form of engagement within GQMC because many of the modalities faculty used to socialize students were driven by an almost simultaneous denial and marginalization of significant proportion of students within these courses.

Chapter Summary

In this Chapter I provided answers to my three main research questions via a running theoretical explanation of students description and understanding of the recurring patterns of transactional and transformational pedagogical socialization they experienced within their graduate quantitative methods courses. My findings make novel contributions to the quantitative methods pedagogical literature. The final theme exists as a robust challenge to the unidirectional focus of graduate student socialization where students developed their own ontological understanding of QM as a socially constructed discipline, GQMC as spaces based on identity politics and GQMF as gatekeepers within GQMC who deny or facilitate students learning and understanding of quantitative methods.

My ontological understanding main theme was also instrumental for illustrating how the push for paradigmatic reform of quantitative methods originates from students

experiences within GQMC and their exposure and strong desire to include qualitative, mixed methods and evaluation research paradigms and teaching modalities to tailor their pedagogical socialization experiences to suit their future QM professional aspirations. In my final Chapter Six I will outline the wider implications of my study's findings for interpreting aggregate figures of the number of graduate students persisting through quantitative graduate programs, and the pedagogical strategies used to teach graduate level QM. I end my study with focused recommendations for reform of the pedagogical socialization process graduate students experience within GQMC and end with my teaching philosophy and statement of professional practice based on my future aspirations of entering academia as full time faculty or conducting institutionally driven research as a mixed methods researcher with competencies in applied quantitative and qualitative research.

CHAPTER SIX

Implications, Recommendations and Future Research

My final Chapter is divided into three sections. In section one I outline recommendations for Professional Organizations, Department Chairs and Faculty of Graduate Quantitative Methods Courses and Graduate Quantitative Methods Students arising from my findings. In section two I describe some directions for my future research. My future research section is also my closing vignette which communicates the main takeaways I gleaned from conducting my research, reflecting on participants experiences and those of my own within GQMC.

Implications

In presenting these implications of my research process I hold that my findings conforms to Glaser (1998, p. 17) four criteria for evaluating the development of “good” grounded theory.

- 1. Does the theory work to explain relevant behavior in the substantive area of research?**

Numerical Storytelling

The NCES (2019) data presented in this section are aggregate figures on the number of degrees conferred in mathematics and statistics between 2014 to 2016 by sex and race/

ethnicity. Table 2. breaks down the number of mathematics and statistics degrees achieved by masters and doctoral students based on race/ ethnicity. The data revealed that for the most part White students received 37 % percent of master's degrees in mathematics and statistics while Black students receive 3 %, Hispanic students 4%, Asian students 7%, Pacific Islander and Native American students received 0.05 and 0.11% respectively. International students received 48% of all master's degrees earned. Figures at the Doctoral level painted a similar story with roughly 39% of degrees awarded to White students, 2 % to Black students, 3% to Hispanic students, 6% to Asian students, and International, Pacific Islanders and native American students receiving 47%, 0% and 2% respectively.

Table 2.

Degrees in mathematics and statistics conferred by postsecondary institutions by race/ ethnicity and field of study through 2014- 2016.

Year	Master's degrees		Doctoral degrees	
	2014-2015	2015-2016	2014- 2015	2015- 2016
White	2784	2813	740	722
Black	200	197	22	39
Hispanic	281	294	38	63
Asian	532	566	88	110
Pacific Islander	4	4	2	0
Native American	8	9	1	4
Mixed	100	100	8	39
International	3680	4463	902	873
TOTAL	7589	8446	1801	1850

NOTE: Data are for postsecondary institutions participating in Title IV federal financial aid programs. Race categories exclude persons of Hispanic ethnicity. Reported racial/ethnic distributions of students by level of degree, field of degree, and sex were used to estimate race/ethnicity for students whose race/ethnicity was not reported. To facilitate trend comparisons, certain aggregations have been made of the degree fields as reported in the Integrated Postsecondary Education Data System (IPEDS):

My findings represent some of the stories behind these numbers especially the deficit and racialized ability expectations, mental and emotional taxation and stereotype threats

particularly Black and Latinx QMS routinely experienced while pursuing quantitative methods courses. White students were more likely to be socialized using transformational pedagogical modalities such as hands on strategies, responsive teaching, guided support, and invested feedback which they attributed as faculty driven empowerment which helped them persist and excel at QM. The URM in my sample experienced disproportionate socialization via transactional modalities informed by gatekeeping, hands off modalities, restricted feedback and faculty incivility. Black and Latinx students are oftentimes the racial minorities most likely to experience discrimination and also attrition out of STEM related fields (Park, Kim, Salazar & Hayes, 2018).

Given the stereotype lift and persistence of the model minority stereotype in the US, it is not surprising that Asian heritage students are the minority group who achieved the largest conferral of mathematics and statistics degrees. Contextually using a JEDI lens international students are presented as an aggregate homogenous mass of students. Demographically these figures should be disaggregated by country of origin or race ethnicity to compare the percentage of diasporic students of Asian, African and or European heritage.

Table 3. provides aggregate figures on the total number of graduate degrees in mathematics and statistics awarded to male and female graduate students from 2010 to 2018 (NCES 2019). During this eight-year period, 42% of all master's degrees were awarded to females. Figures at the doctoral level provide a more dismal outlook, with only 28% of mathematics and statistics degrees awarded to females. Given that some

female GQMS experienced deficit gender based socialization it is not surprising that lower levels of female students persist towards completion of their graduate degrees (Park et al. 2018).

Given the notable challenges reported by all female participants with struggling against the culture of male dominance and patriarchal expectations within their GQMC these figures are also not surprising. My research also makes it abundantly clear

Table 3.

Degrees in mathematics and statistics conferred by postsecondary institutions by level of degree and sex of student through 2010- 2018.

Year	Master's degrees			Doctoral Degrees		
	Males	Females	Total	Males	Females	Total
2010-2011	3459	2407	5,866	1132	454	1586
2011-2012	3695	2551	6246	1198	471	1669
2012-2013	4178	2779	6957	1292	531	1823
2013-2014	4256	3017	7273	1325	538	1863
2014-2015	4508	3081	7589	1298	503	1801
2015-2016	4924	3527	8451	1324	531	1855
2016-2017	5113	3969	9082	1403	522	1925
2017- 2018	5959	4484	10,443	1448	562	2010
TOTAL	36092	25815	61907	10420	4112	14532

NOTE: Data are for postsecondary institutions participating in Title IV federal financial aid programs. Some data have been revised from previously published figures. SOURCE: U.S. Department of Education, National Center for Education Statistics, Earned Degrees Conferred, 1949-50 and 1959-60; Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1967-68 through 1985-86; Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" (IPEDS-C:87-99); and IPEDS Fall 2000 through Fall 2018, Completion's component. (This table was prepared September 2019.)

that quantitative storytelling is important for providing and having an in-depth analysis of student's narratives using qualitative research to interpret aggregate figures. In the absence of rigorous qualitative research to provide essential contextualization then some policy makers may use a deficit lens to interpret these figures as academic achievement gaps and perceive some groups as lagging based on assumptions of innate cognitive

deficiencies among specific groups who belong to racially minoritized communities (Valencia, 2010; Millen, 2021; Tarran, 2021).

2. Does it have relevance to the people in the substantive field?

My study has important implications for increasing the number of women and URM pursuing QM related courses and graduate degrees. The importance of advancing QM within graduate education is underscored by the vast amount of funding already invested in increasing URM students participation in STEM at the federal and state level and the high demand for QM skills in the US and internationally. Graduate education in QM indispensable to the US domestic objectives for research and innovation. Institutions of higher education are charged with the responsibility of facilitating graduate students development into future developers and innovators in QM research (National Academies of Sciences, 2018). More research is needed to discover additional factors inhibiting and facilitating GQMS persistence and progress within GQMC

Capital Investments

In Table 4. below it is abundantly clear that at the federal level considerable funding has been diverted to the National Science Foundation's (NSF) Graduate Research Fellowship Program (GRFP) between 2018- 2020 towards the development of resources conducive for increasing graduate student participation in STEM programs. Although figures has decreased slightly from 284 in 2018 to 256 million in 2020, this represents a considerable sum invested in increasing the amount of masters and doctoral students with applied QM competencies.

Table 4.

Funding allocated for the National Science Foundation Graduate Research Fellowship Program (GRFP) through 2018- 2020.

GRFP Funding by Account			
(Dollars in Millions)			
	FY 2018 Actual	FY 2019 (TBD)	FY 2020 Request
Education and Human Resources	\$142.58	-	\$128.45
Research and Related Activities	142.27	-	128.45
Total	\$284.85	-	\$256.90
Number of New Fellows	2,000		1,600
Projected Fellows on Tenure ¹	5,705		5,400

¹ Fellowship tenure status is the period of time during which fellows actively utilize the fellowship award to pursue an advanced degree in a STEM or STEM education field.

Significant amounts of this funding has also been diverted to understand why racially minoritized groups perform poorly in classes or report on poor experiences. The NSF also invests heavily in STEM related scholarships and by extending the STEM Optional Practical Training for international students post-graduation in the US. Millions of dollars in federal findings have been earmarked for student centered initiatives and interventions that combat inequality in higher education and expand STEM pipeline based on the numbers. The model minority stereotype needs to be examined further to understand how the pedagogical socialization practices of QMF contributes to the stereotype lift of some students and international, White and Asian students higher rates of completion within QM programs (McGee, 2018).

My study also sheds light on the micro relations, attitudes and mindsets, deficit ability expectations, identity suppression and erasure which serves to “weed out” students

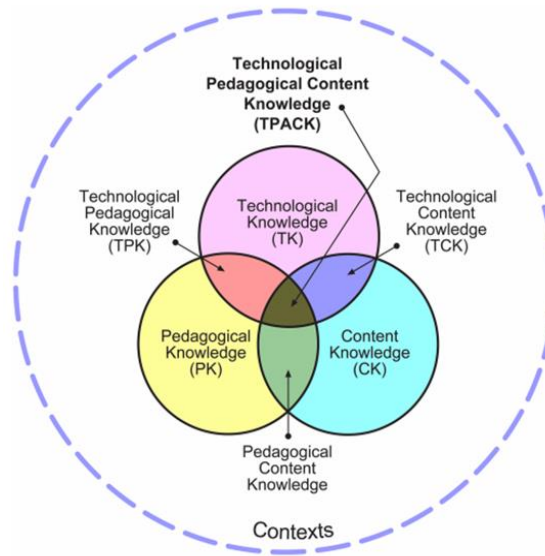
along the STEM pipeline. Suggestions for additional areas of funding includes the creation of student driven communities and collaborative partnerships within interdisciplinary teams representing a broad array of diverse characteristics. There also needs to be greater acknowledgement that STEM exists differently in a variety of programs and especially within the social sciences. For the most part this tends to be an overlooked area in STEM policy and decision making in higher education.

Technological Pedagogical Content Knowledge Framework (TPACK)

The TPACK teaching and learning framework integrates perspectives on technology, pedagogy and content as important elements for understanding classroom teaching and learning (Koehler, Mishra & Yahya, 2007; Mishra & Koehler, 2006). This TPACK conceptual framework is highly applicable to my emergent pedagogical socialization theory and the pedagogical literature connected to GQMC. Figure 9. shown below represents the TPACK model comprised of all the modalities which also emerged in my data (Koehler et al. 2007). My data provided evidence supportive of content knowledge, pedagogical knowledge, pedagogical content knowledge, technological knowledge, and technological content knowledge.

Rahman, (2017) and Henriques & Gutierrez- Fallas (2017) also named the TPACK framework as having strong value for teaching and learning within GQMC. My study has deep relevance with this scholarship particularly on the need for greater professional development for QM faculty.

Figure 9. Technological Pedagogical and Content Knowledge Framework



I found evidence supportive of additional elements to add to the TPACK framework such as static content knowledge, contextual content knowledge and applied content knowledge. Based on my findings contextualized content knowledge is a very important part of GQMS transformational pedagogical socialization process needed for students to break free from the abstract application, interpretation and use of quantitative methods. Technological knowledge and technological content knowledge also emerged as important areas for consideration because of the emergence of hands on approaches and students deep appreciation for developing expert competencies using proprietary and open source quantitative data analysis software while being exposed to this pedagogical modality.

3. Does the theory fit the substantive area?

The graduate student pedagogical socialization process within GQMC is the substantive area of inquiry my Dissertation's impact can be especially felt. My research makes considerable contributions to the process that introductory, cognate and specialization students have in common within their graduate quantitative methods courses. My substantive process theory of pedagogical socialization emerged inductively from participants narratives about their lived experiences and found connectivity with the extant literature in the field.

4. Is it readily modifiable as new data emerges?

My theory of pedagogical socialization is readily modifiable by new data. I can apply different qualitative approaches to my NVivo database or use my case classifications function to look at students with specific characteristics such as only specialization students, only female students, only white students or students attending public universities to determine if my theory still holds or has to be modified based on differences in the data arising from these groups.

Recommendations for Professional Organizations

There is an urgent need for the Guidelines for Assessment and Instruction in Statistical Education (GAISE) reports to provide more guidance on the pedagogical practices of GQMF within intermediate and advanced graduate courses. The GAISE (2016) focused on grades 6 to 12 and undergraduate students within introductory QMC. In the new and updated GAISE (2020) the authors explicitly focused on pre- k-12

education and data literacy for elementary, middle and high school students. The ASA produces statistics education guidelines within booklets and trainings which focus on elementary, high school and undergraduate teachers of statistics. Much more focus is needed within the ASA on QM education for graduate students and the training of GQMF. The pool of QM teachers will most likely possess at least masters qualifications and who are predominantly White. More emphasis should be placed on socializing members into healthy and equitable mindsets suitable for teaching different student populations.

Moreover, the ASA should focus on promotional activities aimed at eliminating deficit cognitive orientations and racialized thinking about women and URM. Although the American Statistical Association recently launched its JEDI special interest group in 2020, the GAISE (2016) and GAISE (2020) does not explicitly focus on JEDI. The Women in Statistics and Data Science Conference and Caucus for Women in Statistics provides mentorship and networking opportunities for female GQMS and faculty. This is especially important since most female participants cited female role model and female mentorship as a transformative modality necessary for socialization into empowered, strong and capable women in QM.

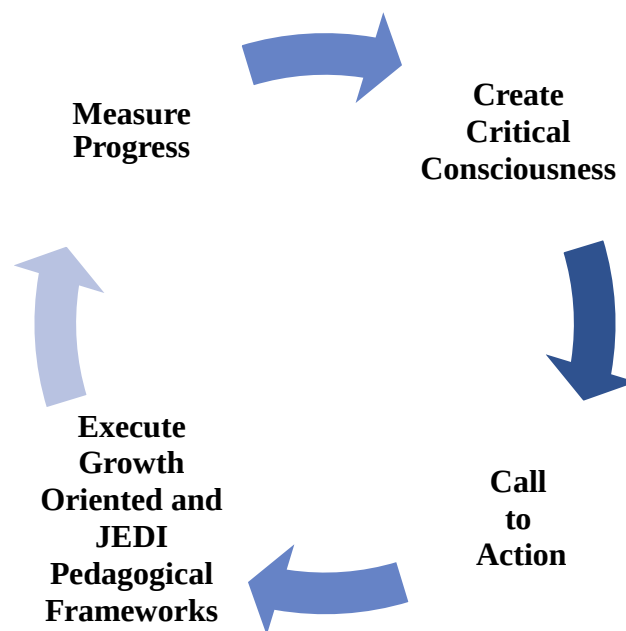
Department Chairs and Graduate Quantitative Methods Faculty

My study also provides crucial information for QM department chairs and faculty's re-structuring of the QM teaching and learning environment. "Department chairs are tasked with curriculum planning, performance reviews, fiscal oversight

advocating for and representing their department to the university at large and to external constituents” (Weaver, Ely, Dickson & Dell- Antonio, 2019, p. 175). Chairs also hold major responsibility for the continuing development and evaluation of faculty teaching within their GQMC (Seagren, Creswell & Wheeler, 1993).

I recommend four salient steps for reforming GQMC, creating awareness, calls to action, execution and measurement of progress (Figure 10.) These four steps are adapted from the work of Millen (2021) as a transformative process for infusing narrative storytelling, JEDI and growth oriented frameworks within GQMC.

Figure 10. Transformation Effort for JEDI and Growth Oriented Classrooms



Step One: Creating Critical Consciousness on the Need for Change

Critical consciousness involves achieving an in-depth understanding of the world to expose oppressive socio- cultural and political contradictions (Freire, 1993). This is an

important step for acting against the deficient pedagogical culture within GQMC. This includes a changeover to reflexive practices which help all QM stakeholders to recognize and embrace the need for change (Coghlan & Brydon- Miller, 2014). The first step can be enacted as trust building exercises, facilitated workshops and “thought spaces” where faculty can recognize their privileges in whatever forms they exist whether it is able bodied, cognitive, model minority, White, or male privilege. These approaches must clearly demonstrate how these privileges and the tensions it produces can hinder and obstruct progress for GQMS within GQMC (Tuitt, Agans, & Griffin, 2016). Department Chairs can also use case studies of more successful institutions who have benefitted from doing the work that is necessary to change the systems and structures attached to QM teaching and learning. During this process Millen (2021) cautioned that it is not easy for faculty and administrators to welcome changes that do not have an easily recognizable benefit for them. This author also recommended working along with the few persons who will show interest and compelling others to participate by focusing on positive outcomes.

Step Two: Calls to Action

A call to action is explicit communication that change is non-negotiable, inevitable and requires commitment from all stakeholders. Chairs and administrators should set specific goals for reform of GQMC and invite persons to specify clear roadmaps for achieving these goals (Millen, 2021). There can be specific calls to action for gender equity (Sax, 2013) based on longstanding barriers and deficit ability expectations ascribed to female GQMS. There can be a call to action to address the model

minority stereotypes ascribed to students of Asian heritage (Hartlep, 2021) or calls to action to dismantle oppression, stereotype threat and racially deficit expectations ascribed to Black and Latinx students (Harper, 2010, Valencia, 2010). Calls to action will also include communicating concrete plans for reforming GQMC syllabi and curriculum and the infusion of critical and inclusive pedagogies to teaching approaches.

Step Three: Execution

Having the right personnel to execute actionable plans may be difficult. Administrators can hire experts in the field and commit resources to bring about the desired outcomes which stem from their calls to action. Millen (2021) recommended empowering minority students and faculty and establishing ally groups for DEI initiatives. Based on my research many changes are possible when students like Isabelle, Marie, Michael, Tom, Amy, Lisa, Susanna, Shaga, Kimberly, Jane, Jessica, Sara, Rose, Megan, Noah, Mike and Tiffany can exist as advocates for DEI and pedagogical reform. For hesitant students there may be some push back that this is a burden they did not ask for. Through open dialogue students can share differences on their experiences with transactional and transformational socialization. This can also include comparisons to the privileges some students are afforded on account of their experiences with predominantly transformational pedagogical modalities. My recommendations for the reform of GQMC also includes institutionalization of critical quantitative and quantitative criticalist approaches to QM and the utilization of growth oriented frameworks to improve the overall pedagogical culture.

Institutionalize Critical Quantitative and Quantitative Criticalism

CritQuant allows methodologists to position themselves as practitioners who deconstruct quantitative research as a means to achieve equity and racial justice. By re-imagining the traditional use of statistical tools, CritQuant resolves the de-contextualization and racialization of statistics by interrogating the imperfect rationality that informs statistical analyses (Lopez et al. 2018). QuantCrit empowers methodologists towards a transformational praxis that harnesses the utility of quantitative methods to empower marginalized groups within statistical reporting. Participants narratives provide socio- historical and personal context for data in ways that numbers do not (Millen, 2021).

The transformational pedagogical socialization students experienced on account of JEDI exposure created their need to learn about critical approaches to quantitative research. Including CritQuant into the GQM agenda is a resource which when properly managed will produce graduates who question the history, philosophical worldviews, ontologies and, epistemologies which legitimize traditional QRM. These orientations are major contributory factors which enable the development of alternative quantitative research paradigms sensitive to diversity (Tabron, 2019), complexity (Poth, 2018), intersectionality (Covarrubias, 2011; Covarrubias, Nava, Lara, Burciaga, Velez & Solórzano, 2018) and context (Allen & Wollniak, 2019). However, it is vital to note that these alternative approaches have met with definite forms of marginalization and de-

legitimization within the traditional QRM community (Stage & Wells, 2014; Wells & Stage, 2015).

Infusing GQMC with critical quantitative approaches can help faculty facilitate the development of GQMS mindsets that they can master the rules of QM enough to know how to break them in ways more responsive to social change and disruptive phenomenon (Wells & Stage, 2015). Standing completely in positivism and post positivism cannot make quantitative research a tool for social justice. Additional frameworks should be included for the teaching and learning of QM.

Growth Oriented Pedagogical Frameworks

Faculty mindsets are a strong predictor of students achievement experiences in their STEM courses (Canning, Muenks, Green & Murphy, 2019). Therefore, growth oriented pedagogical frameworks should be based on advancing a growth mindset about the teaching and learning of QM based upon individual growth goals for faculty, and task- based growth goals at the classroom level (Bostwick, Collie, Martin & Durksen, 2020). Bostwick et al. (2020) and Canning et al. (2019) found significant associations between classroom level and teacher related growth orientations and positive mathematics outcomes among secondary school students. My findings pointed towards the utility of developing growth oriented frameworks for improving STEM classroom culture using anti deficit frameworks (Harper, 2010), culturally sustaining pedagogy (Paris & Alim, 2014), humanizing pedagogy (Freire, 1970; Salazar, 2013) and

convergent historicism (Tabron et al., 2020) to transform educational spaces for all graduate students within GQMC.

Critical and inclusive pedagogy is also an important teaching and learning process for the transformational agenda of reforming GQMC (Tuitt, 2003; Tuitt, Haynes & Stewart, 2016). QM and statistics should also be taught as a tool for equity using an interdisciplinary knowledge base including criticality, ethnic studies, sociology, history, humanities, law, philosophy, STEM, feminist, womanist, and emancipatory frameworks as pedagogical content knowledge (Gray, 2021; Solórzano & Yosso 2002)

Improving Pedagogical and Classroom Culture

Another place to start the pedagogical reform of GQMC is by GQMF acquiring pedagogical training to teach increasingly diverse classrooms (Castillo- Milagros, 2019). All students are deserving of being taught using Life Transformational Education (LTE) approaches via an inclusive excellence lens based upon (Tuitt, 2016; Tuitt 2020):

1. Intentional Praxis
2. Voice and Lived Experience
3. Interdisciplinary content
4. Anti-racist equity mindedness
5. Identity affirming and socially just environments
6. Courageous transparency
7. Resilient emotional labor

The Office of Diversity, Equity and Inclusion and teaching centers within higher education institutions usually possess trained professionals, faculty and faculty fellows who can host pedagogical workshops and trainings sessions for GQMF. GQMF have iteratively developed nurturing growth oriented pedagogy through some transformational modalities this can be honed and further developed to ensure that it benefits all students and stakeholders connected to GQMC. LTE pedagogical strategies, interdisciplinary approaches and antideficit frameworks will go a long way towards creating anti-racist, equity minded and inclusive classrooms where all students can thrive and feel welcomed, heard and affirmed.

McGee (2018) also called on the need for “coalition building” (p. 11) among racially minoritized groups who often exist as a highly marginalized and fragmented group within STEM fields. It is important to note that the conventional predictors of performance within GQMC identified in statistical literacy, thinking, reasoning literature did not emerge as strong factors connected to graduate students pedagogical socialization process. Less attention should be paid towards operationalizing these constructs within GQMC since it may lend itself to the historical continuity of deficit and deficient teaching practices within GQMC. More emphasis should be placed on adult education and andragogical socialization because graduate education should not conform to the harmful pedagogical approaches graduate students encountered and overcame within the k-12 education system.

Step Four: Measuring Progress

Measuring the progress and efficacy of interventions designed to improve the teaching and learning of quantitative methods is an important step for achieving sustainable and meaningful change within departments (Millen, 2021). It is also based on the implementation of different accountability mechanisms to ensure alignment of reform initiatives with desired outcomes and long term impact for GQMF and GQMS..

Student Evaluations

Students evaluations matter. Transformational pedagogical socialization modalities should be consistent for all students. Administrators should include diversity growth oriented and anti-deficit items which will measure students perceptions of their pedagogical socialization process within their GQMC. Spaces should be included for students to voice their individual of what it looks like in everyday practice and encourage additional progress (Millen, 2021). This is a very important recommendation because students satisfaction ratings has larger implications for ranking and campus climate evaluations.

Faculty should also pay more attention to the GTA's selected to oversee coursework support for their GQMC. Since GTA's are most likely to continue on the tenure track there is a definite concern that these students are capable of perpetuating transactional socialization modalities to future GQMS. Transactional pedagogical modalities is an oppressive and inequitable way of organizing GQMC because all students pay tuition in common and deserve to be treated equally and "with respect" (Shaga). Student

evaluations should be upgraded to measure students and faculty's self and classroom based growth orientations at the beginning and end of their participation within their GQMC (Bostwick et al. 2020).

Future Research

I intend to further develop the methodological, content related and praxis related outcomes from my Dissertation research. I intend to utilize an exploratory sequential mixed methods research design to map out the integration of qualitative and quantitative approaches to study pedagogical socialization of graduate students. For my quantitative verification phase, I will explore the factorial validity and reliability of my Pedagogical Socialization Survey using Exploratory Factor Analysis (EFA) to measure the generalizability of students perceptions about their experiences with pedagogical socialization. I found few practical studies which provide concrete examples of how fully integrated mixed methods designs can be applied successfully. The development of fully integrative mixed methods designs remains an elusive goal among mixed methodologists.

After reflexively engaging in my 18 month process of conceptualizing and completing this work I argue that quantitative research in higher education operates within an oppressive system. In order to reform quantitative methods, it is imperative that the historical, demographic, socio- cultural, emotional, cognitive, and personal characteristics of teachers and students that reinforce deficit and racialized ability expectations during teaching and learning be addressed. There is also a definite need to develop more anti-deficit and growth- oriented frameworks for teaching and learning

within Graduate Quantitative Methods courses. I intend to fill these gaps in the quantitative methods pedagogical teaching and research to create more equitable, inclusive, and affirming classrooms where all students' aspirations to become proficient at quantitative methods can be fully realized.

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APPENDIX A
In-depth Interviews Listserv Permission Letter

(Date)

(Listserv Administrators Name)

(Institutional Rank)

(Institution)

Dear (Listserv Administrators Name),

I hope my email meets you well and safe. I am asking for your permission to send out recruitment emails via your listserv to (Name of Graduate School, College or Division) masters and doctoral students to participate in a demographic survey and in-depth interviews for my dissertation research.

My research explores master's and doctoral student's perceptions about with the socialization process they experienced within their graduate quantitative methods courses. In my listserv message I will invite interested students to complete a screening participant information survey containing 12 questions, by clicking the Qualtrics link provided. The graduate students selected to participate in my study will be contacted in a subsequent email to schedule a convenient date and time for:

- One 60-to-90-minute in-depth interview.
- One 30-to-45-minute follow-up interview

If you agree to facilitate my request, once the University of Denver (DU) Institutional Research Board (IRB) approves my study, I will contact you with my recruitment message to send out to graduate students.

Should you have questions about my study, please email me at amanda.k.thomas@du.edu

Thank you for your time and consideration.

Sincerely,
Amanda Thomas
Doctoral Candidate
Research Methods and Statistics

APPENDIX B
Graduate Student Interviews Solicitation Letter

Hello masters and Doctoral Students:

I hope this email finds you well and safe. Please accept this invitation to participate in the first phase of Amanda Thomas' dissertation research which explores graduate students' perceptions about the pedagogical socialization process experienced within their graduate quantitative methods courses. To participate, you must be currently enrolled in a master's or doctoral program of study and must have completed at least one graduate quantitative methods course.

This phase of the study has three components: completing a short survey, participating in one in-depth and one follow up interview. If you'd like to participate, please click the Qualtrics link below to complete this short survey containing 12 questions. Your participation in this study is completely voluntary. Complete details explaining confidentiality, participation and data use are enclosed within the survey. Thank you for your time and effort. Should you have questions about the study, please contact Amanda at amanda.k.thomas@du.edu

Here is the link for the Participant Information Survey:

https://udenver.qualtrics.com/jfe/form/SV_4Zuipz4wIKZdAvX

The survey will remain open and available until Sunday, January 31, 2021.

Thank you,

(Name of Listserv Administrator)

APPENDIX C
Graduate Student Interviews Invitation Letter

Hello masters and Doctoral Students:

I hope this email finds you well and safe. Please accept this invitation to participate in the first phase of Amanda Thomas' dissertation research which explores graduate students' perceptions about the pedagogical socialization process experienced within their graduate quantitative methods courses. To participate, you must be currently enrolled in a master's or doctoral program of study and must have completed at least one graduate quantitative methods course.

This phase of the study has three components: completing a short survey, participating in one in-depth and one follow up interview. If you'd like to participate, please click the Qualtrics link below to complete this short survey containing 12 questions. Your participation in this study is completely voluntary. Complete details explaining confidentiality, participation and data use are enclosed within the survey. Thank you for your time and effort. Should you have questions about the study, please contact Amanda at amanda.k.thomas@du.edu

Here is the link for the Participant Information Survey:

https://udenver.qualtrics.com/jfe/form/SV_4Zuipz4wIKZdAvX

The survey will remain open and available until Sunday, February 7, 2021.

Thank you,

(Name of Listserv Administrator)

APPENDIX D

Qualitative Participant Information Survey

Title of Research Study: An exploratory sequential mixed methods inquiry into the pedagogical socialization of graduate students within graduate quantitative methods courses.

You are invited to participate in this survey which collects demographic information about graduate students who completed at least one graduate quantitative methods course. I am conducting this study for my Dissertation research at the University of Denver. I will use the results of this survey to select a diverse sample of graduate students to participate in semi structured in-depth interviews about their pedagogical socialization experiences within graduate quantitative methods (statistics) courses. Participation in this survey should take 3-5 minutes of your time in responding to (12) questions. If you complete the survey, you will have the opportunity to enter a drawing for one of four \$25 Amazon e-gift cards. Participation in this study is strictly voluntary. The risks associated with this project are minimal. If you experience discomfort, you may discontinue this survey at any time. I respect your right to choose not to answer any questions that may make you feel uncomfortable. Refusal to participate or withdrawal from participation will involve no penalty or loss of benefits to which you are otherwise entitled.

I am the only person who has access to your individual data. Your responses will be kept separate from information that could identify you and will be stored in a secure location. This is done to protect the confidentiality of your responses. If you have any concerns or complaints about this study, please contact my Dissertation Chair, Bruce Uhrmacher Ph.D. at bruce.uhrmacher@du.edu and 303-871-7659 or contact the Institutional Review Board for the Protection of Human Subjects, Office of Sponsored Programs, University of Denver, at 303-871-3454, IRBAdmin@du.edu, or write to, 2199 S. University Blvd., Denver, CO 80208-2121.

I am interested in participating in one in-depth interview and one follow up interview about my pedagogical socialization experiences within my graduate quantitative methods courses

- ☐ Yes
- ☐ No

If yes selected, go to question 1 of the survey.

If no selected, skip to end of survey message

Q1 Please state your preferred email address for future correspondence if you are interested in participating in initial and follow up in-depth interviews

Section 1: This section asks relevant demographic questions to select a sample of graduate students to participate in this study.

Q2 What type of graduate degree are you currently pursuing?

- ☐ Master's Degree
- ☐ Doctoral Degree

Q3 What graduate program are you enrolled in currently?

Q4 What is your gender identity?

- ☐ Male
 - ☐ Female
 - ☐ Trans female
 - ☐ Trans male
 - ☐ Non- binary
 - ☐ Prefer to self- describe
-

Q5 What is your racial/ ethnic identity?

- ☐ White or European (Non- Hispanic)
 - ☐ African American, Black, Black Caribbean, Black African
 - ☐ American Indian or Alaska Native
 - ☐ Asian or Asian American
 - ☐ Native Hawaiian or Pacific Islander
 - ☐ Hispanic, Latinx, Chicano, Chicana
 - ☐ Biracial or Mixed
 - ☐ Prefer to self- describe
-

Q6 What is your nativity status?

- ☐ US citizen
- ☐ International student

Q7 What quantitative methods option are you pursuing within your program?

- ☐ Introductory Quantitative Methods Courses
- ☐ Cognate in Quantitative Methods
- ☐ Specialization in Quantitative Methods

Q8 How many quantitative methods courses have you completed?

Q9 Do you intend to complete your master's thesis or doctoral dissertation using quantitative methods?

- ☐ Yes
- ☐ No

Q10 Did you enjoy most of your teaching and learning experiences within your undergraduate quantitative methods courses?

☐ Yes

☐ No

Q11 Did you enjoy most of your teaching and learning experiences within your graduate quantitative methods courses?

☐ Yes

☐ No

Thank you for completing this survey. Your time is appreciated. If you are selected to continue this research study, the researcher will use the email address you provided to contact you directly.

APPENDIX E
Confirmation of Participation Email

Hello:

Thank you so much for volunteering to participate in my dissertation research study, which explores graduate students' perceptions about their pedagogical socialization experiences within their graduate quantitative methods courses. I am writing to confirm your willingness and availability to participate in:

- one 60-to-90-minute in-depth interview
- one 30 to 45 minutes follow up interview

At your earliest, please reply to this email and indicate whether you're still available to participate. If you are interested in participating, please confirm two dates and times to complete each interview. I will also send you a copy of the verbal consent form with further details about your participation in both interviews.

If you consent to participate, participants will be asked questions about their experiences with the teaching and learning process within their graduate quantitative methods courses while learning quantitative methods (statistics). Participation in this project is strictly voluntary. Choosing not to be in this study or to stop being in this study will not result in any penalty to you or loss of benefit to which you are entitled. Your choice to not be in this study will not negatively affect any rights to which you are otherwise entitled or your class standing.

Please don't hesitate to contact me with questions. I appreciate your time and expression of interest in my study.

Sincerely,
Amanda Thomas
Doctoral Candidate
Research Methods and Statistics



APPENDIX F

Verbal Consent Script

Introduction

I am *Amanda Thomas* a *doctoral candidate* in the Department of Research Methods and Information Sciences at the University of Denver.

Thank you for completing the Participant Information Survey I sent out via the (*insert listserv name and Department*). You provided your email contact when you completed the participant information survey. I am writing to confirm your willingness and availability to participate in two interviews for the qualitative phase of my Dissertation research study.

Participants Rights

Your participation in this study is completely voluntary. You can withdraw at any time. Choosing not to be in this study or to stop being in this study will not result in any penalty to you or loss of benefit to which you are entitled. Your choice to not be in this study will not negatively affect any rights to which you are otherwise entitled or your class standing.

Description of the study and study procedures

I am conducting my Dissertation research to explore graduate students' perceptions about the pedagogical socialization process they experienced within graduate quantitative methods (statistics) courses. The name of the study is 'An exploratory sequential mixed methods inquiry into the pedagogical socialization of graduate students within graduate quantitative methods courses. You are being invited to participate in the first qualitative phase of the study. The IRB Project Number is 1664575-1.

If you agree to participate, you will be asked to be interviewed by me two separate times for:

- One 60-to-90-minute in-depth interview.
- One 30-to-45-minute follow-up interview to review the accuracy of your in-depth interview transcripts.

I would like to audio and video record your responses for both interviews using the Zoom online communications software. Then I will use that information to develop qualitative findings and a survey about graduate students' experiences with pedagogical socialization within graduate quantitative methods courses for the next quantitative phase of the study.

Each participant will be asked to submit the most convenient date and time for one in-depth and one follow up interview. Once these dates and times are mutually agreed upon, the researcher will email a copy of an informed consent form to each participant to review seven (7) days prior to the first in-depth interview. The researcher will also read this consent form to participants before the start of each interview. Participants will also be asked at the start of each interview to verbally consent to participating online in one 60-to-90-minute in-depth interview and one 30 to 45 minutes follow up interview and to be audio and video recorded via Zoom for both interviews.

Confidentiality

The online Zoom recordings of in-depth and follow up interviews will be encrypted by the Zoom software and saved to the researcher's password protected Zoom Cloud recording storage location. Only the researcher has access to this secure storage location. The Zoom program will automatically audio transcribe all interview recordings. All audio transcripts will be encrypted, password protected and stored on the researcher's Zoom Cloud recording storage location. Backups of audio transcripts will be stored in the researcher's password protected Microsoft One Drive data storage location. Subscription to the researchers Zoom account and Microsoft One Drive account is provided by the University of Denver.

The researcher will ensure none of the information you provided that could potentially identify you will be used. No identifying information will be collected during both interviews. Audio video interview recordings will be destroyed after completion of this study. Any identifying data provided included within the participant information survey, and in open comments by interviewed participants will be stripped from the data during data analysis. Before the start of in-depth interviews participants will be asked to provide a pseudonym or fake name to refer to verbatim quotations. The results of this research study will be published and presented at conferences.

Risks

Your participation in this study does not involve any physical or emotional risk to you beyond that of everyday life.

Benefits

You are not likely to have any direct benefit from being in this research study. Your responses will be used to inform advanced teaching and learning in quantitative methods and the pedagogical practices of graduate quantitative methods faculty.

Alternatives

You may choose to not participate in this research study. You may choose to not answer any question that makes you uncomfortable, and you will have the ability to review transcripts of your in-depth interviews during follow up interviews.

Financial Information

Participation in this study will involve no cost to you. Participants will be invited to participate in four \$25 gift card drawings for this study. Four participants who complete both initial and follow up interviews will be randomly selected to receive one \$25 Amazon e-gift card.

Whom to contact with questions

If you have any questions or problems during your time on this study, you should contact my Dissertation Chair at the University of Denver: Bruce Uhrmacher Ph.D., *Department of Research Methods and Information Sciences*, (303)-871-2483, *bruce.uhrmacher@du.edu*. If you have any questions regarding your rights as a research participant, please contact the University of Denver's Institutional Review Board (IRB) Office at (303)871-2121, or IRBAdmin@du.edu, or write to, 2199 S. University Blvd., Denver, CO 80208-2121.

Verbal Consent Section

“Do you wish to participate in this study?” Yes _____ No _____

“Do you agree to be audio-taped and video-taped via Zoom?” Yes _____ No _____

“Would you like to receive a summary of the results of this study to be emailed to you using the email address you provided within the participant information survey?”

Yes _____ No _____

APPENDIX G
Interview Date and Time Confirmation Email

Dear _____,

Thank you for volunteering to participate in my Dissertation research. Please see attached for a copy of your verbal consent form with complete details explaining confidentiality, participation, and data use for one in-depth and one follow up interview.

If you decide to participate, we can arrive at a mutually agreed upon date and time to complete both interviews. I will suggest (dates), anytime between (times) for us to conduct our first interview. Please feel free to select or suggest any dates and times that is best for you to participate. Once we agree upon a date and time, I will send you a Zoom invite with relevant details.

The second follow up interview can take place within one week after completing the first in-depth interview. We can agree upon the date and time for the follow up interview during our first in-depth interview.

I appreciate your time. Thank you for agreeing to participate in my study.

Sincerely
Amanda Thomas
Doctoral Candidate
Research Methods and Statistics
Morgridge College of Education
University of Denver

APPENDIX H

Structured Interview Protocol

My name is Amanda Thomas and I'm a Doctoral candidate in Research Methods and Statistics at the University of Denver. Today is [fill in date]. Thanks so much for agreeing to this interview. I'm going to spend the next 60 to 90 minutes asking you 30 questions about your experiences with teaching and learning within your graduate quantitative methods courses. When I refer to quantitative methods this also includes statistics courses. I'd like you to choose a pseudonym/ first name you would like to be known as, during the interview, on interview transcripts and if it becomes necessary to quote you within my dissertation and future research.

Do you have any questions? Great! Let's get on with the interview.

Introductory Questions

These are some beginner questions I'm going to ask to learn about you and your thoughts about quantitative methods

1. I'd like to start by asking you to tell me a little about why you decided to complete quantitative methods courses within your master's or Doctoral program?
2. What are the things that come to mind when you think about quantitative methods?
3. What are some of the first things that come to mind when you think about quantitative methods faculty?
4. What does quantitative methods contribute to your program of study?

Pedagogy and teaching practices

I'd like to ask you a few questions about the pedagogy (teaching strategies) used within your quantitative methods courses?

5. How would you describe the teaching practices faculty used within your QMC?
6. How did these teaching strategies influence your learning of QM?
7. How did these teaching strategies influence your understanding of QM?
8. How were you taught to use technology (software) during your QMC?
9. Based on your experiences, what are the connections between teaching QM and learning QM?

Roles and Performance

Now I'm going to ask you some questions about your performance within your quantitative methods courses

10. How would you describe your performance within your quantitative methods courses?
11. What were the most important factors which affected your performance within QM courses?

12. How did faculty's teaching strategies contribute to your performance within QM courses?
13. How did faculty's respond to instances when you asked for additional support to understand QM?

Identity Development

Let's talk about your identities (who you are and how you see yourself) I'd like to know...

14. How do you identify?
15. What identities were most important to you while completing your quantitative methods courses?
16. How did QM faculty respond to your identities?
17. How did faculty's response to your identities affect your learning of quantitative methods?
18. How did QM students respond to your identities?
19. How did student's response to your identities affect your learning of quantitative methods?

Typical Day in GQMC

Now I'm going to ask you to reflect on your time spent within your graduate quantitative methods courses ...

20. How did you typically begin your quantitative methods classes?
21. How did faculty begin your quantitative methods classes?
22. How did you end your quantitative methods classes?
23. How did faculty end your quantitative methods classes?
24. How did students end quantitative methods classes?
25. Can you summarize your experiences with the teaching practices used within your quantitative methods classes?

Ending questions

I'd like to wrap up the interview by making sure I didn't miss anything...

26. What did you value the most about the teaching strategies you experienced within quantitative methods courses?
27. What did you value the least about the teaching strategies you experienced within quantitative methods courses?
28. Can you describe any instances when quantitative methods courses met your expectations?
29. Can you describe any instances when quantitative methods courses did not meet your expectations?
30. After reflecting on your experiences is there anything additional you would like to add?

I appreciate your time. Thank you for participating in my study

APPENDIX I

Follow Up Interview Protocol

Preamble

My name is Amanda Thomas and I'm a Doctoral candidate in Research Methods and Statistics at the University of Denver. Today is [fill in date]. Thanks so much for agreeing to this follow up interview. I am going to spend the next 30 to 45 minutes asking you some questions about your responses during our in-depth interview on [fill in date]. Before we start our interview, I would like us to review the consent form I emailed to you on [fill in date] to ensure that you understand the rights and responsibility connected to participation and also to secure your verbal consent to be video/ audio recorded via Zoom for this interview. If you agree, we will continue using the pseudonym/ first name you provided at the start of our first in-depth interview.

Do you have any questions?
Great! Let's get on with the interview.

I appreciate your time. Thank you for participating in my study

Note: Follow up interviews are designed to follow an unstructured design where the researcher asks for clarification of participant responses during the first in-depth interview.

APPENDIX J

Characteristics of Individual Study Participants

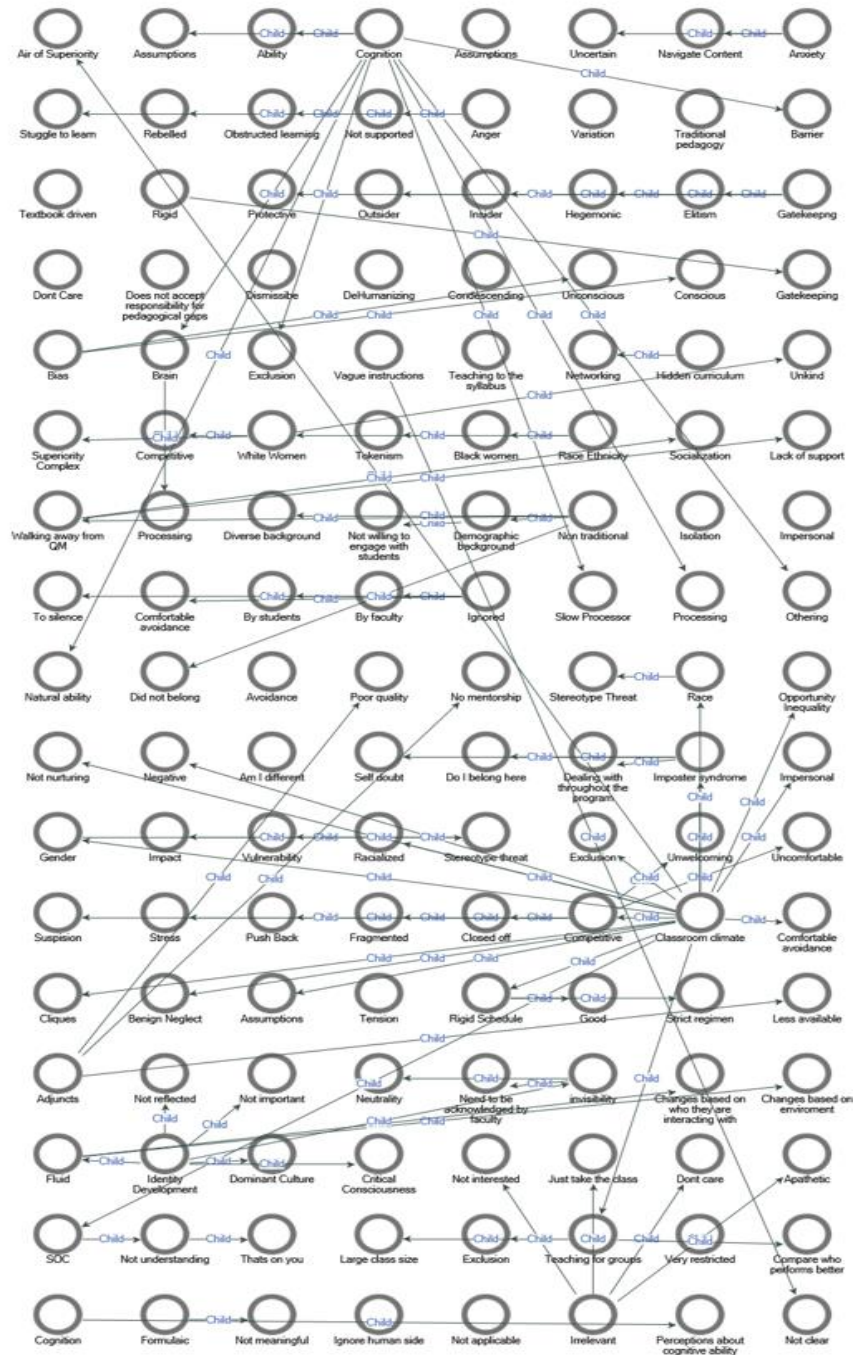
Pseudonym	Gender Orientation	QM Option	Courses Completed	Nativity	Institution	Race/ Ethnicity	Degree
Amy	Female	Specialization	7	US	Public	White	Doctoral
Angelica	Female	Cognate	4	US	Private	Mixed	Doctoral
Bob	Male	Specialization	12	International	Private	Saudi Arabian	Doctoral
Ines	Female	Specialization	5	International	Public	South American	Doctoral
Isabelle	Female	Introductory	1	US	Private	White	Doctoral
Jane	Female	Specialization	6	International	Private	White	Masters
Jessica	Female	Introductory	2	US	Public	African American	Doctoral
John	Male	Specialization	7	International	Public	Asian	Masters
Kimberly	Female	Specialization	10	US	Private	White	Doctoral
Lily	Female	Specialization	12	International	Private	Saudi Arabian	Doctoral
Lini	Female	Specialization	6	International	Private	White	Doctoral
Lisa	Female	Cognate	3	US	Private	Latina	Doctoral
Marie	Female	Specialization	7	US	Private	White	Masters
Megan	Female	Specialization	6	US	HBCU	African American	Doctoral
Michael	Male	Specialization	12	US	Private	Mixed	Doctoral
Mike	Male	Specialization	12	US	Private	White	Doctoral
Noah	Female	Specialization	5	US	HBCU	African American	Doctoral
Nora	Female	Specialization	6	US	Private	White	Masters
Ramsey	Male	Specialization	20	International	Private	Asian	Doctoral
Randolph	Male	Specialization	6	International	Private	White	Doctoral
Rebecca	Female	Cognate	5	US	Private	White	Doctoral
Rose	Female	Specialization	6	US	Public	African American	Doctoral
Sara	Female	Introductory	2	US	Public	African American	Doctoral
Shaga	Male	Cognate	4	US	Private	African American	Doctoral
Simple	Female	Introductory	1	US	Public	Native American	Doctoral
Stephanie	Female	Introductory	3	US	Private	Bi-racial	Doctoral
Susanna	Female	Introductory	2	US	Private	Latina	Doctoral
Tiffany	Female	Introductory	2	US	Public	Asian	Doctoral
Tom	Male	Specialization	2	US	Private	American Latino	Doctoral
Yan	Female	Cognate	3	International	Public	Asian	Doctoral
Zi	Male	Cognate	6	International	Private	Asian	Doctoral

APPENDIX K
Summary of Study Participants Characteristics

Participant Information	n	%
Gender Identity	22	71
Female	9	29
Male		
QM Option		
Introductory	7	23
Cognate	5	16
Specialization	19	61
Nativity		
International	10	32
US	21	68
Institution		
HBCU	2	6
Public	9	29
Private	20	65
Race/ Ethnicity		
African American	6	19
Asian/ Asian American	5	16
Latinx	3	10
Bi-racial/ Mixed	3	10
White/ European	10	32
Native American	1	3
Saudi Arabian	2	7
South American	1	3
Degree		
Masters	4	13
Doctoral	27	87
Enjoyed Undergraduate QMC		
Yes	18	58
No	13	42
Enjoyed Graduate QMC		
Yes	17	55
No	14	45
QM Dissertation		
Yes	20	65
No	11	35
Quantitative Methods Courses Completed		
1- 3	9	29
4- 6	13	42
7- 9	3	10
≥ 10	6	19

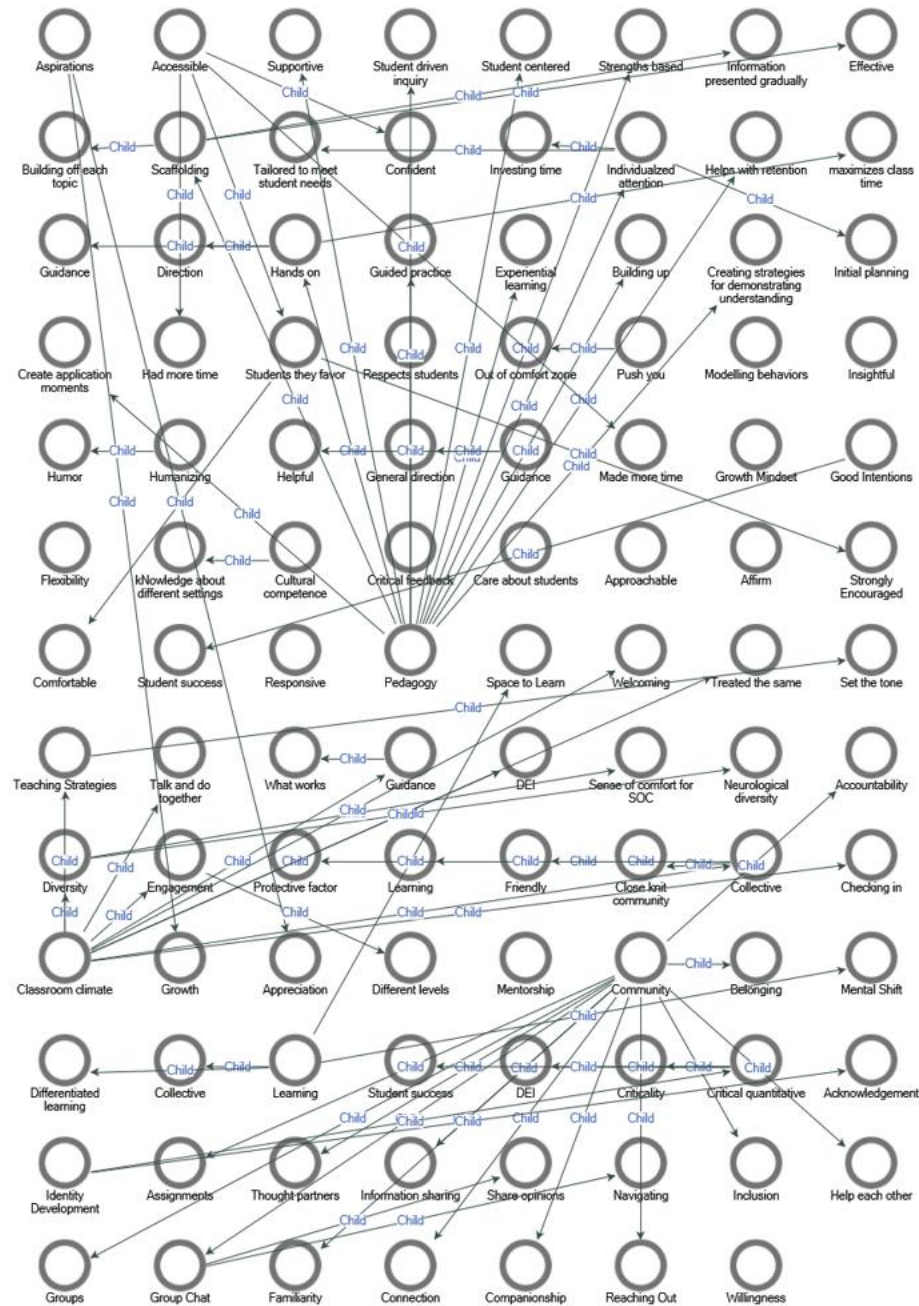
APPENDIX L

First Main Theme: Transactional Pedagogical Modalities Project Map



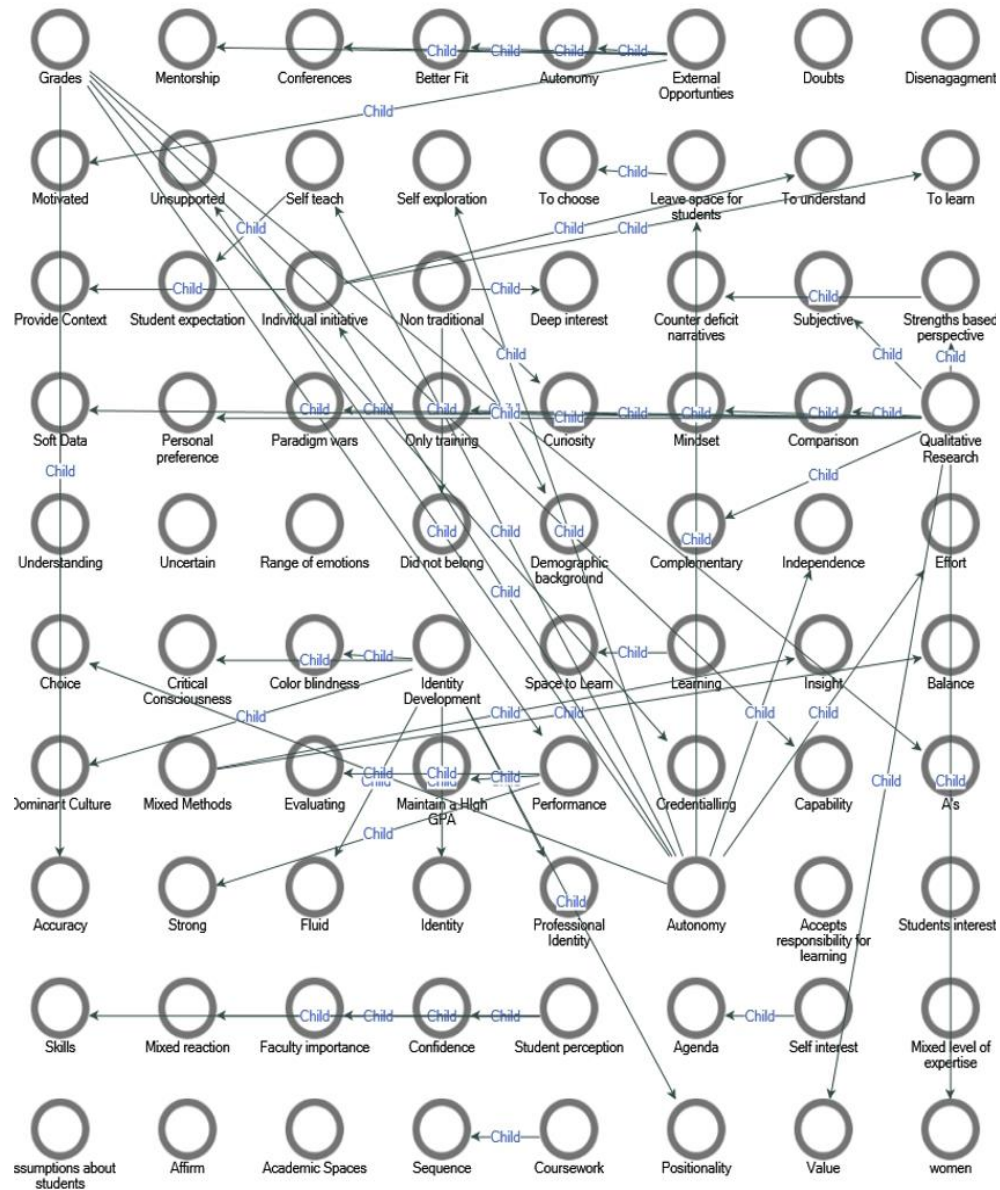
APPENDIX M

Second Main Theme: Transformational Pedagogical Modalities Project Map



APPENDIX N

Third Main Theme: Ontological Understanding Project Map



APPENDIX O

Dedication and Acknowledgements

Dedication

To my everlasting and loving God, Jehovah. Your ways are unsearchable, your goodness towards me is immeasurable. You created me, shape me and sustain me. I will love and honor you for the rest of my days.

Acknowledgements

My Family. To my grandmother and best friend Merle Thomas Guevara, this Dissertation is yours as much as it is mine. You love me unconditionally and always believe in the best of me. To Peter Samuel Phillip, your love, sacrifice and commitment is infused within every page of this work. I could not have completed graduate school without you. Dad I love you, thank you for passing on your legacy of laughter and reading which helped me to persist throughout my journey. Ma I love you. I am indebted to you for your prayers, resilience, and faith. I am grateful for my paternal great grandparents Cornell and Emelia Thomas for the solid foundation. You lived on through my grandmother's stories and gave me the strength I needed on difficult days. For my loving nephew Kyrie and godson Jalen. Thank you to my beautiful and brave sisters, Jamila Anisa Thomas, and Gilisa Akiya Thomas. Special thanks to my cousin Tenesha Bramble for always being there. To my cousins Larry Ince, Marcia McMillian, and Marcus Smith you added so much encouragement to my days. Aunty Alberta, you passed on and another one of your Black diamonds continues to shine. To my Aunt Denise thank you for all you've done to take

care of my grandmother. Thank you, Aunt Pearl and my Uncles Donald, and Lawrence, for your love and unwavering support.

My Dissertation Committee. I could not have completed my Dissertation without the encouragement and support of my advisor Dr. Bruce Uhrmacher. Thank you for sharing your experience and expertise with me throughout my journey. Thanks to my committee members Drs. Antonio Olmos and Lolita Tabron for their support and encouragement. Dr. Franklyn A. Tuitt deserves special mention for being a consistent mentor and advocate throughout my Doctoral journey. Thank you for all you have done to inspire me into becoming a critically conscious, confident, compassionate, and caring research methods scholar.

To my friends, mentors, advocates, well- wishers, and colleagues, thank you for every kind word, or action. It took a village for me to achieve my Ph.D. Steve Joshua, Eugene Gomez, Sharon Sharpe- Gomez, Mrs. Merna Riley des Vignes, Delories ‘Mama Dee’ Alexander, the Sylvan family especially Stephen Sylvan, the Smith family and my Joyley, Keisha Jackman- St. Hilaire, Janet Alexander, Wendy Ann McIntyre, Khadijah Hamilton, Ian Georges, Alvin LaBorde, Dr. Debra Mixon Mitchell, Dr. Christine Nelson, my dear friend Viki Rey Eagle, Dr. Amanda Meise, Dr. Cerise Hunt, Dr. Saran Stewart, Dr. Raquel Wright-Mair, Dr. Meseret Hailu, Kahlea Hunt- Khabir, Patrice Greene, Darlene Milton, Elder Phillip and Jerwonja Ragland, Stacey Mackenzie, Ceema Sammimi, Michael Jeffress, Karen LeVelle, Colin Greene, Rebecca Edmington, Patvaughn Dick, Derwin Glasgow, Anthea Johnson Roonen and Sistah Network, Tracy Adams Johnson,

administrators at the University of the Southern Caribbean, Gina Kellert, Dr. Nicole Latino, Dr. Liliana Rodriguez, Linda Quintenar, Jasmine Pulce, Jeremy Hoffer and Hilary David. To my colleagues and friends in the RMS program, it was amazing being around so many people who shared my love for research methods. This love inspired me throughout my time in our program and it will sustain me throughout my professional career.

To all my participants, current and future graduate quantitative methods students. May all the happiness, hopes and dreams you imagine and re-imagine for your future be fully realised.