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Adult Learners, Learning Disabilities, and Mathematics : A Case Study

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ADULT LEARNERS, LEARNING DISABILITIES, AND MATHEMATICS: A CASE STUDY

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ABSTRACT

ADULT LEARNERS, LEARNING DISABILITIES, AND MATHEMATICS:

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by Marguerite Sheehan Flood

The purpose of this research was to understand how mathematics is taught at a small, liberal arts college that self-advertised as accommodating diverse learners. A qualitative case study was conducted on the mathematics program at Waterview College. Waterview College is unique in that almost half of their students self-identify with a disability, including learning disabilities (LD). The number of students with learning disabilities that attend college is increasing; therefore it is important for mathematics instructors to understand and accommodate diverse learners. The data for this research were collected using one-on-one instructor interviews, classroom observations, and student focus group interviews. The data were analyzed using the constant-comparative method of analysis. The findings indicate that mathematics is taught by instructors who have passion for their students and want them to succeed. The instructors are all part-time employees who devote much of their own time to helping students outside of the classroom structure. The instructors teach their classes so all students have access to mathematics; it isn't necessary for LD students to self-identify with disability services. However, the classroom demeanor and tone of one instructor negatively affected his students. Additionally, students expressed concern about the relevancy of their coursework. They want to learn math that is useful for their future careers and that will help them succeed in their personal and professional lives. Mathematics Learning

Disabilities and adults with LD are areas in need of more research. Mathematics faculty teaching at post-secondary institutions should be familiar with the characteristics of LD and consider accommodations that ensure all learners succeed.

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I am grateful to my committee for all their encouragement, insight and guidance. I doubt Dr. Mika Munakata recalls the first conversation I ever had with her. It was the summer of 2010. I left a her voice mail message inquiring about the Mathematics Ed.D. Program. She returned my phone call on her way to the airport. The fear and apprehension I was feeling must have traveled across the phone line. She encouraged me to take a course, to go ahead and give it a try. The words were just what I needed to hear, especially after being out of graduate school for over 20 years. I'm thankful for your encouragement Dr. Munakata. I want to acknowledge another phone conversation, one with Dr. Helen Roberts. Over two decades ago, when I was a young mother with five little ones, I called her and expressed my desire to teach math part time at a community college. Dr. Roberts said no problem and put in a good word at the local community college. Thank you Dr. Roberts for getting me started.

I've taken five courses with Dr. Eileen Fernandez. Her example in the classroom has made me a better educator. She has patience, kindness, and understanding. She listens. She is a teacher's role model. Dr Fernandez, I thank you for showing me how to teach. Dr. Kathryn Herr quietly inspires and pushes people to achieve their best. She is calm and reassuring. Dr. Herr also knows that students have many roles, and appreciates that "studenting" is only one of them. I am glad I know you. Thank you Dr. Herr.

The faculty and staff at Waterview College were extremely accommodating and helpful while I was conducting my research. I am grateful to KB, KH, and JL along with

the Academic Dean. I learned so much from Waterview's students. I admire their openness and willingness to share.

I'm fortunate that my mom, Margie, age 90+, is interested in my work. She wasn't given the opportunity nor was she encouraged to attend college. She would have been an excellent student. Meg, Patrick, Matthew, Eileen, and Elizabeth are my children. They all have been curious about my work, or at least they were good at pretending to be. Matthew S. is my son-in-law who recently became a special education teacher. It's a perfect fit for him and his students are lucky. My good friend Gerrianne D. deserves much more than an acknowledgement. She picked up my youngest daughter, Elizabeth, after school several times per week in the beginning of my doctoral program. Gerrianne always says yes, I can do that for you.

The final acknowledgement is for my husband, Jim F. He works so hard to make each member of our family successful in the ways they've chosen. He is my hero.

Dedication

Happiness is beneficial for the body, but it is grief that develops the powers of the mind.

Marcel Proust

My dissertation is dedicated to three young men, full of promise, who were denied a long, complete life. Each of their lives was taken by someone who did not consider the consequences their actions would have. Our brother, Thomas Flood, was killed by a drunk driver in September 1985. He was 27 years old and had recently gotten engaged. His fiancée was permanently disabled in the same accident. Thomas was a computer whiz kid, artistically talented, and had just begun a new job. His star was rising. Our nephew, Thomas Rouleau, was killed by a DUI in February 2009. He was a 19 year old college sophomore. Thomas never failed to make us laugh and brought joy to all who knew him. He had recently fallen deeply in love with a classmate. His adult life had just begun. Our friend, Brandon Sega, age 25, was killed by a reckless driver on New Year's Eve 2015. Brandon was an athlete, artist, and a loyal friend to my son-in-law. He had purchased his first house, close to his parents and many friends. He was a beautiful young man, inside and out.

The promising futures were not to be for any of these young men. They were all smart, artistic, and fun. I desperately wish they could have lived to pursue their dreams. I thank them for helping me fulfill one of mine. Peace to you, Thomas, Thomas, and Brandon.

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Chapter I

Introduction

One afternoon I was sitting in the adjunct office at the local community college where I had been teaching for many years. The office was where part-time instructors compared notes regarding what was happening at the college and traded stories about classes and experiences. One seasoned mathematics instructor, Jeb, came into the office filled with complaints about his students and one complaint in particular stood out to me. He said a student in his class was counting on his fingers. Jeb's felt that a student who counted on his fingers did not belong in college. This type of comment was not unusual to hear from other math faculty at the college. I would hear math instructors disparage students who didn't have multiplication facts memorized or who arrived at college unable to do long division. I resented these comments because they were coming from instructors who were good at math, and were about students who had difficulty with math. An instructors' job is to help students, particularly those who find the subject difficult or who may learn differently. I found the comments offensive but I was not brave enough or knowledgeable enough to respond.

If I encountered those comments today, I would counter them with research. Specifically, I would mention research on Mathematics Learning Disabilities (MLD). Although research of MLD is scant, especially when compared to research on reading disabilities, the faculty member's comments could be addressed by Geary (2003). He identified subtypes of MLD and one is the procedural subtype which includes frequent use of immature procedures such as finger counting. Procedural subtype LD learners

commonly rely on finger counting much longer than students without this disability. Another subtype of MLD is semantic memory which includes difficulties in retrieving mathematical facts like multiplication facts. The math students who were disparaged most likely had some type of MLD. The mathematics instructors were unwittingly commenting on students with disabilities. In retrospect, I find it ironic that the math faculty at a college which is the destination of many students with LD is not aware of MLD.

I have an adult daughter with disabilities, including learning disabilities. She recently graduated from college. Her alma mater is Waterview College (pseudonym), a small, private, liberal arts college located in the northeastern United States. Approximately 40% of Waterview's students identify with some type of disability, including learning disabilities. My community college experience with respect to mathematics motivated me to look at Waterview's mathematics program, especially since my daughter had taken and passed their required mathematics course. Specifically, I wanted to learn about Waterview's mathematics instructors and their backgrounds, and if they received any special training on recognizing and accommodating students with LD. Additionally, I wanted to talk to Waterview's math students to learn about their experiences.

The college environment is very different from the secondary school environment for the student with LD. There is less formal support and students are expected to effectively manage their time. These increased expectations can be challenging for all learners but the adult with LD has additional challenges, including self-advocacy. If they

want accommodations, they need to identify themselves as disabled to the appropriate college personnel. This process requires current documentation of the disability accommodation approval, and most importantly, faculty understanding of LD and accommodations. As the opening anecdote suggests, the mathematics faculty where I was teaching did not appear to possess that understanding.

I am fortunate to have been involved in the LD community for over twenty years as both a parent and an educator. My parent role has provided me with heightened awareness of the needs of adults with LD. The educator role has made me aware of the lack of understanding with respect to LD. Both of those roles led me to take on a third role, as a student-researcher investigating how mathematics is taught at a college that self-describes as accommodating diverse learners.

Research Questions

The purpose of this research was to gain insight into Waterview College's mathematics program. The research questions that guided the study are:

1) How is mathematics taught at a small, private liberal arts college that self-identifies as accommodating to diverse learners and

2) How do students describe their own experiences of learning mathematics at this college?

The "how" questions led me to decide a case study was the appropriate methodology. The data I collected were from mathematics professor interviews, classroom observations, and student focus groups. The study was conducted during the spring semester of 2016. The data were analyzed using the constant comparative method of

analysis. Categories and themes were identified and data were assigned to them. Although Waterview's mathematics program is small, a large amount of data were collected and analyzed. This document is intended to provide the reader with a robust description of the mathematics program at Waterview College.

The literature indicates there is a need for more research of learning disabilities, in particular MLD. Research on adults with LD is minimal. Learning disabilities are life-long; there is no cure. Educators at all levels need to familiarize themselves with LD so that fair and equal educational opportunities are provided to all. Eliphas Levi (1810-1875) said, "A good teacher must be able to put himself in the place of those who find learning hard." Math educators need to spend time in the space of the adult with LD to eliminate thinking like "those people don't belong in college."

Chapter II

Literature Review

Dewey's view that it is the responsibility of a democracy to protect and promote the full potential of all individuals is a weighty belief and heavy responsibility, especially in the highly competitive post- secondary environment. The full potential of individuals should include an opportunity to receive a good education, including college. The college process, particularly finding the right college, is cumbersome for all students but can be even more challenging for students with learning disabilities. Numerous colleges self-advertise as providing support for LD students but often times the support is minimal and is not embedded in courses. This dissertation describes a case study on a private four year institution that self- advertises as inclusive and accessible to all learners. The college's mathematics instruction is the focus of the case study.

The literature review is a synthesis of various topics related to the adult learner with LD. A general review of learning disabilities, particularly related to definitions, is provided. Legislation affecting people with disabilities is reviewed along with current data from the United States Department of Education. Literature on mathematics LD is reviewed along with characteristics and concerns of adults with LD. Because the case study was conducted at an institution offering both associate and bachelor degrees, literature on college students and college faculty, including both two and four year colleges, is presented.

The adult learner has at least one important advantage over a child and that is years, or sometimes decades, of experience. Those experiences, however, can either be

positive or negative. Those of us in the mathematics classroom environment often hear students comment that "Math is my worst subject" or "I have never been good at math" or "I'll never get this stuff". Comments like these are not unique to the times; they have been heard by math teachers for decades. A bit of digging reveals the root of the problem, quite often, to be a negative mathematical experience at some time during their academic career. These experiences can affect a person's self-confidence and self-esteem. An adult with a learning disability may never recover (Gerber, Ginsberg & Reiff, 1997). Mathematics educators have a responsibility to educate; not to humiliate, not to embarrass nor to decrease the self-confidence of a student. This is particularly true of learners with LD. Learning disabilities, unlike most physical disabilities, are not visible. The invisibility of LD and a lack of knowledge about learning disabilities may influence educators' behavior. It is the hope that knowledge about LD will provide educators with enlightenment and understanding, and will create empathetic educators concerned with the plight of adults with learning disabilities. As Reiff and Shessel (1999) state, "As professionals, we cannot do our jobs well until we understand the full magnitude of how learning disabilities affect people's lives" (p. 314).

Please note that the terminology learning disabilities, learning differences, specific learning disabilities and learning disorders were used interchangeably in the literature and thus are used interchangeably herein.

Learning Disabilities: General Definitions.

This section will review the myriad of learning disability definitions. The definition of learning disability is important because the individual's diagnosis and legal

rights depend upon it. Learning disability definitions are perplexing, confusing, varying, and also have a general lack of understanding by the public. The lack of understanding is not surprising as there are legal, educational, medical, and organizational definitions of LD. The term LD was first coined by Samuel A. Kirk (1962). Much of Kirk's nomenclature would be considered offensive today; however the descriptive term, learning disability, is still in use. LD was an emerging field in the 1960s and only concerned with children; therefore, most definitions refer to children. The most common, operational definition of learning disability in use is the discrepancy model. The discrepancy definition was first proposed by Bateman (1964):

> The first diagnostic step is a comparison of the expected level of functioning with the actual performance of the child. In almost all areas of possible disability, e.g., speech, reading, motor coordination, etc., our estimate of the expected level of functioning is based on some normative combination of mental age, chronological age, and certain experimental factors. Both standardized and informal tests are used in the assessment of the actual level of performance. When a significant discrepancy is found between expected and actual performance, a disability exists (p. 171).

Prior to the use of LD as a classification or diagnosis, clinicians often described children with LD as retarded, brain injured, emotionally disturbed, or other diagnosis that did not capture the discrepancy between ability and performance (Bateman, 1964). The discrepancy approach is further explained by Colker (2011):

> Using the discrepancy approach, one would assess a child's aptitude, typically through an IQ test. Then, one would administer various achievements tests. Normally, one would expect the child's achievement to be consistent with the child's IQ. Hence, if a child scored in the 50th percentile for IQ--a score of 100--then one would expect the child's achievement to be around the 50th percentile. If the child's achievement is significantly below what is expected, and that result cannot be explained by other factors, then, under the discrepancy model, the child would be considered to be "learning disabled" (p. 86).

The National Advisory Committee on Handicapped Children (NACHC) (Kirk, 1968) added the word "specific" to the Bateman definition in 1968 to emphasize that LD encompasses a discrete number of differences opposed to a general neurological impairment (Colker, 2011). The National Joint Committee on Learning Disabilities (NJCLD) adopted the following definition in 1990:

> Learning disabilities is a general term that refers to a heterogeneous group of disorders manifested by significant difficulties in the acquisition and use of listening, speaking, reading, writing, reasoning, or mathematical abilities. These disorders are intrinsic to the individual, presumed to be due to a central nervous system dysfunction, and may occur across the life span. Problems in self-regulatory behaviors, social perception, and social interaction may exist with learning disabilities but do not by themselves constitute a learning disability. Although learning disabilities may occur concomitantly with other handicapping conditions (for example, sensory impairment, mental retardation, serious

> emotional disturbance), or with extrinsic influences (such a cultural differences, insufficient or inappropriate instruction), they are not the result of those conditions or influences. (p. 18-20)

The National Center for Learning Disabilities (NCLD) defines LD as affecting "the brain's ability to receive, process, store, respond to and communicate information. LDs are actually a group of disorders, not a single disorder" (NCLD, 2014). According to NCLD:

> Learning disabilities are not the same as intellectual disabilities (formally known as mental retardations), sensory impairments (vision or hearing) or autism spectrum disorders. People with LD are average or above average intelligence, but still struggle to acquire skills that impact their performance in school, at home, in the community and in the workplace. Learning disabilities are lifelong, and the sooner they are recognized and identified the sooner steps can be taken to circumvent or overcome the challenges they present (NCLD, 2014).

NCLD (2014) lists four categories of learning disabilities and accompanying areas of difficulty: 1) dyslexia or processing language 2) dyscalculia or math skills 3) dysgraphia or written expression and 4) dysproxia or fine motor skills. Related processing disorders are auditory processing disorder and visual processing disorder. Learning disabilities do not include Attention Deficit Hyperactivity Disorder (ADHD) or Attention Deficit Disorder (ADD) although they may be comorbid diagnoses.

Kavale, Spaulding and Beam (2009) claim that, technically, Specific Learning Disability (SLD) has not been redefined over the past forty years but has been re-

operationalized. They also claim that the most widely used definition of SLD is from the Individuals with Disabilities Education Act (IDEA) (2004) which states, "The term 'specific learning disability' means a disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, which disorder may manifest itself in an imperfect ability to listen, think, speak, write, spell, or do mathematical calculations" (p.40). This definition is somewhat puzzling in that "imperfect" ability implies a "perfect" ability to listen, think, speak, write, spell, and do mathematical calculations. Kavale, Spaulding and Beam (2009) believe the definition of SLD is nebulous and that it is in need of refinement. They proposed an updated definition describing SLD as "heterogeneous clusters of disorders that impede the normal progress of academic achievement" (p. 45). The lack of progress is not due to a lack of instruction nor interpersonal, cultural or sociolinguistic experiences. Kavale, Spauling and Beam (2009) provide specifics with respect to the discrepancy approach. Their definition encompasses persons with an average or above average Intelligent Quotient (IQ) of greater than 90; however, the performance profile of those persons with LD would not be commensurate with their IQ. They argue they have written an operational definition of SLD that clinicians, educators, and parents can utilize.

The American Psychiatric Association (APA) has its own definition as found in The Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (2013). The DSM-5 is used by mental health professionals to determine diagnoses. It lists a four part diagnostic criteria for SLD. Part A details difficulties in learning and using academic skills, which have persisted over six months despite targeting

interventions. Part B is essentially the discrepancy approach stating that the "affected academic skills are substantially and quantifiably below those expected for the individual's chronological age. For individuals age 17 years and older, a documented history of impairing learning difficulties may be substituted for the standardized assessment" (p.67). Part C states the difficulties "begin during the school-age years but may not become fully manifest until the demands for those affected academic skills exceed the individual's limited capacities" (p.67). Finally Part D essentially states there are no other reasons, such as intellectual disabilities, etc., for the difficulties. The DSM-5 (2013) states the prevalence of specific learning disorders in reading, writing and mathematics to be 5%-15% among school age children. The prevalence among adults is unknown according to the DSM-5 (2013) but it goes on to state that "it appears to be approximately 4%" (p.70). No explanation is given in the DSM-5 (2013) for the decrease in learning disorders since "specific learning disorders typically persist(s) into adulthood" (DSM-5, 2013, p.70).

Another approach to diagnose SLD was offered in amendments to IDEA in 2004. (IDEA was reauthorized in 2004 and is cited as the Individuals with Disabilities Education Improvement Act of 2004). The alternative to the discrepancy approach is called Response to Intervention or RTI. According to Fuchs and Fuchs (2006), in the RTI method, a subgroup of students are identified, monitored, assessed, and given an academic intervention if necessary. RTI is an outcomes-oriented approach in which the learner's response to instruction is paramount (Swanson, Graham & Harris, 2003). Students are given a diagnosis of LD only if intensive instruction has failed. The RTI

approach was included in the IDEA amendments for various reasons including legal, economic and political. According to Colker (2011), Congress amended the IDEA to provide a new rule for diagnosis but not modify the definition of a learning disability.

The language and definitions of learning disabilities is varied and confusing. One might question why the label learning disability exists. Colker's writing (2011) is appropriately named "The Learning Disability Mess". Her summary argues that all students should have access to supportive resources such as extra time on tests without having a label "learning disabled". Additional testing time should not have to be justified by test takers; test designers should justify why the test needs to be given under timed conditions.

Mathematics Learning Disabilities and Incidence

The majority of learning disability research deals with reading difficulties; Math LD research is not plentiful (Geary, 2004; Ginsburg, 1997; Montis, 2000). Most mathematics LD research is concerned with children which is true of LD research in general. The following section reviews various definitions, symptoms and incidences of Mathematics LD (MLD).

As with the SLD definition, controversy also surrounds the MLD definition. Gable and Watson (2012) state that there is a lack of unanimity regarding a precise definition of mathematics learning disorder. Bryant, Bryant and Hamill (2000) identified characteristics that students with math weaknesses displayed. The top characteristic was word problem difficulty followed by multi-step problem solving. The third characteristic is difficulty with the language of math which includes symbols and vocabulary.

According to Geary (2004), 5-8% of school age children have some type of mathematics LD with the discrepancy approach the most common diagnostic method.

The DSM-5 (2013) lists the following two mathematics-related symptoms in their diagnostic criteria of SLD:

> Difficulties mastering number sense, number facts, or calculations (e.g., has poor understanding of numbers, their magnitude, and relationships; counts on fingers to add single-digit numbers instead of recalling the math facts as peers do; gets lost in the midst of arithmetic computation and may switch procedures).
>
> Difficulties with mathematical reasoning (e.g., has severe difficulty applying mathematical concepts, facts, or procedures to solve quantitative problems) (p. 66).

Geary (2003) lists three general subtypes of mathematical learning disability: procedural, semantic memory, and visual spatial. The procedural subtype includes frequent use of immature procedures and frequent errors in the execution of procedures, poor understanding of the concepts underlying procedural use, and difficulties sequencing the multiple steps in complex procedures. Procedural subtype LD learners commonly rely on finger counting much longer than students without this disability (Geary, 2003). Included in semantic memory subtype are difficulties in retrieving mathematical facts, and a high error rate in the retrieved facts. The semantic subtype also has difficulty discerning relevant versus irrelevant information (Geary, 2003). The visual spatial subtype is characterized by difficulties spatially representing and understanding

numerical and other forms of mathematical data. Visual spatial LD learners misinterpret and misunderstand spatially represented information as found in certain areas of geometry and complex word problems (Geary, 2003).

Working memory is an important part of the mathematics LD discussion. Working memory is defined by Berch (2011) as a "limited capacity system responsible for temporarily storing, maintaining, and mentally manipulating information over brief time periods to serve other ongoing cognitive activities and operations" (p.22). Similarly, Abedi, Aghababaei and Malekpour (2013) describe working memory as the "ability to store information and process the information at the same time" (p. 35). Swanson and Wilson (2001) found that deficits in mathematics are mediated by both a domain-general and domain-specific working memory system. Domain general working memory system refers to either verbal and visual-spatial working memory, or executive systems (Swanson & Wilson, 2001). Domain-specific refers to either only verbal or only visual-spatial working memory. Swanson and Wilson (2001) found that both verbal and visual-spatial working memory scores predicted mathematics performance. The same study considered whether the relationship between mathematics disabilities and working memory deficits weakens with age. They found that the relationship was stable across a broad span of ages. Osmon, Smerz, Braun and Plambeck (2006) found that both spatial and executive function abilities and deficits relate to math achievement in adults. A study by Wilson, Andrewes, Struthers, Rowe, Bogdanovic and Waldie (2015) showed that difficulties with numerical tasks continued into adulthood. According to their study, "Adult dyscalculia remains a serious impediment to those affected" (p.128).

A population-based, retrospective birth cohort study by Barbaresi, Katusic, Colligan, Weaver and Jacobsen (2005) determined that the incidence rate of MLD by age 19 varied from almost 6% to almost 14%. The range of incidence rates is due to three different LD definitions used in the study: two discrepancy based formulas and one low-achievement formula. The discrepancy model provided the lower limit (5.9%) and the larger percentage resulted from the low-achievement definition (13.9%). Males were more likely to be affected than females. This study found that many children with MLD did not have a comorbid reading disorder. A case study by Montis (2000), however, determined that the learning of mathematics cannot be separated from language learning. According to Gable and Watson (2012), mathematics learning disorders "rarely occur in isolation" (p. 182). The differences in incidence rate of mathematics learning disorder across studies may be due to the lack of an instrument to assess MLD and the lack of a discrepancy test score cutoff criterion (Judge & Watson, 2011).

Legislation

There are three major pieces of legislation that protect people with disabilities, including learning disabilities: The Individuals with Disabilities Education Act (IDEA)(2004); Section 504 of the Vocational Rehabilitation Act of 1973; and Title II of the Americans with Disabilities Act (ADA) of 1990. (Please note the ADA was amended in 2008 and is legally referred to as the Americans with Disabilities Act of 1990, as Amended). IDEA is legislation that requires a free appropriate public education (FAPE) must be made available to any child with a disability. IDEA coverage ends at age 21 or at the completions of secondary school, but not necessarily in that order. Adults' legal

protection is provided by either Section 504 or the ADA (Swanson, Harris & Graham, 2003). The Office for Civil Rights in the U.S. Department of Education enforces both Section 504 and Title II of the ADA.

The ADA definition of disability is somewhat vague in that it considers a disability to be a physical or mental impairment that substantially limits one or more major life activities including seeing, hearing, learning, etc. A post-secondary student with a learning disability is not only protected by the ADA, but is also provided accommodations through Section 504. Both laws mandate that post-secondary institutions provide equal access to programs and services for students with learning disabilities. According to the U.S. Department of Education Office for Civil Rights (2011), post-secondary schools are required to provide appropriate academic adjustments "as necessary to ensure that it does not discriminate on the basis of disability" (p.2). Appropriate modifications include priority registration, course load reduction, course substitution, note takers, recording devices, sign language interpreters, extended time for testing, etc.

Institutions set the standards for the documentation of learning disabilities and post-secondary institutions are required to have a disability services coordinator. Post-secondary students are required to gather and pay for the required recent documentation whereas at the elementary and secondary level it is the responsibility of the school district to evaluate an identified student. The documentation required is often in the form of a neuropsychological evaluation which may cost thousands of dollars. Additionally, the responsibility for advocacy falls entirely on the post-secondary student. The student must

self-identify, provide the proper documentation of the LD, work with the institution on the appropriate accommodations, and inform instructors of their accommodations.

Adults with Learning Disabilities

Adults with LD are not children with LD who inhibit larger, older bodies (Rich & Shapiro, 1999). However, their thoughts and feelings regarding their disability may have its genesis in childhood. Gerber, Ginsberg and Reiff (1997) conducted a qualitative study on adults with LD which examined the ways they became successful in their lives. Success was defined by five criteria: income level, education level, prominence in one's field, job satisfaction, and job classification (Gerber, Ginsberg & Reiff, 1997). Their sample included 46 highly successful and 25 moderately successful adults with learning disabilities. The subjects' overwhelming memories of school included feelings of fear, terror and frustration (Gerber, Ginsberg & Reiff, 1997). Many of their negative experiences in school had a positive effect on them in that it pushed them to succeed. According to Gerber, Ginsberg and Reiff (1993), the factor underlying the success of the adults with LD was the desire to gain control of their lives. The adults did not feel they had control during their school years and felt that they were not meeting expectations. They wanted the ability to make decisions and take charge of their own life. However, these adults with LD were able to make adaptations in order to succeed (Gerber, Ginsberg & Reiff, 1993). A key component in the adult experience was the "reframing" or reinterpretation of their disability (Gerber, Ginsberg & Reiff, 1993, p. 4). The adults transformed their focus from learning disability to "their abilities to confront and

overcome challenges imposed by their learning style"(p. 4). Negative thinking was transformed into positive thinking about their abilities.

The qualitative research of Reiff and Shessel (1999) found both positive and negative impacts of having a learning disability in adulthood. They conducted ethnographic interviews with 14 adults with learning disabilities. Some of the negative impacts included frustration from poor word retrieval and reading comprehension. Several study participants felt they were creating a false impression and had fears of their disability being exposed. Social isolation and feelings of depression were also two negative impacts mentioned in the study. Positive impacts include the desire to help others, an ability to be creative and resourceful, and increased sensitivity to others, and making themselves better professionals. Hall, Spruill and Webster's (2002) quantitative study found that college students with LD scored significantly higher on both resiliency scores and on a need for achievement scale than college students without LD. College students with LD also self-reported significantly fewer stress triggers than college students without LD.

Adults with LD define LD most often with themes of processing difficulties, specific functional limitations, underachievement, and differences (Gerber, Ginsberg & Reiff, 1993). The subjects in Gerber, Ginsberg and Reiff's (1993) qualitative study described their processing problems as "breakdowns in processing" and "not mental retardation, higher IQ, processing problem, you work hard and you fail" (p. 118). Specific functional limitations, or the inability to function in certain situations, were felt by some (23%) of the participants. The majority of the functional themes dealt with

academic subjects like math and reading. Although the adults in study were successful, they felt their learning disability held them back or that they were "smarter than can illustrate to others" (p. 121). Many of the subjects preferred the term learning difference over learning disability.

The adults' definitions of LD in Gerber, Ginsberg and Reiff (1993) reveal that they had difficulty describing what is happening in their brain. This should not be surprising since professionals have difficulty coming to a consensus regarding the definition of learning disability. Additionally, the adults thought of their disability in terms of a discrepancy with statements such as, "Prevents one from developing one's potential" and "A difficulty, sometimes an inability to achieve at one's potential" (p. 121). It should be noted that several of the adults felt their difficulties were from poor teaching, not a disability (p. 122).

Dirkx (2008) discusses the role of emotions in adult learning. Although his writing is not specific to adults with LD, it does highlight the need to consider how curricular content can awaken powerful emotions. The LD learner may have emotional baggage in many subjects and past experiences and feelings need to be addressed by instructors at the college level. Math anxiety is a well-known fear that students bring to the classroom. The mathematics classroom can resurrect feelings of inadequacy. It is important for college faculty to understand the feelings of the adult learner with learning disabilities. The following sections will discuss the experiences and feelings of college students with LD and the perceptions that faculty have of LD students.

College Students with Learning Disabilities

Students with learning disabilities are attending college in increasing numbers (Sweener, Kundert, May & Quinn, 2002; Orr & Hammig, 2009). The National Center for Education Statistics (NCES) (Raue & Lewis, 2011) reported on students with disabilities at Title IV eligible 2-year and 4-year degree-granting post-secondary institutions. The data include both public and private colleges and universities. The data are from the 2008-09 academic year and they include 707,000 students who had identified themselves to the institution as having a disability (Raue & Lewis, 2011). In this study, a disability was defined as "a physical or mental condition that causes functional limitations that substantially limit one or more major life activities" (p. 1). Half of the 707,000 students with disabilities were reported to be in two-year public institutions. About one-third of the reported disabilities were specific learning disabilities. It is important to note that the above figures only include students who have self-identified to the appropriate personnel at the institution. It does not include those who have not self-identified, nor does it include adults who have been discouraged from attending college due to their disability. This data lead to the conclusion that 707,000 students with disabilities at 2-and 4-year public and private colleges is a low figure since not all students are self-identifying when they arrive at college. LD students don't self-identify for a variety of reasons including embarrassment and the desire to attempt college without accommodations (F.Apfel, personal communication, April 8, 2015). They may not be aware of the process of self-identification or they may not want to be labeled as disabled due to concerns about social stigma (Kurth & Mellard, 2006).

A post-secondary education is critical for success in the 21st century. Adults with disabilities deserve the same college opportunities as their non-disabled peers. To better understand the post-secondary experiences of students with disabilities, The National Center for Special Education Research, U.S. Department of Education funded the National Longitudinal Transition Study-2 (NLTS2). The Post-High School Outcomes of Youth with Disabilities up to 4 Years after High School (Newman, Wagner, Cameto & Knokey, 2009) found that fifty-five percent of post-secondary students who were identified with a disability in high school did not consider themselves disabled when they arrived at a college or university. This data also lead to the conclusion that there are more than 707,000 students with disabilities at public and private colleges in the United States.

The responsibility for identifying as a student with LD was previously discussed in this paper. Self-identification is the first step for the LD student, whether at a 2-year or 4-year college, followed by the provision of the acceptable documentation of the learning disability. Step two is a letter from the college's disability services coordinator that the student delivers to the instructor(s). Accommodations are not always provided; the disability services coordinator reviews the documentation and determines if the student can meet the program requirements in spite of the handicap or disability. Most colleges use the assessment guide issued by the Association for Higher Education and Disability (AHEAD) to determine if a student has a learning disability (Denhart, 2008). Reasonable accommodations include "auxiliary aids, alternative evaluation methods, and modifications to the policies and procedures (including instructional delivery and program requirements) that serve to lessen or ameliorate the impact of a disability on

eligibility decisions, performance, evaluation, or the ability to benefit from courses, programs, and services" (Lissner,1997, p. 16). If the request is approved a letter detailing the accommodations is provided to the student. The most common accommodation is extra time on tests and exams (Raue & Lewis, 2011; Kurth & Mellard, 2006; Dean, Osborne, Weis, 2014).

Although the letter of the law is followed by post-secondary institutions, the accommodations may not meet the students' needs. The LD population is not homogeneous yet blanket accommodations, such as extra time on tests, are generally what is offered. Blanket accommodations, according to Brinckerhoff, McGuire and Shaw (1992), do little to "build upon a student's strengths or compensate for specific weaknesses" (p. 418). According to Kurth and Mellard (2006), post-secondary accommodations focus on a student's disability instead of their ability. Kurth and Mellard (2006) conducted a mixed methods study to determine student's perceptions of the accommodation process in post-secondary education. They found accommodations effective 75% of the time which conversely indicates ineffective accommodations in a quarter of the cases. Furthermore, students may find accommodations detrimental. One student in their study, whose accommodation was a separate test location, found the experience isolating. Dean, Osborne and Weis (2014) found that clinician's recommended accommodations did not match students' needs nor were they supported by the assessment process for learning disabilities. McLeary-Jones (2008) reported that some students at community colleges had difficulties with obtaining accommodations. There was a lack of understanding by some professors along with an unwillingness to

give extra test-taking time or to provide separate, quiet test-taking location (McLeary-Jones, 2008; Graham-Smith & Lafayette, 2004).

College students with LD have many positive characteristics, including good self-awareness. They are resilient, goal oriented and report fewer college stressors than non-LD students (Hall, Spruill & Webster, 2002). Students do not feel their learning disability is a barrier to learning, however, they have difficulty in describing their disability (Hake, Hinz, Hitchings, Johnson, Luzzo, & Retish, 2010). Community college students with LD have a desire to succeed and accomplish goals and have a sense of personal accountability (McCleary-Jones, 2008). Their desire to succeed and persistence does not translate into retention and graduation however (Koch & Mamiseishvili, 2012). Nearly 25% of students with disabilities in 2-year colleges did not continue beyond their first year and nearly half did not return by the end of their third year. Koch & Mamiseishvili (2012) included students with all disabilities and LD students comprised approximately 8% of their sample.

Mathematics LD in College

There is a scarcity of research specific to college level students with MLD (Sullivan, 2005). The research findings that do exist with respect to college students with MLD tend to be similar to research finding on Math LD students at the elementary and secondary level (Holliday, Knoop & McGlaughlin, 2005). For example, significant weaknesses were found in reading comprehension, reasoning, working memory, and math fluency.

Sullivan's (2005) qualitative study with college students having MLD reported on factors that the students felt promoted success in the math classroom. Her study emphasized the importance of classroom instruction and teacher-student mutual respect. The three students in Sullivan's (2005) has a history of repeated attempts to pass their college mathematics class. A "student-centered, sense-making classroom" where the mathematics instructor respected the students' learning style contributed to success.

Although traditional accommodations, such as extended time are designed to support LD learners, quite often more than traditional accommodations are necessary for students to succeed. .According to Holliday, Knoop and McGlaughlin (2005), "they (accommodations) do little to address the wider variety of differing abilities of students who do not have documented disabilities but experience significant difficulty when performing math tasks" (p. 229). The following section will address faculty attitudes.

College Faculty

College students with LD feel misunderstood by faculty (Baker, Boland & Nowik, 2012; Denhart, 2008). Denhart (2008) found that students with LD sensed faculty misunderstanding of their learning difference, considered them lazy, and considered their accommodations cheating. There are several studies, however, that measure faculty attitudes about disabilities and their willingness to accommodate students with disabilities (Black, Brodwin & Weinberg, 2014; Bourke, Silver & Strehorn, 2000; Vogel, Leyser, Wyland & Brulle, 1999). Vogel, Leyser, Wyland and Brulle (1999) found that faculty was positive about willingness to provide both teaching accommodations and exam accommodations provided the accommodations were not too time consuming.

Faculty beliefs regarding the efficacy of accommodations impact their willingness to provide accommodations (Bourke, Silver & Strehorn, 2000). A study done at a community college in 1999 by Sweener, Kundert, May and Quinn (2002) found wide variability of faculty comfort level with providing accommodations. Again, the level of comfort varied according to the time required of the faculty to make the accommodation. Black, Weinberg and Brodwin (2014) found faculty were willing to provide accommodations and had positive attitudes towards students with disabilities. The study also found that some faculty felt that all students could benefit from a variety of teaching methods. However, Black, Weinberg and Brodwin (2014) found that some faculty made incorrect assumptions regarding accommodations such as the proctoring of exams taken outside the classroom. One faculty member in the study thought it provided an opportunity for an LD student to cheat, unaware that the student was proctored during the exam.

Disability focused training improves faculty attitudes and perception of students with LD (Murray, Lombardi, Wren & Keys, 2009; Murray, Wren & Keys, 2008). Workshops provided faculty with the most comprehensive understanding and positive perceptions of LD students but a wide range of training opportunities were found to be helpful (Lombardi, Murray & Dallas, 2013). One possible means for improving faculty understanding is the introduction of Universal Design for Learning (UDL) or Universal Design for Instruction (UDI) or as referred to by Bourke, Silver and Strehorn (1998), Universal Instruction Design (UID). The acronym UDL will be used herein. UDL is based upon the principle of inclusivity for a broad range of learners (Black, Brodwin &

Weinberg, 2014). Our physical world is rapidly becoming more accessible because of laws designed to help the physically handicapped; the same approach for accessibility can be applied to learning. Post-secondary institutions are increasingly diverse. Kell, Krangund and Young (2014) summarized the urgency and necessity for increased student access: "It is incumbent upon those in educational settings to recognize disabilities and to provide an optimal environment to maximize student engagement" (p.8).

Theoretical Framework

Several theories have provided the motivation for conducting the research and therefore inform this study: adult learning theory, socio-cultural theory, transformative theory, and social justice vis à vis Paulo Freire.

Adult learning theory. It is essential that adult learning theory be understood by college faculty. Although it is not always apparent, students attending college are adults and their learning needs differ from the kindergarten through twelfth grade learner. Learning is a lifelong process and the art and science of helping adults learn is called andragogy. Knowles (1970), one of the architects of andragogy, proposed four assumptions regarding adult learning. They are: 1) Maturity drives a person from dependent to self-directed; 2) Experience is a vast learning resource; 3) Adult learning readiness is related to the developmental tasks of his/her social role; and 4) Adults are more problem centered than subject centered because of their mature perspective. For example, adults are more interested in useful mathematics rather than a required Algebra II course. Two additional assumptions were added by Knowles in 1984 (Merriam &

Bierema, 2014). They are: Adults are driven by internal motivation and need to understand why they are learning something.

According to Merriam and Bierma (2014), increased attention to adult learning began in the 1960s. Andragogy provides assumptions about adult learners which educators of adults should employ. Self-directed learning (SDL) refers to the process of adults engaging in their own learning; for example, teaching yourself how to code. There is debate on whether andragogy and SDL are theories or processes (Merriam & Bierema, 2014). Regardless of what it is called, andragogy provides a framework for understanding adult learning. However, there is criticism that andragogy ignores socio-cultural theory (Merriam & Bierema, 2014).

Socio-cultural theory. Socio-cultural theory is rooted in the work of L.S. Vygotsky (1896-1934). According to Vygotsky (1926), the social environment is made up of an inexhaustible collection of diverse elements to which individuals adapt. Adaptation requires mediating artifacts, and Vygotsky's primary artifact was language. According to Lantolf and Thorne (2007), Vygotsky thought the distinctive dimension of consciousness was its capacity for voluntary control over biology through the use of higher level cultural tools, such as language, literacy, etc. These higher level tools, or cultural artifacts, serve as a buffer between the person and the environment and mediate the relationship between the individual and the world. Cole (1996) extend artifacts to include human thoughts and interactions.

Socio-cultural theory is relevant to the study of adults with learning disabilities on several levels. Adults with LD have thoughts about themselves as discussed previously.

Those thoughts include processing problems and breakdowns, frustrations, and feelings of failure (Gerber & Reiff, 1991; Gerber, Ginsberg & Reiff, 1993). Adult with LD also have coping skills and compensatory strategies; that is, they can adapt to their learning environment when often times the environment does not adapt to them. Their thoughts, coping skills, and strategies are mediating devices which help adults with LD navigate classroom learning and the world. The classroom should be a safe, social and non-threatening place for adults with LD to learn mathematics.

Transformative/transformation theory. Mezirow (1923-2014) can be considered the architect of transformative theory. Mezirow's theory of transformative learning is "at its core, a rational, critical, cognitive process that requires thinking, reflection, questioning, and examination of one's beliefs" (Merriam & Bierema, 2014). Cranton (2006) sees transformative learning as more than just a cognitive, rational process but as one that incorporates "imagination, intuition, soul, and affect into their understanding of the process" (p.2). It should be obvious that not all learning is transformative; however, for the adult with LD, the mathematics classroom has the potential to be a transformative experience. As has been stated previously, many adults with LD feel they have not had control of their lives. The post-secondary environment gives them some measure of independence and control and provides them with an opportunity to transform.

Social Justice-Paulo Freire. Paulo Freire's passionate language resonates as much today as it did when *Pedagogy of the Oppressed* was first published in 1970. Although Freire was writing about the oppressed in Brazil, his language can be used as a

framework for thinking about disenfranchised adults in today's mathematics classroom. Adults with LD may see the college classroom as an unfair and unsafe environment that highlights their mathematical weaknesses. As students, they may not be able to process as quickly; they may not be able to take notes and listen; they may need additional help; they may experience test anxiety; they may be afraid to ask questions. "This, then, is the great humanistic and historical task of the oppressed; to liberate themselves and their oppressors as well" (Freire, 1970, p.44). Liberation can happen in a classroom that fosters and promotes success. Both the educator and the student need to be liberated. The educator needs to be better informed regarding the struggle of the adult with LD and the student needs to feel valued.

Freire discusses the banking concept of education where "knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing" (Freire, 1970, p. 72). Mathematics knowledge and fair mathematics instruction should not be considered a gift, but a right of every student. Robert Moses said, "In effect, math instruction weeds out people and you wind up with what amounts to a priesthood, masters of the arcane secrets of math through what appears to be some God-given talent or magic'" (Cobb & Moses, 2001, p. 9). bell hooks (1994) discusses safe classrooms for students of color; safe classrooms need to exist for adults with LD. Teachers have a responsibility to provide a safe, unthreatening space and teachers also have a responsibility, as an "unfinished being" (Freire, 1998), to respect the identity and experiences that each adult brings to the classroom. Repressive education practices "are more acceptable at state institutions than at places like Oberlin or Yale. In

the privileged liberal arts colleges, it is acceptable for professors to respect the 'voice' of any student who wants to make a point. Many students in public institutions, mostly from working-class backgrounds, come to college assuming that professors see them as having nothing of value to say, no valuable contribution to make to a dialectical exchange of ideas" (hooks, 1994, p.149). Adults with LD have a voice that needs to be heard.

Chapter III

Methodology

There are over 4700 postsecondary Title IV degree granting institutions in the United States (U.S. Department of Education, 2013). Approximately 3000 are 4-year colleges or universities with the balance forming 2-year institutions. The United States has a multitude of colleges and universities so why study just one college? Is there any particular characteristic that makes a school different from the other thousands of colleges and universities? According to many college and university websites along with the many college visits I've made with my five children, each college considers itself unique. This study focused on one school and one particular academic area of interest to me. Specifically, how is mathematics taught to a diverse population of adult learners at Waterview College? The questions investigated in this qualitative case study are the following:

1) How is mathematics taught at a small, private liberal arts college that self-describes as accommodating diverse learners?
2) How do students describe their own experiences of learning mathematics at this college?

The "how" part of the research question suggests one type of study methodology: the case study (Yin, 2014). Case study methodology is a form of qualitative research done on a bounded system. According to Merriam (2009), "a case study is an in-depth description and analysis of a bounded program" (p. 40). Case studies satisfy a need to know about a particular program, person, institution, etc. The Waterview College

mathematics program represents a bounded program, a single entity to be studied. I wanted to determine how mathematics is taught to different types of learners. I wanted to investigate what type of support is in place for students. I thought Waterview was an unusual institution since it advertises itself as accommodating to diverse learners. I had hoped my findings would indicate if it was truly unusual and if so, why.

This case study is on a single site and is intrinsic in nature (Stake, 1995). I am interested in one particular case, Waterview College, and one academic area, mathematics. My concern for students with learning disabilities motivated this research. I felt the community college where I worked was not adequately serving students with LD in their mathematics courses. I was curious to learn about mathematics instruction at Waterview and also how students felt about their mathematics instruction.

Site Information and Participants

Waterview College is a small, private liberal arts college located in the northeastern United States. The college prides itself on providing a highly individualized approach to post-secondary education. Many of the students at Waterview College, including my daughter, have a diagnosed learning disability. Waterview awards both associate (three programs) and bachelor (thirteen programs) degrees. The enrollment is approximately 750 full- time and 85 part-time students. Thirty percent of the students are considered minorities and enrollment is 52% male and 48% female. The average class size is fourteen students. Almost half of the students at Waterview are eligible for disability services.

The Princeton Review's K & W Guide to College for Students with Learning Disabilities (2014) lists fifty-six colleges in the United States that offer structured programs for LD students. A structured program is described as one that offers a comprehensive program for students with LD. There is not a plethora of comprehensive programs; for example, there are only ten colleges with such programs in New York and three in New Jersey. Waterview is the only structured program in its state.

One notable feature of Waterview College is their commitment to diverse learners as the percentage of students eligible for services illustrates. The college self-describes as embedding support for diverse learners in their programs. Diverse learners are supported in several ways, including a building devoted to comprehensive academic support. The college has professional tutors and academic coaching. Additionally, Waterview has a one year residential post-secondary program, Hudson Academy, where students can earn college credit in a supportive environment. The Hudson Academy students are fully integrated in Waterview's community; their residence hall is located a short walk from campus. There are approximately 35 students at Hudson Academy (2015). The enrollment for fall 2016 is 60 students.

Data Collection

Data from semi-structured faculty interviews, classroom observations, and student focus groups were collected during the spring semester of 2016. Please see Attachment I for the interview protocols. Waterview's Mathematics faculty consists of three part-time professors. None of the professors teach at any other academic institution. Please note the pseudonyms used in this document are Professor A, Professor B, and Professor C.

Professor A taught one Math 102 course and one Math 104 course in the spring. (Attachment II lists the mathematics course descriptions.) I interviewed Professor A at the end of January 2016. The interview was held in Professor A's office and lasted approximately one hour. The interview was audio-recorded and transcribed immediately afterwards. I observed Professor A's Math 104 course once in February (week 5 of the semester) and once in March (week 7). I observed his Math 102 course once in February (week 5) and once in March (week 10). Extensive field notes were taken during each observation and I wrote an analytic memo after each observation (Saldaña, 2016). One focus group was conducted with students in each of Professor A's courses. The first focus group was held in early March (week 7) and consisted of five students from both Math 102 and Math 104. The second focus group was held late April (week 13) and consisted of three Math 104 students. Both focus groups lasted approximately one hour and were audio-recorded and transcribed.

Professor B taught two sections of Math 104 during the spring semester. I interviewed Professor B in early February (week 3) in a conference room in Waterview's Learning Center (WLC). The interview lasted approximately one hour and was audio-recorded and transcribed. I observed Professor B three times during the spring semester. The first observation was in mid-March (week 8) and the second and third observations were done the beginning of April (week 11). The second and third observations were done on the same day since Professor B teaches two sections of the same course on the same days of the week. I took extensive notes of each observation and wrote analytic memos. A focus group was conducted with students in each of Professor B's Math 104

sections. Both focus groups were held in early April (week 11) and each group was comprised of three students. I audio-recorded and transcribed the focus groups.

I interviewed Professor C in early February (week 3) in a conference room in the WLC. Professor C taught a section of Math 103 and a section of Math 104 in the spring of 2016. I observed her Math 103 class once in April (week 11). I observed Math 104 twice in March (weeks 8 and 10). A focus group was held with three students in her Math 104 course (week 14) and a series of short interviews were conducted with three of her 103 students (week 13).

In addition to faculty interviews, classroom observations, and focus groups, I spoke with Waterview's unofficial archivist about the school's history. I also met with the head of the Waterview Learning Center (WLC) to learn about Waterview's support services.

Data Analysis

Yin (2014) and Merriam (2009) agree that data analysis is the most difficult part of a case study, particularly for the novice researcher. Data analysis was conducted simultaneously with data collection as recommended by Merriam (2009). An organizing scheme, a case study data base (Yin, 2014), was designed to manage the data and the management was done without the aid of qualitative computer software system. Yin (2014) suggests the researcher first play with the data, create categories and look for patterns. The constant comparative method (Glaser & Strauss, 1967) of data analysis was the most compatible way to build categories into which data items were placed. The

constant comparative method of analysis is drawn from grounded theory (Glaser & Strauss, 1967; Corbin & Strauss, 2008). It is an inductive method of analysis.

Corbin and Strauss (2008) recommend three phases of coding in grounded theory: open, axial and selective. The first pass through the data is called open coding whereby important pieces of information are identified and labeled. I read and reread field notes and transcriptions during this process. Axial coding follows open coding and the data are reexamined to determine relationships or themes identified in the open coding. This was an ongoing process throughout the data collection. The final coding procedure is selective coding. Core categories were developed. Data collection and analysis are repetitive, iterative processes which are fluid in nature and the end result is an intrinsic case study of mathematics at Waterview.

Corbin and Strauss (2008) state the procedures for analyzing the data are not as important as the essence of the data, or what the data is telling the researcher. In order to "hear" what each piece of data was telling me, I wrote an analytic memo following each professor interview, classroom observation, and most focus groups. Additionally, the focus group interviews and the professor interviews were transcribed within a day or two. Notes and key words and phrases were written on the margins of the transcripts throughout the data collection phase. I read and reread the professor interviews and classroom observations and searched for categories or themes. I did the same with the student focus groups. Once the categories and themes were identified, supporting data were assigned to them. Stake (1995) defines analysis as taking something apart and

giving meaning to the parts. I attempted to do this repeatedly through the data collection process.

Collection of data and analysis should occur simultaneously in qualitative studies (Corbin & Strauss, 2008; Merriam, 2009; Stake, 1995). Underlying the analysis of this data, from the first piece of data to the last, is the theoretical framework which supports this research. Even though the constant-comparative method was used to analyze the data, I entered the data collection and analysis focusing on Adult Learning Theory, Socio-cultural Theory, Transformation Theory, and Social Justice. Freire's social justice philosophy has been crucial to my practice and to this research. It is essential that mathematics is accessible to students who have learning disabilities and differences. Subsequent to using the constant-comparative approach, I also examined the data thinking about the underlying theories. For example, with respect to Adult Learning Theory, I considered whether the "why" of learning was present for students. Were the students engaged in the classroom or did the instructor dominate the lesson? I was interested in the coping skills of students and their thoughts about themselves (Socio-cultural Theory). Was there anything transformational in the data? Finally, I considered the concept of social justice as it's related to mathematics instruction. For example, is the classroom inclusive of all students? In addition to thinking about the theories throughout the collection and analysis process, they also provided me with a starting point, or a way to develop questions for both the professor interviews and the focus groups.

Validity, Reliability, and Positionality

Multiple sources of data (data triangulation) were used in this study. According to Patten (2012), data triangulation is one of the ways qualitative researchers ensure the dependability and trustworthiness of their data. The data collection method was triangulated since three methods of collecting data were used: semi-structured interviews, focus group interviews, and classroom observations. Also, the data were obtained from multiple sources: three math instructors, six student focus groups, and ten classroom observations. A total of twenty students participated in the focus groups during the spring 2016 semester. A member check meeting was held with the professors at the end of the semester with two of the three professors attending. The third instructor was invited but did not respond to the invitation.

Qualitative studies are not reliable in the traditional quantitative sense. Merriam (2009) says "replication of a qualitative study will not yield the same results "(p.222). This study considered a five month period of time at one small college. The interviews and observations represent a particular time, place, and participants.

My positionality during the data collection phase was that of a parent of Waterview student. I was also a financial contributor to the college and a member of the Parents' Council. I am presently a part-time instructor of mathematics at Waterview but I was not employed at Waterview during the data collection or analysis phase. Herr and Anderson (2015) state that "While the researcher's positionality in relation to the setting is important, it is no simple matter to define one's position" (p.39). Although they are referring to Action Research, their statement can be applied to my case study. I

employed a process I call “remindfulness”. I reminded myself each time I entered a research space not to let my familiarity and experiences with Waterview bias my role as a researcher.

Chapter IV

Findings

The questions investigated in this qualitative case study are the following:

1) How is mathematics taught at a small, private liberal arts college that self-describes as accommodating diverse learners?

2) How do students describe their own experiences of learning mathematics at this college?

In order to best answer the research questions, this section will begin with background information and a self-description of each instructor along with their teaching philosophy and self-reported classroom structure. That will be followed by the findings gathered from the professor interviews, classroom observations, and student focus group interviews. The data were considered as a whole in order to identify themes and categories using the constant-comparative method of analysis drawn from grounded theory (Corbin & Strauss, 2008). Although the data were considered in aggregate during analysis, I have presented the findings separately for each professor. As you would expect, the professors are remarkably different. The individual discussion of categories with respect to each professor makes the document flow in a more logical, orderly manner. The one exception is the category of LD self-perception. Students' perception and understanding of LD were independent of their professor; that category is combined for students taught by all three professors. The research questions will be answered considering the professors together in order to provide a complete picture of mathematics at Waterview.

The constant comparative method of analysis was used to compare the various pieces of data. The data were grouped together based upon their characteristics. This was an iterative process of analysis which occurred during the entire data collection period. Critical friends read my initial findings and provided valuable insight regarding the categories. The final categories that emerged are:

- Instruction: A description of both the material presented and instructor and student perception of the material.
- Professors' Understanding: The professors' understanding of learning disabilities and its impact on their teaching.
- Affect: The impact of the instructors' words, actions, and instruction on students. This category includes students' descriptions of past experiences.
- Students' Understanding: LD students' perception of themselves.

The research questions will be specifically addressed in the Discussion section which follows the findings from each of these categories. Stake (1995) says that "qualitative case studies are highly personal research" (p. 135). These findings report what I saw, felt, heard, processed, and analyzed. I write this section with respect and gratitude for the participants. Pseudonyms are used for all participants.

Meet Professor A, "The Coach"

Background, philosophy, and classroom. Professor A has undergraduate and graduate degrees in Theoretical Mathematics from a state university in the Northeast. He also has a Computer Science degree along with minors in Anthropology and Philosophy. Although he does not have a teaching certificate nor has he had specific training in

learning disabilities, he said he has taught himself the "how" of teaching by reading education books and he continues to read voraciously. He has raised four children, including one with a developmental disability. Professor A's professional background includes an engineering position at a large company and running his own companies, one in engineering and one in tutoring mathematics. He has coached soccer for many years, including part-time at the collegiate level. As you will read, sports analogies play a prominent role in Professor A's discourse.

Professor A's tenure at Waterview spanned fourteen years, both as a full-time and part-time employee. He was a part-time instructor and taught three classes during the spring semester of 2016 when this research was conducted. The courses were: Math 105 for Waterview students, Math 104 for Hudson Transition students, and Math 102 also for Hudson Transition students. At the time of this research, Waterview did not have an official head of their mathematics program. Professor A mentioned that previously he had been the director of mathematics for a couple of years but that "they stopped that for financial reasons, just because of a lot of reasons. We don't need to go into that …I still take ownership of what we do here." Professor A considered himself the de-facto head of the department.

Professor A has a tremendous amount of energy and a self-described passion for mathematics. "Energy is important, passion is important… and it's important for me to portray that." He considers himself a life-long problem solver and this is reflected in his approach to teaching. He asks himself, "Why isn't this student understanding how to do this?" He follows that up with, "How can I help this person to understand?"

Puzzles play a significant part of Professor A's persona. He has written several puzzle books and views students' lack of mathematical understanding as another puzzle to solve. "I like to figure out why…why this person isn't getting it " He describes his job as taking kids who haven't had a lot of success and helping them experience success in mathematics. "Success is having kids enjoy it [math]. They want to come to class. I can't tell you the number of kids that say this is my favorite class. It just happens all the time." When asked how he would describe himself as a teacher, Professor A responded, "Having fun is what's important. Students are not used to having fun in math."

In some ways Professor A seemed to possess traditional thinking. He attributed the lack of foundational skills in college students to two things: 1) calculator usage and 2) students not taking individual responsibility. These two complaints are very common to hear from seasoned mathematics faculty. He was not just addressing Waterview students but all students in general, including those he tutors through his mathematics company. Although Professor A is traditional in some respects, he had strong feelings about student testing. He feels testing ruins a student's love of learning and he believes in a more individualized assessment for his students. "I think tests are one of the big things that kill our math education because now kids are more interested in getting a ninety instead of understanding the material." He does not equate success with grades but views success as improvement in their math skills and an increase in their confidence level. He uses tests to determine what students' needs are and as a self-assessment for what he may need to re-teach in the class. Professor A has his Math 102 students individually take short assessments, in his office, to determine if the student is

progressing and he grades students on "effort". He described the Math 102 assessments as "individualized". He assesses his Math 104 students with in-class tests.

Professor A sees the classroom as his stage and feels he has a responsibility as a performer to be insightful, entertaining and informative. He considers himself a math diagnostician. His students could have a diagnosed learning disability, have a non-diagnosed LD, have math anxiety, or could have been instructed poorly. Professor A said, "We're diagnosticians, we diagnose things, and we're like a doctor." Professor A has confidence in his ability to get through to all students and stated that he strives to make each class better. He feels he is always curious and wants to understand why a student might not understand a concept. Professor A's own feeling of success is entirely dependent upon this.

Professor A implied that he was good at pinpointing students' lack of understanding. For example, he mentioned a student's experience with linear equations and the equal sign. "I'd look at something and say how come what is obvious to me is obvious to me? What are they [student] missing…I found reasons why [a lack of understanding]…like I'll show somebody a linear equation and they can't get a linear equation…and they can't solve it…I'll ask them what they are looking at…the answer I got most was the equal sign." Professor A felt the student was focused on the equal sign instead of the equation. I mentioned that research was available on students' understanding of the equal sign but he did follow up with any question regarding the research.

How does Professor A describe his typical class? He said, "I tend to lecture and it's a very Socratic lecture. I ask most of the questions, but I'll entertain questions." When asked if students are afraid to ask questions, he replied, "I don't want them to [be afraid]…if you have that question, everybody has that question. And I always say, that's a great question." Professor A said he was "very encouraging of questions."

The self-description of Professor A's class is paradoxical. He describes himself as a performer, with an obligation to entertain, as though the classroom was a theater and he was the main attraction. In contrast, he also stated he gives Socratic lectures. The two descriptions are difficult to reconcile and it's unclear what his teaching philosophy is from his statements. Additionally, the descriptor "Socratic" implies not a lecture, but a back-and-forth method of asking and answering question where student questions guide the class. As you will read, his actual instruction differs from his description of his classes.

Professor A does not have his students purchase a book. He feels a textbook is a "half a set of bookends [dust collector]." He does require students to buy access to a website he has developed. The access cost is $25. Professor A said, "…I like my website because it randomly generates problems and you get immediate feedback. A lot of the websites, you can do it wrong. So now it's guiding you and I call it perfect practice." Homework assignments are both online and in a workbook that Professor A has created for students in his Math 102 class. His Math 104 class uses a combination of online homework and classroom handouts. Professor A feels he does not assign excessive homework and thinks thirty minutes is sufficient. If a student is not

understanding, he encourages them to walk away from the problem and return to it later. Professor A provided a sports analogy, with the presumption that walking away and returning later will improve students' understanding. "It's like baseball…don't take more than eight swings. Get out of the [batter's] box."

Professor A has developed a phrase –Practice, Perfect Practice. He wants his students to achieve mastery in certain skills and mastery, according to him, is perfect practice five times in a row (five correct answers in a row). Professor A said, "I use shoe tying as a great example. Let's say if you can tie your shoes five times in a row, you've made a big stride towards mastering." This analogy is odd. Tying shoes is a procedure that most people can master and it does not require a deep understanding of the process – it's rote and mechanical. Understanding mathematics should not be reduced to shoe tying. This analogy confirms Professor A's thinking that with enough practice, students will achieve success.

Professor A said he practiced what he preached. He teaches himself a new skill every year and achieves success with practice. For example, his most recent endeavor was learning how to ride a unicycle. To help instill confidence in his students, he offers free juggling lessons every spring. He believes in his students' ability to achieve, and not just in the mathematics classroom—"You want the kids to realize improvement is on their shoulders. You can get better at anything. I'm not saying you're gonna be a professional basketball player, but you can become a better basketball player." Another sports analogy, which Professor A is very fond of, probably due to his coaching experience.

Professor A: Instruction. Professor A described his teaching philosophy as Socratic lecturing and although he delivered the lecture part, the questioning part was often missing. Professor A would pause throughout his lecture and ask, "Does this make sense" but did not wait for feedback from the class. He often asked questions but then answered them himself. Hands were often raised and he either did not notice or chose to ignore. This contrasts with his self-described classroom of encouraging questions. He claimed he would say, "That's a great question," but that did not occur in the classroom. One student, Wes, told me that "…sometimes when you ask a question that he thinks is sort of stupid or something he'll sort of dismiss it…" This contradicts Professor A's statement that he was very encouraging of questions.

One lesson in particular is worth highlighting—fractions in Math 102. Most mathematics instructors are familiar with the primal fear and anxiety associated with fractions. During this lesson, Professor A was telling the students what to do, but not why it was important. He was showing students a procedure: there was no meaning or understanding connected with the lesson—it was context-free.

Professor A presented fraction addition and subtraction using a short cut method that was unfamiliar to me. He referred to it as "bow-tie" method. The bow tie method looks like this:

$$\frac{2}{3}+\frac{1}{5}=\frac{10+3}{15}=\frac{13}{15}$$

Professor A explained that the denominator is found by multiplying 3 x 5. Ten in the numerator results from multiplying 2 x 5 (which he circled) and 3 in the numerator results from 3 x 1 (which he also circled). The circled numbers look like a bow-tie. A

student announced that she was not understanding and once again practice was suggested. The professor repeated the misunderstood problem. Professor A did not provide an example of adding or subtracting fractions where the least common denominator wasn't the two denominators multiplied together. For example: $\frac{3}{4}+\frac{1}{6}$. In this case, the least common denominator is 12, not 24 (4x6). Professor A's method would lead students to use 24 as a common denominator and although that is not wrong, it is not the least common denominator (LCD) and would require an additional step of simplifying the fractional answer. All the examples in this lesson had the product of the denominators as the least common denominator. If Professor A had presented different problems, he could have engaged students in a meaningful mathematical conversation about LCD and simplifying fractions. The examples he used avoided the need for any such discussion.

Another lesson in Math 102 that students struggled with was unit pricing. The lesson was a continuation of work from the previous week. Students were asked to look at an example of peanut butter prices the professor had made up, and then students followed with their own example. One student, Roy, made up an example using different types of candy bars. The candy bars and the weights were random choices created by the students without any real world context of what a candy bar might weigh. Roy chose Hershey bars, M&Ms, Reese's, Almond Joys, and Milky Way bars as his example. Roy then assigned a different ounce size to each bar. For example, the Hershey bar size was 5 ounces and the M&Ms were 10 ounces. Professor A wanted Roy to realize that the unit price for the Hershey bar should be more than the unit price for the M&Ms because the Hershey bar was a smaller size. The message conveyed was somewhat confusing to the

students and to myself – the larger the size of an item, the less the unit price should be. Many hands were raised during this exercise and Professor A roamed the classroom giving individual help. The lesson would have been more effective if students were asked to calculate unit prices of various types and sizes of a commodity, like laundry detergent, to determine the most economical purchase. The professor mentioned that larger amounts do not always have a lesser unit price, contradicting the conclusion he was attempting to have students reach. There was no indication he sensed this was confusing for the class—he moved on to the next exercise without further explanation.

The next exercise was rounding and shopping. Professor A said he wanted the students to "get good at doing things in their head." This type of fast-paced calculation exercise can be troubling for students who have working memory issues. Additionally, the professor felt students should be able to do this without a calculator. Students were asked to round items from a list he provided to the nearest dollar. For example, the professor called out "peanuts from aisle one" and the students had to find peanuts on their list and round the price. Another item would then be announced and students had to keep a running tally of the total. One student said the professor was going too fast. The professor acknowledged the concern and tried to slow down. The professor continued with more examples like this and it seemed as though most students were getting the correct answer, although a few appeared to be left behind. One student said "I don't feel like I can go that fast." The answer once again was "practice." This lesson could be considered outdated and irrelevant. Many supermarkets have scanning devices that customers can pick up when they enter the store. It is not necessary to keep a running

total of purchases while shopping. I did not have the opportunity to discuss relevancy with Professor A.

Practice, thirty minutes per day, was often emphasized in the classroom. "You aren't going to get better at free throws by watching someone else practice; you have to practice." Once again a sports analogy was used. Professor A firmly believes that practicing mathematics will lead everyone to success in mathematics. Practice was often mentioned and it seemed like it was the remedy for lack of understanding. For example, he talked about a program he developed for memorizing multiplication tables.

> And the other thing is, I don't know if it's a reason [referring to calculator usage] or not but a lot of the kids can't multiply. That's not a problem. I can teach you to multiply. I've got a little mental math program I've put together. Kids will come to me, come to me numerous times and say I can't do that. They'll have excuses upon excuses and I'll say I really don't care because if you practice you are going to get better. And that's all I'm trying to do. I'm not trying to say you are going to be me. I want you to be able to multiply. And that kid, say there's 20 problems and they'll do it in 200 seconds with 4 misses. A week later they're doing 20 problems in less than 60 seconds. Not everybody, but I've had this numerous times.

Practice was often mentioned as the route to understanding. Professor A's website was the place students generally went to practice. Larry commented on the website: "He said we have to go on [website] for like a half-hour every day…I was doing it at night and I was…falling asleep doing it. It's like the same thing, over and over

again." Elliot added that the website had "the exact same three questions [in one session]." Larry also stated he had the "exact same question three times in a row." The students felt the website was repetitious and it did not make sense to do the same problem, with the same numbers, three times in a row. This may be a glitch in the website. I did not have the opportunity to look at Professor A's website.

Students had strong feelings regarding the mathematics that was presented. Larry, a Math 104 student, stated, "I love math but when it comes to usefulness, a lot of it is extra stuff that you probably won't ever use but maybe for like a quarter second of your life." He felt finances "would be a little more useful for the upcoming years and beyond." Jenn, another Math 104 student with a visceral hatred of math, said that she wouldn't do anything in math and therefore it was of no use to her. Wes, Math 104, hopes to attend law school and feels the "critical thinking" aspect of Math 104 is useful. Math 104 includes basic logic and this may be what he was referring to as critical thinking.

I noticed several students arriving late for class. Professor A did not comment on the late arrivals. During the focus groups, students said that it was not typical for him to dismiss tardiness. Two students mentioned that they arrived late for class and Professor A did not allow them to enter. Wes added, "Well sometimes if people are late, he'll give them a super embarrassing lecture." Merriam (2009) discusses contamination of data when the researcher is the primary instrument of data collection. The discrepancy between my observations and what students reported during the focus group interviews was consonant with Merriam. I suspect that Professor A's classroom behavior changed

when he was being observed. Patten (2012) states, "the participants' behavior may change from its normal course because they know they are being observed" (p. 156).

An area of concern for students regarding instruction was Professor A's mandate that students work independently. Joe said, "…he doesn't want us to have so much help on how to solve the problem and stuff which kind of doesn't make sense to me…if we're going ahead and solving a problem and we have to try to figure it out ourselves …specifically he doesn't want us to have help…how can I do it without help?" Ali followed up with, "…I'm like sitting there for twenty minutes and I can't do it, I'm gonna get help…it's a waste of my time…last night I got help from a student. I didn't know what I was doing." Elliot said, "…if you have a teacher who is not teaching in your learning style, you should really reach out to a few students that really get it." Students want to work together but Professor A does not want them to collaborate on assignments. I did not observe any in-class collaboration either. Andy mentioned an incident when he was trying to help his classmate and then Professor A "starts yelling at us." Reiff and Shessel's (1999) qualitative study discussed the impacts of having a learning disability in adulthood. One impacts was the desire to help others. Professor A's students want to work together and get help with their math assignments but are instructed to work independently. I was unable to follow up with Professor A on his policy.

Professor A: LD understanding. Professor A does not have any formal teacher training nor course work on learning disabilities. When we were discussing his Waterview experience, he stated, "What's funny…you talk about kids with LD that are intellectually challenged for whatever reason." Although Professor A said "you talk", I

had not referred to "kids that are intellectually challenged." He seemed to equate students with LD with students who are intellectually challenged. Intellectually challenged implies intellectual disabilities. According to the DSM-5 (2013), learning disabilities are not "intellectual disabilities." The term that was used in the past for intellectually challenged or intellectually disabled people was mental retardation. Fortunately, this term is no longer used due to the negative connotations associated with it. Waterview does not serve an intellectually challenged or intellectually disabled population.

I asked Professor A what got him interested in LD. He replied, "…I can do math so easily… and others can't. It's really a conundrum to me…I'm not bragging but in my high school I was one of the top three math students…" He described himself as a puzzle solver and he may see a student with LD as another puzzle to solve.

Professor A was self-referential during most of his interview. I asked him about students that have working memory issues and he responded:

> It's interesting, because you say that right? And they say, I can't do multiplication, I tried it before. I say to them, well, I'm going to teach you a sequence right now. A pattern of 26 objects with no connection whatsoever. Multiplication has a connection and you are gonna get it. And I do the alphabet and I say can you do the alphabet? And they say yeah. Well, there's a collection of 26 objects that have no connection…so I think you can do it.

Professor A's analogy is troubling. The 26 letters of the alphabet are familiar to us through songs, stories, television shows (Sesame Street), etc. from a very young age. The ABC's are learned as a unit, almost as though the alphabet was one long word. It would

be hard to recite our ABC's in a random order, and multiplication facts are often needed randomly. Additionally, multiplication facts are not quite as pervasive in our lives. Memorizing between 100 (10 by 10) or 144 (12 by 12) multiplication facts is not comparable to learning ABCs. There seemed to be a lack of understanding with respect to working memory issues that his students may have.

Professor A said he was not given any instruction on LD when he began his career at Waterview. What he finds the most challenging is "not knowing about the problems a kid has ahead of time…you want to be aware of certain things just so you can prepare." Learning disabilities equated to "problems". His philosophy regarding accommodations amounts to what I can provide you with: "…whatever you need just let me know…if you need bigger font for the tests, if you need me to put something around my neck so you can hear me, if you need more time, more space to take an exam, if you need the notes." When asked if he taught his courses as though everybody has a learning disability he responded, "I'll accommodate anybody who needs to be accommodated. You know I definitely teach a certain way…I try to explain things well." Professor A is confident in his explanations and seems to view LD as a problem that can be accommodated or fixed with larger fonts, microphones, and the like. He thinks in terms of helping a student hear, or see, or read better. Professor A's accommodations are not different from what LD students may be entitled to under the ADA. No mention was made of adjusting or modifying his teaching methods. Professor A did not talk about student understanding, or his own understanding of LD. Professor A thinks that continued practice leads to understanding, like tying shoes.

Professor A seemed proud of his lack of teacher training. He referred to teaching certification as a "double-edge sword. If you look at NCAA standards for athletes, it often lowers kid's scores and the objective is to bring people up and it doesn't. The same for certification. It can often be analogous to brain washing." Once again, sports analogies are prominent in Professor A's explanations. He feels teacher certification can take away from an individual's creativity. He did not elaborate but the comment suggests that Professor A feels teacher certification isn't essential.

I asked Professor A if he had any advice for professors who may encounter a student with LD in their math classroom. He responded, "Preparation, patience and make sure you have a plan set out so you can explain things properly. Look at Betty [a student]…she's gonna sit down with me tomorrow and she's gonna understand everything she doesn't understand right now. You've got to be willing to sit down with kids and help them understand things on a one-on-one basis." Professor A's office hours were very generous and he encouraged students to see him on an individual basis. Math 102 students were required to see Professor A individually for their assessments and one student, Joe, mentioned he sees Professor A on a regular basis for help.

Professor A: Affect. Professor A's can-do attitude and confidence in his ability to reach all students had a remarkable impact on students. They viewed his confidence in different ways. Below are students' reactions to Professor A's stated confidence in them. (Please note that the disabilities represented with Professor A's students are Auditory Processing Disorder, Visual Processing Disorder, ADD, ADHD, Epilepsy, Dyslexia, Dysgraphia, Autism Spectrum Disorder, Obsessive Compulsive Disorder (OCD), Post-

Traumatic Stress Disorder (PTSD), Pervasive Development Disorder/Not Otherwise Specified (PDD/NOS), LD —slow processing speed and handwriting difficulties, and Cerebral Palsy (CP).) In all cases, students willingly self-disclosed their diagnoses. Joe spoke first.

> I think the most important thing is that he [Instructor A] showed confidence in my abilities in math. Which has really helped me and um when I go to see him I don't know about anyone else, it feels like the lessons he is teaching me are individualized. And that really helps and with his mentality, no excuses mentality, he'll make me do some stuff that I wasn't originally comfortable with. He wants you to get it so he'll go into this way, let's do it this way.

Professor A's one-on-one worked well for Joe. He felt the lessons were tailored for him. Professor A even made a slight modification to his website for Joe. He [Professor A] referred to the modifications as a "little scratch pad for him [Joe]…where he can type in his thoughts." Joe has fine motor skill issues, along with other disabilities, and this modification gave Joe another way to communicate with Professor A.

Joe appreciated the confidence that Professor A expressed in his abilities but not all students viewed that confidence in a positive way. One student, Ali, felt Professor A's confidence came across as a denial of her lack of understanding.

> If someone doesn't understand something, well this is what I've noticed with Professor A. It doesn't bother me all that much but, I don't really, but it's a bit frustrating when he tells the students when they say I don't understand this and he

> says of course you understand it, you don't know how to do this? No, [I] don't know how to do this. No.

Ali wanted Professor A to know she wasn't understanding something, but his response was, "Of course you do." Ali's feelings were not acknowledged nor was an attempt made to understand what she was not understanding. Other students noted Professor A's behavior and empathized with their peers. Joe mentioned that he needed to be super specific in describing what he needed help with. "He [Professor A] doesn't like general questions." Larry described the need for specificity this way:

> I remember several weeks ago somebody asked a question and he [Professor A] said what don't you understand about it and she just couldn't figure it out. If you knew what you didn't understand, it would be a lot easier to figure it out.

Larry's point reinforces Ali's experience. It is hard to explain what you don't understand. It's paradoxical in that if a student could explain it, they would understand it.

Joe talked about the Professor A's philosophy of practice and thirty minutes per day of math work.

> And it helps the fact he does it that way and definitely I believe the second part to it is definitely the effort that I'm making is, like putting in the time. Since he told us we have to do thirty minutes it seemed daunting at times, especially the first couple of times, we had to do thirty minutes a day, how the heck are we going to do this? But eventually it seemed like something I wanted to do. I wanted to learn more about math and there's days that I still don't do it, but there's days that I did do it for thirty minutes a day, and it would help me progress in math. I feel

> like doing it every day on a consistent basis has helped me… Professor A, all he cares about is effort and putting in the work and he doesn't care about [if] the answer is right or wrong.

Joe's description matches what Professor A thinks about effort and practice. Math is like a sport--people practice, put in the effort, and that leads to improvement.

Although Professor A's demeanor and "no excuses' mentality was well received by Joe, several other students felt differently. In particular, his tone of voice bothered some students. Jenn mentioned that she has had trouble with math since 7th grade and her mom was her unofficial tutor. Jenn was diagnosed with dyslexia and Math 104 is a very wordy course. Her intense reaction to Professor A and his demeanor may be due, in part, to her reading difficulties. Jenn said, "It [math] looks like a different language to me." She talked about Professor A's voice.

> And Professor A, he talks and I want to cry. Because his tone of voice. I know he's trying to be nice but his tone of voice is so harsh. I want a nice teacher, like a nice little princess voice, but no, he's trying to yell at you I feel. And I don't know, but I feel like I want to punch him in the face. And he's like a living hell.

Several students in addition to Jenn mentioned Professor A's voice. Larry said, "And with the way his voice is, it's loud and almost intimidating to a point for some people it would definitely be intimidating." Andy referred to Professor A's tone as "sarcastic" and said this about his voice: "…I find it [Professor A's voice] very intimidating…" Professor A may use a loud voice in the classroom because he described

himself as giving a "performance" and feels he needs to be "entertaining". His audience, the students, need to hear him.

Students spoke about Professor A's inappropriate classroom language. Students mentioned that Professor A referred to a question that Elliot asked in class as "stupid" and that he had done that a "couple of times" when various students had questions. Andy said "It's also like he's insulting but sarcastic about it like once he told, he said next class we're gonna get a muzzle and put it on Andy." Andy mentioned he was "off my meds" that day. Andy also quoted Professor A saying "…doesn't give a rat's ass…" Larry corrected Andy and said Professor A used "rat's rear." Regardless of the specific word, the meaning was the same.

It is clear that Professor A's demeanor affects students. For example, Andy was disenfranchised from the mathematics classroom and skipped a class out of fear. Gerber, Ginsberg and Reiff's (1997) research on adults with LD mentioned fear, terror, and frustration as feelings that successful adults remember from the classroom. Andy and his classmates described what happened:

> Andy: Because the thing is he barely calls on me in class no matter how much I raise my hand. Also, maybe two or three classes ago he was really raising his voice and his face was getting all red because he was yelling at me because my roommate Fred was asking was this a quadratic? And I was just trying to explain it to him. And then he [Professor A] starts yelling at us and saying he doesn't give a rat's ass what we're talking about and he really starts getting furious and
>
> Me: How did that make you feel?

> Andy: Like scared so I didn't go to the next class, I just skipped it. I really just did not like that. Also the thing is since it's a bigger class [Hudson Transition], I'm not able to … absorb all the information because in my high school, let's say there was a problem on the board and I didn't know how to do it. He'd write how to do it in a different way, like the same way to do it but with a different problem. So I would do that so eventually by doing it in my head or by writing it down by the way his example, not the one that's on the board, then I would use that example, the way I did that example to solve the problem.

Andy also mentioned another class where he was trying to help his classmate. He described Laura as "about to burst into crying" because she wasn't understanding something. Larry added, "I remember the exact conversation. He [Professor A] was like would you [Andy] like to teach the class? And you [Andy] were like I'd like to teach this part and he [Professor A] was like see me after class." Andy did not meet with Professor A after class and said "I just ran out the [expletive] door.

There were many contradictions between Professor A's self-description and what students described. Professor A said he was open to questions, and that student questions were great, but that does not match what students' experience. Many students were very sensitive to his voice, and several students feared him. I found him to be a very dominating figure in the classroom. He lectured in a loud voice, talking at the students and not to them. Additionally, I felt he was talking at me during our one-on-one interview. I don't know if Professor A was aware of the impact his words and actions

had on students. I was unable to share the findings with Professor A as he did not attend the member check.

Meet Professor B, "The Newbie"

Background, philosophy, and classroom. Professor B was in her second year at Waterview College in the spring of 2016. She has twenty years of teaching experience with a background in education and computer science. She was also a civilian employee of the army as a systems analyst. Professor B has a Master's degree in education and an undergraduate degree in liberal arts. Her husband is also employed by Waterview in an administrative position. Her teaching experience includes several long tenures at private schools, both elementary and high school. She enjoys the academic freedom that private schools offer.

Professor B felt that she received meaningful professional development (PD) during her tenure at one private school in particular. She estimated she received about thirty credits worth of PD at the private boarding school for boys where she taught mathematics. The school is well known for its athletic program. Her students either struggled with mathematics or just didn't like mathematics. Support services were readily available at the school to provide additional help to students who might be struggling with math for any number of reasons.

Waterview's mission of "working with kids who are struggling" was part of the reason she came to the college. She taught two Math 104 classes in the spring 2016 with approximately twenty students in each class. She stated that she usually has at least eight to ten students with documented disabilities (total) but that this semester only three

students have self-identified. She enjoys working with the student population and loves what she is doing. Professor B said that "I love what I'm doing…I try to get to know each one of the kids the best I can…I try to understand how things work best for them."

Professor B talked about a statistics course she designed last year. She quickly realized it was not going to work with the students. Professor B said she broke the course down into "tiny pieces", rebuilt it and that the students did extremely well. She is willing to make adjustments, even complete redesigns, on her own time, to ensure students succeed. Professor B explained how her class is structured.

> …when they come in the class I always tell them what the outline is for the class. What we are going to accomplish for the class so that way everybody has the expectation of what's coming down. So then we go into the day's lesson and that. I use Power Point for that because I don't have any other resources…I can use the overhead if I need to explain things in more detail … If that doesn't works I use the white board behind me…I check and see if anybody has any questions and then they start the assignment…a lot of times they finish it in class but I'd rather them do that and be able to get through it when they have questions…And then I send them the Power Point in an email. And any notes that we've done in class. I'll make up for each class, I'll make up what I'll call a cheat sheet but it highlights the important stuff so that way you don't have to go back through the Power Point.

Professor B uses the official course book, *An Introduction to Modern Mathematics and its Applications* by Andrew McHugh (2009). She supplements the

course in various ways. She does not use the website designed by Professor A for homework assignments. Professor A's website has tutorials but Professor B said she prefers Khan Academy tutorials. She provides her own assignments for the course and has the students begin the assignment during class in case they don't understand the language in the assignment. With respect to homework assignments, here is what Professor B said.

> No, I'm making them [homework assignments] up. I use stuff in here [book] but the language in this book, some of the kids are really having a hard time with it, the directions. I try to go over it before and I'm jumping ahead but I try to give them time at the end of class to start it. That way if they run into any trouble, I'll say now read through it and see if there's anything you don't understand. So that way before you leave you know you can do this.

Professor B recognized that the vocabulary in the book could be troublesome. Students might have difficulty reading and/or following directions. She has them begin their assignments at the end of class so she can assist them if they are having problems with the written instructions.

During the spring 2016, three of her students were eligible for extra time so she made the tests shorter so the extended time students could complete the test during the class period. If students haven't completed it by the end of class, she will stay until they complete it. There is no time pressure on the student nor does the student have to go to a separate testing location for extra time. There are approximately five tests and one final exam all of which Professor B creates. Formulas are given on the exam but notes are not

permitted. Her final exam review questions are drawn from the tests given during the semester and she holds two review sessions before the final exam.

Professor B said she self- assesses her teaching practice and the curriculum. One example of this is her modification of Math 104. Professor B was teaching two Math 104 classes in the spring and since she was teaching two of the same course, she was able "take the time to do this [modify Math 104]. I'm taking it all apart and I'm rebuilding it and extending it." She is open to new ideas and is innovative in the classroom. For example, halfway through the semester she gives her students an assignment where they have to present what math means to the career or curriculum they've chosen. She said, "So one of the things I introduced in this course…is to come up with a Power Point presentation, five to ten slides, go find what math means to the curriculum or the career you have chosen. And then present it to the class…I learned a lot of stuff." Not only was this a learning experience for the students, but it was also one for Professor B. She said she has learned a lot about math's relevance to different fields, like criminal justice.

Professor B would like to have better communication with the rest of the math faculty. She feels one limitation at Waterview is the lack of a full-time math instructor. She feels this contributes to what she considers poor communication between the three part-time math instructors.

Professor B: Instruction. Professor B greeted the students by name as they entered the room and students appeared comfortable and were conversing with each other before class. At the beginning of one class, Professor B returned tests and she informed the class they could make corrections and resubmit the test before class ended. Students

were given the opportunity to learn from their mistakes. Several students remained after class to redo incorrect problems. One student, Sam, said, "I think that's really good [allowing for corrections] because it can help us see what we've done wrong…actually helps us learn…" Quite a few students took advantage of the opportunity to correct their mistakes.

The typical (non-student presentation) classes followed the structure that Professor B had described. One topic covered in Math 104 is sequences. One of Professor B's classes began with the formulas for arithmetic and geometric sequences and she provided examples of each type of sequence. Students were able to ask questions throughout her presentation. Following the Power Point, she had some practice problems for students. The practice problems were only on the overhead (Power Point) — students needed to copy the problems down themselves, leaving room for errors in copying. Students were given about ten minutes to work on the in-class problems before the answers were shown on the overhead. Professor B explained how she arrived at the answers, using Power Point. Other than asking Professor B questions or working on the in-class problems, there was very little student involvement in the class. Homework was assigned and students had time in class to begin the assignment which consisted of identifying the type of sequence and a particular term in the sequence.

A second lesson on sequences unfolded in the same way. Professor B's slides covered the formulas and provided a few examples. The in-class work-sheets had six problems. Here is the first problem:

Write the 3^{rd}, 5^{th}, and 9^{th} terms of this sequence: $a_n = 2n + 3$

The second problem asked students to write the 3rd, 5th, and 9th term of this sequence:

$$a_n = (-2)^{n-1}$$

The next three problems were similar. For example, the third problem was:

Write the 3rd, 5th, and 9th term of this sequence: $a_n = (-n)^3$

The sixth problem on the worksheet had context relating to banking:

> One year before a trip you begin making deposits to an account. The first month you deposit $40. For the next 11 months, you deposit $3 more than the previous month. Here is the rule for your deposits: $a_n = 3n + 37$. A) Using this rule, how much money will your 12th month deposit be? B) How much money will you have saved over the 12-month period?

The work was procedural and for the most part—students plugged numbers into formulas. The formulas had no meaning other than it was for a sequence. Professor B's class was rigid with respect to the Power Points—there was little room for spontaneity and impromptu conversations. Examples were not explained step-by-step on the white board. Several of Professor B's students commented on the Power Point presentations and the lack of step-by-step instruction. Greg said, "I like more examples on the board…step-by-step." Although Professor B emailed the presentations to students, Jim said he "when I'm trying to take notes it's [Power Point] not giving me enough time to do so."

With respect to relevancy, Professor B said the textbook is "old and has limited information…a silly book that's ten years old." When asked about the usefulness of the course, Professor B responded, "No, I wouldn't say that [it's useful]…kids sign up for it

because there's no other option…So what they need is something, they either need the basics or something like a course that's going to help them, like what do I need to work in hotels…" Her comments made sense since Waterview has a hospitality and tourism major.

The student presentations are highlighted in the following section because they were unique to Professor B and provided relevancy in her Math 104 course. Since Professor B did not find the material in Math 104 relevant, she asked them to do a special project. The project consisted of relating mathematics to their career choice and giving a short in-class presentation on their findings. Criminal Justice and math was the first presentation. The question posed by the presenter was "How does law enforcement use math?" Several examples were given including the formula for skid marks, the BAC (Blood Alcohol Content) for drunk driving, linear equation for speeding tickets ($70 plus $2 for every kilometer over speed limit), gun ballistics including the path and height of a bullet. There were three other presentations by Criminal Justice majors including one where actual statistics from the New York City Police Department were presented.

The relevance of the presentations to the students' goals cannot be overstated. Students were engaged and the why of learning math was present in the classroom. Professor B facilitated the presentations by forwarding the slides, and commending each student on their presentation. The other majors and careers presented by students were early childhood education, graphic design, soccer coaching, athletic director, hotel hospitality, and hotel sales. One young man wanted a job at Nike and presented data on that company. Students seemed attentive, as the hour went on only two or so heads were

on the desk even though the lights in the room were out for the length of the class. One young man had a speech impediment and students were all respectful even though he was difficult to understand. The presentations lasted approximately five minutes each and their works cited was the last slide. Several students were very shy and hesitant and the professor was very encouraging. Students had emailed the professor their Power Point in advance and one woman was hesitant about presenting and the professor said "Yours is great". The woman presented from her seat which was fine with the professor.

One student spoke about his desire to be a writer, a career not traditionally thought of as math-related. He listed the following uses of math in writing: calculate a percent, read a graph, convert units, understanding the difference between an hourly rate and project fee and converting an hourly rate to a project fee. He saw uses for logic, common sense, patterns, yes or no and right or wrong. He also provided salary ranges for writers with the top salary belonging to someone who writes for the New York Times. Another presentation was given by a local soccer coach. He gave many examples of where math was used in his positon including data analysis, pay calculations for employees, and market predictions. This particular non-traditional student, who works full-time and has two children, won the Waterview student-athlete award for 2016.

At the end of class, one young man, an aspiring police officer, approached me and said he had struggled with math in high school. He liked Waterview because, "I'm a name, not a number." The implication was that he mattered at Waterview, and in this course. Professor B's special project allowed students to realize that they were important

and that their interests were valued. It offered students an opportunity to realize the importance of math in their career choices.

I spoke to Professor B's students about relevancy. Sam said he had taken a business and consumer math class in high school, which he thought was very useful. He learned about buying a house, paying a mortgage, rent, cars loans, student loans, and all that "sort of adult stuff". Both Sam and Rob felt the special project – mathematics in their career- was useful. They both hoped to go into some type of sports related career. However, Sam didn't feel the topics in Math 104 would be particularly useful in his future. He said, "Some of the stuff we are going over now [sequences], we won't really use day to day in that [sports management] career."

Professor B: LD understanding. I asked Professor B what brought her to Waterview and she replied, "Well, Don [husband] works here. It just made sense for me to teach here and when I found out what Waterview's mission was, working with kids that are struggling, it made a good match for me." Professor B expressed a desire to work with a particular group of students, "kids that are struggling".

Professor B's desire to accommodate diverse learners was demonstrated in her classes. On the day I interviewed Professor B, she had just given her first test. Students were permitted to use their notes, book, etc., on the first test because she wanted them to succeed and feel confident. She took a lot of testing development classes in her Master's classes and feels the knowledge from those courses is helpful. Midway through the interview I asked Professor B to define learning disabilities in her own words.

> Well, this is going to sound terrible but I think we all have learning disabilities. I think it's just a different learning style. When you and I were in Catholic school, things were lectured to us in class and you learned it or you didn't learn it. And the people that learned it passed on and got A's and the people that didn't learn it stayed back and did it again. Remember I think it's a teacher's responsibility to present material in various different ways so that everybody can get it or benefit from the repeat. You know there are kids that have attention problems but I always teach math with that in mind. Maybe Joe doesn't [understand] but Ralph does but Joe is going to benefit if I teach that way…I'm not into labeling.

Within this brief explanation, Professor B is describing the essence of Universal Design for Instruction (Black, Brodwin & Weinberg, 2014; Dallas, Sprong, & Upton, 2014). Professor B's comment, "…we all have learning disabilities…" is significant. She clearly understands that one-size does not fit all. She thinks it's a teacher's responsibility to present material in different ways since students have different learning styles. It's noteworthy that Professor B is the only math faculty person to have formal training in education—a Master's degree in Education from a prominent school. Her understanding of differing learning styles may be due to her educational background.

One way that that Professor B presented material differently was with the special project. Students had an opportunity to look at math as it related to their intended field of study. Students also had an opportunity to present math-related information to their classmates using Power Point.

Professor B doesn't like labeling students. She spoke about her experience at a parochial school.

> "I would watch parents, they'd be like freaking out because they're slapping this label [special education] on this poor kid…just because this kid needs to hear things more, see things more, doesn't mean they have a disability. They just need a different style of learning. That [labeling] used to drive me nuts."

There is a social stigma attached with the label of special education or learning disabled (Kurth & Mellard, 2006). Labels, as most adults realize, can accompany us throughout our lives. The "specialness" of special education and the "disability" of learning disabled are not labels that adults desire.

Later in the interview I asked Professor B what recommendations she would make to other instructors teaching a diverse groups of students.

> The only recommendations I would say, I mean don't approach it like these are disabled kids. These are just kids that learn differently and they want to learn so you just teach your topic in many different ways. And I think that helps you as a faculty member as well because you learn more. I've learned so much more about math doing that.

Professor B recognizes that students with LD are not disabled. She understands that they learn differently. She supported LD students (and perhaps all students) in the classroom with various practices: emailing Power Points, allowing corrections on test, allowing all students extra time, verbal encouragement, reading homework instructions, and beginning assignments in class. She was willing to meet with students one-on-one

outside of class. Since Professor B taught two sessions of the same course, she allowed students to attend both sessions on the same day to reinforce concepts. I often saw Professor B sitting outside the classroom with students before class began, talking to them about their weekend, activities, etc. Students were very comfortable in her presence. Professor B demonstrated respect for all learners.

Professor B: Affect. Students responded positively when asked about Professor B and Waterview. Professor B's students self-identified their disabilities as ADHD, Learning Disability (not specified), Dyslexia, Communications Impaired, and Asperger's Syndrome. One student, Greg, stated that, "The structure [at Waterview] is really different. Here the professors really care about you…" Anna liked that she could attend either of Professor B's Math 104 classes, or both if she felt she needed reinforcement. She added, "And this class [Math 104] in general is good. This class is like hard at first but once you get the grasp of it and get the help that you need which Professor B is always there for us, for the help and everything…showing that this college has a lot of diverse learners really, like shows here." Rob thought math at Waterview was more "effective than in high school…if you need help, she [Professor B] will help you find the answers." Professor B's students found mathematics challenging but manageable. They were not timid about seeking help. They could attend another session of the same class or get individual help from Professor B.

As mentioned earlier, several of Professor B's students mentioned they wanted her to do more problems on the board. Greg said, "I got the Power Point, sometimes I am more visual learner, kind of, and I like more examples on the board than on the Power

Point. I want somebody who talks about this step-by-step…and it's one of the things Professor B doesn't do. She just gives you a Power Point and that's it. And gives you a [work] sheet…" Jim agreed with Greg and added, "having the work actually done out on the board like really helps me a lot…I like the Power Point, it's a good job explaining …it just feels like when I'm trying to take notes, it's not giving me enough time to do so." Both Greg and Jim wanted Professor B to give more thorough explanations on the white board.

Greg's story is noteworthy in that his past experience impacted his feelings about Waterview and Professor B. Greg felt he was underestimated in high school and would have preferred not to have had as many course modifications as he did. He attended an urban public high school in a northeastern failing school system. Greg's story is remarkable in that he was not initially accepted into Waterview. He attended community college for a semester where he did not do well on the math placement test. He was not allowed to use a calculator during the placement test nor could he use one in his remedial mathematics course. The lack of a calculator affected his performance on both the placement test and in his math class, which he failed. He mentioned the community college provided him with a note-taker when his real need was for a calculator. He reapplied to Waterview the following year and was accepted. Greg liked the math instruction at Waterview and felt that Professor B cared about him. Professor B's caring is in contrast to his experience at a community college where Greg was not provided with the tools he needed to succeed. He was very concerned about his future and planned on transferring to a state school due to financial reasons.

Anna appreciated that Professor B allowed students to make corrections on their returned tests. She was happy to get a few more points. She also made a general comment about the college. Anna sometimes felt underestimated in the past, but not at Waterview. I had several informal chats with other students in Professor B's class and they also had positive comments about Waterview. They indicated that the school gave them a sense of belonging to a community of diverse learners.

Meet Professor C, "The Oldtimer"

Background, philosophy, and classroom. Professor C has been working at Waterview for thirty years. She started her career as a math tutor in the tutoring center and after many years began teaching part-time at Waterview. Her background is undergraduate degrees in history and math and a master's degree in Russian history. She is no longer a full-time employee at the tutoring center but continues to teach at Waterview.

Professor C's LD education came from a combination of on the job training, reading, and conferences. The first conference she attended was held at Landmark College and she has attended several others at that location. Paul Nolting was a conference speaker who she mentioned as a resource for teaching mathematics to students with LD. Another conference Professor C mentioned was held at Wesleyan University and she recalled that elementary school teachers were talking about giving students calculators in second or third grade. She wanted to discuss what they do with students who don't have their multiplication tables memorized by that grade. The teachers at the conference did not want to discuss it with her. Professor C's opinion is

that calculators are given to students at too early an age. Professor C said, "They give them calculators way too soon…when they're working on a complicated algebra equation and they're typing in two times three…it's probably just like a crutch…it slows them down, it's not necessary." Professor C may not realize that some students with math LD may not be able to perform even simple calculations without a calculator.

Professor C feels her students at Waterview have a wide range of mathematical ability. She said, "Students that are willing to work do fine [in my courses]. We have incredible tutoring services." Professor C feels the one-on-one tutoring is a great asset that Waterview offers their students. She uses the same textbook for 104 as Professor B and had Pearson design a custom book for her Math 103 class. She used MyMathLab for the homework assignments in Math 103. She does not like the fact that all of the answers are in the back of the Math 104 book because it doesn't challenge the students. Professor C thought the students would copy all the answers and not solve the problems so she uses Professor A's website for Math 104 assignments.

Professor C provided several definitions for success in the mathematics classroom. One was the basic – a student needs a C- or better to pass the course. Another definition was knowing enough math to be able to function as an adult in our society, and feeling more confident about math. She acknowledged that students have had bad experiences in high school with mathematics. Some of those experiences, according to Professor C, are rude teachers and teachers expecting students to get the material right away. Professor C stated that even students who receive a D or an F on the first test, and come to her for extra help, usually get through the course.

According to Professor C, her classes unfold like this. The class goes over homework problems and students ask questions about material that they had covered. Professor C feels students should spend about 30-40 minutes or so on homework, which she collects and grades. Professor C presents the new material and then looks for volunteers to go to the board to solve problems. The problems are directly taken from the book and she encourages students who need the class notes to highlight them in the book. She does not explicitly provide all students with copies of notes.

Professor C gives two to three tests over the course of the semester in addition to the cumulative final exam. Students can bring a 3 x 5 notecard to each of the tests and two notecards to the final exam. She provided students with all the formulas on the tests. "They don't need to know those formulas in most cases. There's no point in asking them to memorize them." She offers extended time to any student. She said she gives thorough test reviews and practice tests which are similar in content to her official tests.

Professor C: Instruction. Professor C's classroom presentation follows a typical flow—homework is reviewed, new material is presented, and students work on problems. The classes were fairly predictable in how they unfolded. For example, during one observation the class was working on factorials and permutations. The first question written on the board was how many ways can you choose a president and vice president from a group of 6? This problem is directly from the book. The instructor asked if anyone remembered the fundamental counting principle. Many students said "NO" emphatically. She proceeded to write it on the board – if there are *m* objects taken *n* ways then it is *mn*. Using a different color marker, the instructor wrote the formula:

$$_nP_r$$

Note that the variables are *n* and *r* instead of *n* and *m* that was used previously in the fundamental counting principle (*mn*). Students did not comment on this – they may not have noticed or did not understand the formulas.

The formula was explained on the board like this: *n* = a set of elements and *r* = the number selected and the following was written:

$$_nP_r = \frac{n!}{(n-r)!}$$

Students asked some questions and another example using numbers instead of variables was given. The example was:

$$_6P_2 = \frac{6!}{(6-2)!}$$

One student, JT, stated he was taught a different way and the professor responded by asking JT to demonstrate his method on the board. Basically he said start with *n* and count down from *n "r"* times. JT said start with 6 times 5 or count down two from 6 (meaning multiply the first two digits). The professor was gracious and polite towards JT. The professor explained what JT put on the board and said, "I like this method." It appeared to me that JT was saying the same thing the professor said, but using different words. The students had some problems to do in class but first Professor C explained that 0*!* = 1 as does 1*!* She wrote the following on the board and suggested they do it together: How many ways can you arrange six books on a bookshelf? JT again answered the question. A student wondered aloud if it would be 30 but JT explained the solution to him. Professor C didn't return to the original problem of choosing a president and vice-president.

Professor C's approach to permutations was algorithmic and procedural. Although the first two examples used elected officials and books, most of the subsequent examples were formulaic. Permutation is a rich mathematical concept and can be presented in multiple ways. A simple example using student's names might have provided relevant context.

Students worked on these problems: ${}_8P_5$, ${}_{10}P_4$, ${}_5P_5$, and ${}_5P_0$. The professor walked around the room and helped whomever needed it. She checked in with a student who was late and helped him. Quite a few volunteers went up to the board and solved the problems. A student did the first problem incorrectly and the instructor went over it without mentioning or saying the word "wrong." Professor C showed several ways to compute the answers and students participated in this. She made sure that everyone understood and asked how many students were feeling pretty confident. About half of the students' hands went up. She mentioned her office hours which were shortly after class.

Professor C said the next set of exercises was from the book. She wrote the problems on the board for those who did not have their book. The first problem was: There are twelve students, and a president, vice-president, and secretary need to be selected from this group. The second problem was a paint color problem: There are sixty colors and a main color and trim color are needed but cannot be the same. Professor C roamed the room to see how everyone was doing. There was a lot of discussion on the paint problem and students began to argue (politely) over their answers. Volunteers went up to the board including one student who had been struggling. He said, "Math class

isn't so bad when you actually understand what's going on." The instructor replied, "Isn't that amazing?"

Many of the problems in Professor C's lessons were presented without any context. This is noteworthy because Professor C had a difficult time describing the relevancy of her course. In fact, both Professor C and her students had comments about the relevancy. For example, both Mark and Jamie struggled with mathematics in the past. They found it frustrating that they will not use any of the Math 104 topics in the future. Mark stated, "It's something [Math 104] you need to check off a list [a required course], it's irrelevant to me." Jim said, "I don't need to know the square root…I need to know how to balance my checkbook." Mark suggested checkbook balancing should be a class. Mark and Jamie were both full time students in addition to working thirty hours per week. Their time was very valuable. Mark said, "…just going into a class like this [Math 104] …it kind of gets discouraging because I could be doing something a lot more important…"

When Professor C was asked about the relevance of her courses, she said, "It's relevant for a mathematician, I'm not sure of the relevance for our students. I'm curious to know what she [Professor B] is doing [with respect to her course modification for Math 104]." Professor C was curious and wanted "to look at what she's [Professor B] is doing. I was not privy to or aware of any discussions between Professor B and C regarding relevance.

Professor C: LD understanding. I asked Professor C about her students and the number that had learning disabilities during the spring of 2016.

> Well, funny you should ask. I just mentioned in class today, I always mention this the first day and it's in the syllabus that if you have a disability please see me after class, as there's a form for me to sign. Nobody did in either class…I must have students in both classes with learning disabilities, so this has never happened before. Never. That no one asked me to sign these forms…But I'm, I must have students with disabilities and frankly, I don't really teach any differently… we try to be all inclusive.

Professor C's description of teaching and inclusivity is meaningful in that she is willing to include all learners in her classroom and would teach the same way regardless of the student population. She exhibited patience when students were not understanding material, and circulated throughout her classroom to help students. Jamie said, "She's [Professor C] very good…she'll try to explain it [class material] a couple of different ways."

Professor C's recommendation to other instructors teaching a diverse population is to allow them to bring note cards, don't ask students to memorize formulas, and provide extra time to all students. In the past, she gave a quiz on signed numbers that she expected students to complete without a calculator (Math 103). She is not going to do that moving forward and will let students use the calculator for all work. Professor C found that after the quiz, "they [students] didn't learn the rules [for signed numbers], they just used their calculators."

Professor C thinks that it is very important for the instructors to have respect for the students. There is a tactful way to let students know their answer might be wrong and

she doesn't use the word "wrong." She was respectful while students were solving problems on the board. I saw her quietly working beside one student at the board and she helped him correct his answer, guiding him through the process. She does not expect students to know it all.

Professor C: Affect. The disabilities represented in Professor C's focus groups and conversations were: Asperger's syndrome, ADHD, ADD, and one student who had a diagnosis when he was young but was uncertain as to a diagnosis as an adult. One student mentioned math anxiety as an issue. The overall student consensus was complimentary of Professor C. Most of Professor C's students had positive things to say about her instruction. Both Alan and Rudy like her teaching style. Alan had attended a community college previously and was taking math in his final year at Waterview because he "is not good at it". He appreciated the small size of Math 103. He felt he was getting the one-on-one he needs from Professor C. Kerry also mentioned the small class size and the availability of the one-on one with the instructor. Jamie and Mike commented that they have seen Professor C for extra help and that "she is very good one-on-one". This may be due to Professor C's years working in the tutoring center at Waterview. They also mentioned that Professor C explained concepts several different ways in class and that she really understands her students. Although Professor C circulated in the classroom while students were working on problems, Mark understood that the one-on-one is difficult to provide in the classroom setting.

One student in particular in Professor C's class had an impact on other students. Jamie mentioned an incident where Professor C asked if there were any questions near

the end of a class. Jamie raised his hand and another student said something "smart", indicating he was annoyed that Jamie prevented the class from ending early. Both Jamie, Mark, and Deb referred to this student as the "wizard". I was aware of the wizard, JT, during the classroom observations and thought that Professor C could make more use of him in the classroom, perhaps in assisting other students. In retrospect, I think it is an issue of JT's being placed in a class that he clearly did not need.

Another placement issue arose during my research. A student was placed in Math 103 when she had already taken a Math 104 equivalent at a local community college. She was essentially taking a course that was a lower level than one she had already received credit for. Waterview's math placement process is in need of review. Both Professors B and C mentioned this need at the member check.

Mark felt that his classmates get frustrated with him because it takes him longer to understand concepts. "…everyone else in the class seems to get frustrated with me…I'm like I ask questions and I just don't understand it. I just don't understand it…I like the kid, but JT, he gets it like that." The student Mark was referring to is the same student that had annoyed Jamie. Another student, Rudy in Math 103, mentioned how several students were making "animal noises" during class and had other distracting behaviors. Rudy said, "… there are five people that are actually trying to learn and sometimes it get annoying having four of them that are like that…" Classroom management is insufficient and is impacting student learning.

Mark also talked about his anxiety. "…She kind of moves on, and like once I'm starting to get it, she just kind of moves on to a new topic…that's when anxiety kicks

in….then I just get lost and I'm sitting in the back twiddling my thumbs." Despite Professor C's intentions, there are students in her classroom who feel left behind.

Students' LD Understanding

Students willingly shared their disability diagnosis. Since almost half of the Waterview population has some type of disability, students may sense safety in this space, making them feel free to discuss their diagnosis. Their disabilities could be disclosed without fear. Several students talked about the word "disability" and reframed their disability as a difference. Anna said she finds the word disability "…a little bit offensive in a way." Evan said "not to look at disabilities as disabilities but rather differences…just because it's hard for you to get one thing one way…doesn't mean you can't be taught in another way and get it."

Joe spoke about his difficulties being compensated by his strengths. He had difficulty writing and signs his name with an "X" but feels his auditory skills make up for his difficulties. Greg also spoke about his learning disabilities in terms of weaknesses that can become strengths. "…like if I have a presentation [referring to his public speaking class]…it's frightening and sometimes the professor needs to help you improve those weaknesses to strengths." Evan, Joe, and Greg all mentioned teachers and instruction, emphasizing that weaknesses can be transformed to strengths with the proper support. As Joe stated, "Teachers should look for the strength of kids…you take away their difficulties."

Although Joe was diagnosed with multiple disabilities, including physical and learning, he had a positive outlook and felt he had strengths that compensated for his

differences. Evan, a student with multiple diagnoses, also had a positive outlook with respect to his abilities and was proud and self-aware of his math skills: "…math has always been my strongest subject along with pattern recognition…if I had my neuropsych documentation…I could go on and gloat like look at my ninety eight percent and whatever." Evan offered to help his classmates who might be struggling with math – an example of LD students desiring to help each other.

Several students mentioned the impact of self-confidence as well as the confidence others have in them. Evan said, "You want to always feel confidence in yourself …the second you start doubting yourself you take yourself down a notch." Although Joe and Wes appreciated the confidence that Professor A had in them, several students thought it was too much confidence. LD students appreciate confidence but also need to have their feelings of not understanding acknowledged.

Students talked about their academic experiences prior to Waterview. Greg is a student with multiple disabilities including a speech impediment. He was the only student who mentioned bullying that occurred while he was in high school: "…you know how kids are, bullying. Sometimes the kids would call me Forrest Gump kind of things…they called me retarded one time." He defended himself by taking action – he reported the bullies and they were suspended. None of the twenty students I met with mentioned any type of inappropriate actions or comments with respect to their disability occurring at Waterview. I spoke with a math student informally in the hall one afternoon and she inferred Waterview provided her with a community where she belonged. It's a safe space for students with differences.

Mark said that he was diagnosed with ADD in elementary school and that math "freaks him out…it snowballs to a point where I just want to give up." Mark mentioned a high school experience where a math teacher told him not to come to the final because he wouldn't pass. "You're the person who is supposed to be teaching me this…I don't get it and that's my fault?" He felt humiliated. Students bring emotional baggage from the past into the classroom.

Another student mentioned a humiliating experience from high school. Jamie, Math 104, said he was considered special education early in his life but then "they just realized he was lazy…and had me test out of it." He said math really stresses him out and he doesn't like that "there's only one answer." His math high school experience was not good: "…I wasn't understanding it and I would ask her [teacher] questions and she would just like crap on me…by the end I would just take naps [in math class]."

Jamie mentioned an interesting phenomenon—testing out of special education. According to the DSM-5 (2013), learning disabilities persist into adulthood which would seem to indicate that a diagnosis should follow your academic career. However, testing in and out of special education does occur due to the myriad definitions as well as state regulations such as arbitrary capping of services.

Awareness of one's disability varied. Anna talked about having her diagnosis kept from her as a "liability". She found out that she had Asperger's syndrome when she was a teenager even though her parents were aware of her diagnosis when she was much younger. She said she wished that they had discussed it with her. "Sometimes you just want to know…like why do I have these speech therapists, why do I have this, why do I

have that?" Another student, Jim, knew he had a learning disability but did not know what type. According to Jim, "they just tell me I have a learning disability, they didn't say what." Rob's awareness helped him with advocacy. Rob is dyslexic and word problems are a struggle for him. His mother helped him in high school; at Waterview he found the tutoring center to be an asset. "It's been really good. They really work with you. For whatever amount of time you have…take you step-by-step with how you can do it." Rob was self-aware with respect to his diagnosis and took the initiative to get help.

Alan was diagnosed with ADHD when he was four years old and was medicated "for almost my entire life but I weaned myself off the medication because it had bad side effects like paranoia." He "just works out instead. It's my anti-depressant. I mean I do have ups and downs which is similar to bi-polar disorder…ADHD and bi-polar disorder have similar characteristics." Alan has always struggled with math but does not go to tutoring for extra help. "…It's almost like a pride thing. I would go to the tutoring center but I'm almost ashamed to go…I'd rather be the tutor…" Alan was the only student to express feelings of shame associated with extra help.

The next chapter, the Discussion Section, will address the specific research questions. In addition to answering the research questions, Waterview's mathematics program will be viewed through the theoretical framework supporting this research.

CHAPTER V

Discussion and Summary

Nine-tenths of education is encouragement

Anatole France (1844-1924)

My research began as an attempt to identify how to better support diverse learners at the community college where I was teaching. I had been teaching mathematics at the same community college for sixteen years, encountering a wide variety of students. As the literature review discusses, community colleges serve a diverse population and community colleges are the "go-to" colleges for students with learning disabilities. I felt that my community college was not adequately supporting students with LD. The ADA and Section 504 were followed, but as Holliday, Knoop and McGlaughlin (2005) point out, blanket accommodations do little to help students of varying abilities who do not have documented disabilities or have chosen not to identify themselves. I felt the college's mathematics program was discriminatory, punitive and abusive. I informed the college's academic dean of my concerns and she agreed with my description but no action was taken to remedy the situation.

I became aware of Waterview College in the early 2000s when a parent casually mentioned the school to me. Her son had a learning disability and had attended Hudson Transition. The parent described the school as one where LD students were supported and thus thrived. I filed this mention in my long-term memory, thinking that one day I may need it because I had a young daughter with a learning disability. When it was time for my daughter to attend college, I recalled the conversation. I wanted my daughter to

get a college education at a school that could accommodate a variety of learning styles. My daughter attended both Hudson Transition and is a 2016 graduate of Waterview College.

This purpose of this research was to gain insight into Waterview College's mathematics program. The research questions that guided this study were:

1. How is mathematics taught at a small, private liberal arts college that self-describes as accommodating to diverse learners?
2. How do students describe their own experiences of learning mathematics at this college?

The "how" questions led me to decide that a case study was the appropriate methodology. Waterview's mathematics program was the particular intrinsically bound case. The data were analyzed using constant comparative method which, as the name implies, compares each new data piece with the previous data to determine and refine categories. Please note that unless specified, the Waterview College and Hudson Transition mathematics programs are considered as one.

The individual research questions will be addressed first. That will be followed by viewing Waterview's mathematics program through the lens of the theoretical framework.

Question 1

How is mathematics taught at a small, private liberal arts college that self-describes as accommodating to diverse learners? To answer the first research question, it's essential to know who is teaching at Waterview. The findings indicate that

mathematics is taught by three dedicated part-time instructors who are devoted to students. Their part-time status gives them no guarantee of employment from semester to semester. All three instructors only teach at Waterview although one instructor does have two outside consulting businesses. The instructors have decades of teaching experience among them; however, only one instructor has formal training in education. None of the instructors received specific training on learning disabilities from Waterview.

Faculty teaching at an institution that accommodates diverse learners should understand learning disabilities. Waterview does not provide any formal LD training prior to employment. Waterview's math instructors had varied understandings of LD. Professor A, the coach, viewed learning disabilities as a physical problem in need of a solution that he could provide by giving student notes, using a larger font size, or wearing a microphone. Professor A did not talk about student processing difficulties, nor did he address working memory issues. He equated memorizing multiplication tables to memorizing ABCs. This analogy underestimated what is involved in learning multiplication facts. He felt confident in his own explanations of concepts and made no mention of modifying or adjusting his teaching methods, all of which were self-taught as he does not have an education background. Professor A felt that practice, practice, and more practice would lead to understanding and success in the mathematics classroom. Professor B, the newbie, had formal educational training (Master's degree in Education) in addition to non-Waterview teaching experience. She said she thinks that everyone has some type of LD and felt it was a teacher's responsibility to present material in different ways. Professor B recognized that students with LD should not be considered disabled

and understood that LD students learn differently. Professor C is the old-timer. She has been teaching and tutoring at Waterview for decades. She does not have formal teacher training and her LD background came from workshops and her Waterview experience. She said she tries to be all inclusive in the classroom. Her approach to teaching mathematics doesn't change whether she has students with LD or does not have them.

College is a transition period for all students, especially for students with disabilities. As discussed in the Literature Review, college students with disabilities who desire accommodations must self-identify and also provide appropriate documentation of the disability. If the documentation does not meet the college's requirement for timeliness or completeness, the student may have to pay a considerable sum to be reevaluated. Additionally, accommodations are not automatic: the disability services coordinator reviews the documentation and determines if the student can meet the program requirements in spite of the handicap or disability. If the accommodations are approved, the student must inform their instructor. The process can be time consuming, intimidating, confusing, and unwieldy for a student with disabilities. The NLTS2 (Newman, Wagner, Cameto, & Knokey, 2009) found that fifty-five percent of post-secondary students who were identified with a disability in high school did not consider themselves disabled when they arrived at a college or university. No explicit reason is given for this; it may be that students do not want to be labeled or they may want to attempt their course work without accommodations. Research (Kurth & Mellard, 2006; Dean, Osborne & Weis, 2014; McLeary-Jones, 2008) suggests accommodations can be

ineffective, isolating, difficult to obtain, and inappropriate for a student's disability. It's not surprising that students who have disabilities may not want to self-identify.

What happens at Waterview College with respect to identification and accommodations? The formal process for LD identification is the same at Waterview as it is at other colleges and universities. What may be different at Waterview, with respect to mathematics, is the instructors' philosophies and teaching styles. For example, Professor C commented that she hadn't received any accommodation forms from students this past spring. Even though no forms were submitted, she stated, "I must have students with disabilities and frankly I don't really teach any differently. Yes, we try to be all inclusive." Professor B felt "we all have learning disabilities." She also stated "it's a teacher's responsibility to present material in various different ways so that everybody can get it." Professor A stated that he'll accommodate "where possible" and told students to come see him if they need "bigger font for the tests, if you need me to put something around my neck so you can hear me, if you need more time, more space to take an exam, if you need the notes."

The instructors provided various accommodations to most students regardless if they identified as LD or not. Professor A provided copies of his notes and did not require students to memorize formulas. He also provided students with extra time. Professor B emailed copies of her notes to students, allowed corrections on returned tests, provided extra time on tests, provided formulas, read the homework instructions in class, and began homework assignments in class. Professor B also had students look at math differently through their own lens by introducing a special project. The special project

had students investigate how math was used in their career choice. Professor C did not provide notes but since her problems were directly from the book, she had students highlight them in their books. She provided students with formulas on the tests and allowed students to bring note-cards to tests. Students could write whatever information they felt was important on the cards. Professors B and C both stated that they gave thorough reviews before the final exam. All three professors had office hours and were willing to meet with students at the students' convenience.

The results of this case study revealed that Waterview's mathematics faculty supported LD students beyond what is required by the law. For example, in addition to providing LD students with their entitled accommodations such as extra time on tests (in addition to generally providing them to all students), Waterview's math faculty provided summary review information and practice tests to all their students. Faculty did not expect students to memorize mathematical formulas and students were not typically assessed on their memorization skills. In most cases, notes and Power Point presentations were available online. Additionally, professors were willing to provide extra help to students outside of the classroom. The professors remained after class to help students and were willing to meet with students at mutually convenient times. One student mentioned that "Professor B is always there for us." Quite often the perception of adjuncts is that they teach their course and leave to teach elsewhere. This is not the case with the three Waterview adjunct mathematics professors.

Geary (2003) wrote about the specifics of Mathematics Learning Disability (MLD). Waterview's professors supported students who may have two of the general

subtypes of MLD that Geary (2003) discussed: procedural and sematic memory. Students with procedural subtype of MLD often use immature procedures and make frequent errors in the execution of the procedures. They may have poor understanding of the concepts underlying procedural use and have difficulty sequencing multiple steps. Professor B allowed students to make corrections on tests after they were returned. Students had an opportunity to correct their procedural errors and receive partial credit. Professor C guided students through multi-step problems while students were at the board, helping students that may have difficulty sequencing steps.

Semantic memory subtype of MLD refers to difficulties retrieving mathematical facts, and a high error rate in retrieved facts. Additionally, this subtype may have difficulty discerning relevant and irrelevant information. Students with this subtype were supported by all three professors. Professor A wrote formulas on the board during a test. Professor C allowed all students to bring notecards for tests. Professor C also provided practice tests for her students, which help students discern relevant verses irrelevant information, another characteristic of MLD (Geary, 2003). Professor B created what she referred to as a "cheat sheet" for each class that highlighted the important information from the lesson, providing students with relevant information. Additionally, Professor B allowed her students to bring notes, their books, and other supporting material to their first in-class test. Students didn't need to memorize soon to be forgotten material. Students were able to use calculators in class in most cases.

The visual spatial subtype of MLD is characterized by difficulties spatially representing and understanding numerical data. Complex word problems and certain

geometric topics are difficult for this learner. Students may have had this subtype but support was not observed as geometry and complex word problems were not part of the coursework.

The classroom supports offered by Professors B and C helped students with working memory issues. Working memory, as defined by Berch (2011), is a "limited capacity system for storing, maintaining, and mentally manipulating information over brief time periods to serve other ongoing cognitive activities and operations" (p.22). Abedi, Aghababaci and Malekpour (2013) talk about working memory as the ability to store and process information simultaneously. Professor B and C's students were not asked to memorize formulas and procedures for assessments. They were provided with what they need to know and were able to practice the skills before the tests through practice tests and summary information. Working memory load was lightened for all students, but in particular those with MLD. Unnecessary and irrelevant information did not burden working memory. Students could concentrate instead on the procedures which often involved "plugging" numbers into formulas. Although formulas were provided, the ability to "plug' numbers into formulas is of questionable educational value. According to the college president and academic dean, Waterview plans on a self-evaluation of their mathematics program in the near future.

Sullivan (2005) reported on factors that promoted success for LD students in the college mathematics classroom. The study emphasized classroom instruction and teacher-student mutual respect. Professor C stated in her interview that "it's really important that the teachers respect the students. [Respect has] got to go both ways." Her

words were supported by her actions. Professor C was gracious and polite to all the students in her class. During one observation, a student did board work incorrectly. Professor C went over the problem with the student without mentioning or saying the word "wrong." Her manner was gentle and respectful at all times. Positive feelings were expressed by students in both Professors B's and C's courses. One student commented that "Math class isn't so bad when you actually understand what's going on" and another student remarked how he liked Waterview because he was a name and not a number. The implication was that he mattered at Waterview. Conversely, Professor A, according to students, took a less respectful approach in the classroom. As the focus group results demonstrated, several students feared him. Research by Gerber, Ginsberg and Reiff (1997) revealed adults with LD to have some bad memories of school. Those memories include feelings of fear, terror, and frustration. Waterview students confirmed this finding in the focus groups when discussing their math experiences prior to Waterview. Unfortunately, Professor A did not remedy those feelings for several students.

How is the mathematics taught? The answer to that question, in most cases, is procedurally. The topics covered by Professor A in Math 102 were basic concepts, for example, fractions, decimals, and percent. There was generally no context associated with the procedures when they were explained to students. For example, students were presented with two fractions and shown how to add them, using procedures, which is something students had probably seen many times before. Professor C's instruction was also procedural in nature whether it was Math 103 or Math 104. For example, the formula for sequences was presented, and although an initial example had some context,

the problems students worked on did not. Permutations, a topic with many applications, was also taught procedurally. Professor B added context to her Math 104 course with a special project. Students had to investigate and present how mathematics was used in their major or future career choice. Context and relevance were not present in her typical classes – they were also procedural in nature.

All three professors relied on traditional teaching methods. The classroom flow was predictable: go over homework, present new material, and work on in-class problems. Technology was minimally used in the classes. Professor A occasionally showed an overhead slide from his computer. Professor B used technology to present the material via Power Point slides. Several student commented on Professor B's use of Power Point. Students preferred that more work be done on the white board. The students wanted the problems worked out in a step-by-step way as opposed to all the steps on one slide. Students said they had a difficult time taking notes at the pace the material was presented. The subjects in Gerber, Ginsberg and Reiff's (1993) described their processing problems as "breakdowns in processing" (p.118). Asking students to look at Power Point slides, take notes, and absorb information simultaneously could contribute to a breakdown in processing.

The instructors defined student success not in terms of a grade, but in terms of relating to students' feelings. Professor A felt success was students having fun in the classroom, but as you read, many students were not having fun. Professor B wanted students to feel accomplished and structured her tests so students could succeed. Professor C wanted students to know enough math to function in society. Given

Professor C's definition of success, it was surprising that she did not modify the course to make it more relevant, reflecting how math is used in society.

Question 2

How do students describe their own experiences of learning mathematics at this college? To answer the second research question, it's essential to know the student population at Waterview. Approximately 40% of the student population has some type of disability, including learning disabilities. It is a diverse group of students who have many challenges and can present many challenges in the classroom. Here is a list of some of the diagnoses that were present in Waterview's math classes: Learning Disabilities including Dygraphia and Dyslexia, Autism Spectrum Disorder, Asperger's Syndrome, Post-traumatic Stress Disorder, Cerebral Palsy, Epilepsy, and Obsessive Compulsive Disorder. I've taken the liberty to alter a famous saying regarding autism and substituted learning disabilities: "If you've met one person with learning disabilities, you've met one person with learning disabilities." In other words, students with LD are very different from each other. Instruction that may work for one student with LD may be completely inappropriate and unnecessary for another student. It is not surprising that students responded to their mathematics instruction in different ways.

How do students describe their own experiences of learning mathematics at Waterview? There is no short, single answer to that question. The findings indicate that one professor's demeanor had a negative effect on students and their learning. One

student felt disenfranchised from the mathematics classroom, fearing Professor A. The student's fear caused him to skip the following class. Several students referred to Professor A's tone of voice as loud and intimidating and felt he was sarcastic. Students talked about Professor A's inappropriate language in the classroom. Although Professor A claimed to encourage students' questions, several students mentioned that they had to be very specific when asking questions and that he does not like general questions. Students didn't understand why Professor A had them do assignments independently, and not work together. Students indicated that they want to work together, but were discouraged from doing so. This was a missed opportunity particularly because Professor A's students all attended Hudson transition and were living in the same dorm. Students could have been working together, collaborating on group projects.

Professors B and C's demeanor did not affect students in the way that Professor A's did. Their students were not timid about asking for extra help and both instructors encouraged this. Specifically, several of Professor C's students commented that she was good one-on-one. This may be due to her extensive experience working in Waterview's tutoring center. Although students were pleased with the instructors, several of Professor C's students mentioned classroom management issues. These issues had an impact on student learning. For example, one student in Professor C's Math 104 class was a "hijacker", or that is someone who answers all the questions and gets frustrated when others aren't as quick to understand. A student in Professor C's Math 103 class complained about classmates making inappropriate noises while Professor C was speaking.

Students spoke about the relevance of math courses. As mentioned, most of the lessons were procedural in nature. Professor A's lesson on shopping, which had the real world component of a supermarket, was outdated. His lesson on unit pricing, in which students made up product size and prices, was confusing for students. Professor B did add relevancy to Math 104 with the special project, but the remainder of Math 104 was procedural. Professor's B and C acknowledged the lack of relevancy and students are also acutely aware of it. Students made comments like the following about their courses usefulness: "…probably won't ever use but for like a quarter second of life" and "…it's something you need to check off a list, it's irrelevant to me." Several students mentioned courses that they had taken in high school, including topics like personal finance, which they felt were much more useful. The lack of relevance for students can be considered another missed opportunity—an opportunity for real learning to occur and for students to develop an appreciation for mathematics.

The next section will address Waterview's mathematics program as viewed through the lens of Freirean Social Justice, Adult Learning Theory, Socio-cultural Theory, and Transformative Theory.

Freirean Social Justice

The concept of social justice is the most important theory underlying my research. I have navigated the LD world for decades as a parent and math educator and have witnessed the discrimination and oppression that sometimes occurs. Freire discussed the task of the oppressed, "to liberate themselves and their oppressors as well" (Freire, 1970, p. 44). Liberation has many forms. It can be physical liberation or it can be liberation

from thought. For example, an adult with LD can be liberated from thoughts of inadequacy, such as inadequacy in the mathematics classroom. This section will view Waterview's mathematics program with a Freirean lens of social justice for the adults with learning disabilities.

The existence of college programs like Waterview and Hudson speaks to the importance of social justice for adults with LD. A recent New York Times article stated that "people with disabilities are the largest minority group in the United States" (Garland-Thomson, 2016). Included in this minority group are adults with LD. Their educational needs are often underserved. Waterview's mission is to live and learn "alongside students from different backgrounds, ethnicities, and learning styles" (Waterview College, 2016). The institution offers students with LD an opportunity to get a college degree. Adults with LD should be provided with the same college opportunities as their peers without LD. Those opportunities include a safe, friendly mathematics classroom where different learning styles are supported and respected.

A college where all learning styles are part of the community would impress Freire because of the opportunity for liberation it offers. Waterview College is proud of their diverse community, and rightfully so. It's a place where students feel comfortable and recognized for who they are and how they learn. As one student stated, "I'm a name, not a number". Diverse learners are accepted, but perhaps more importantly they are not made to feel different. What does that mean? Let's take the mathematics program for example. Students do not need to identify themselves to the disability office in order to obtain accommodations. Standard accommodations, such as extra time on tests, are

provided to all students. A learner with a disability is not considered disabled in mathematics but is equal with other math learners in their class. Consider the label "learning disabled" and juxtapose that with what our society considers the opposite end of the learning spectrum, the "gifted and talented." At Waterview, a label that carries a negative connotation has been removed. A learner is no longer "disabled", but abled in mathematics.

We should think about the formal process of obtaining LD accommodations in most colleges. It is a process that many students prefer not to go through. The NTLS2 (Raue & Lewis, 2011) found that 55% of students who identify as disabled in high school do not identify as disabled in college. There are several reasons for this. In addition to the social stigma connected with the label learning disabled, there is also the economic factor. If an LD student wants or needs accommodations, several steps are required to obtain them. Colleges require proof of disability, usually in the form of neuropsychological testing which can be prohibitively expensive. It's an unfair practice to require expensive documentation to obtain basic accommodations. In this respect, the ADA (1990) is flawed. For example, a person requiring wheelchair ramps does not have to pay for the installation. A person requiring a calculator in a class that prohibits its use, needs to pay for an evaluation, get the documentation approved, and provide the documentation to their instructor. A student must go through this entire process for what is considered an entitlement, the use of a calculator. Additionally, the research (Brinckerhoff, McGuire & Shaw, 1992; Dean, Osborne & Weis, 2014) indicates that standard accommodations may not meet the students' needs. One of Waterview's

current math students, Greg, spoke about his previous math experience at a community college. He needed a calculator but was denied the use of one in his math course. Instead he was provided with an accommodation he did not need: a note–taker. At Waterview, he didn't need to obtain special accommodations. Accommodations are provided to all and are not considered accommodations, but embedded support that provides students with the opportunity to succeed.

The commitment of Waterview's math instructors is commendable. The three instructors that I observed were part-time employees without job guarantees. They devoted many hours of their own time meeting with students and often mentioned their outside availability during class. They encouraged students to see them for extra help. I often encountered Professor B sitting outside her classroom, while waiting for the previous class to vacate the room, having informal conversations with students. Professor C asked her students about their weekend plans and students were comfortable having conversations with her also. Freire (1998) mentions teacher's gestures having a profound impact on students. I consider small talk, or interest in students' lives, in the same category as gestures. Friendly gestures and conversations help to establish a positive relationship between instructors and learners.

There are several areas of concern in Waterview's mathematics program with respect to social justice. The first area of concern is teacher-student mutual respect. Professors B and C respected their students and demonstrated their respect in the classrooms. Students appeared comfortable asking questions and called both instructors helpful. It is the duty of the teacher to respect the student (Freire, 1998). Respect for the

student and their life experiences was not always present in Professor A's classes. Students mentioned that he occasionally called their questions "stupid." He also ignored students when they had their hands raised in class. As described in The Findings Section, one student said he was afraid of Professor A, and this fear caused him to miss a class. I consider his mantra of "Practice, perfect practice" to be an unintended affront to students' dignity. How does a student practice what they don't understand? Students felt that their feelings were denied when Professor A told students they could do a problem that they really couldn't. One of Professor A's students said she was guessing on the homework because she didn't understand it but was expected to complete thirty minutes of practice problems on Professor A's website. Professor A was able to monitor the amount of time students spent on his website. I find the "big brother" aspect of that capability disturbing, particularly for adult college students.

Professor A was a complex instructor with a disconnect between his intentions, his practice, and how students perceive him. Freire and I would suggest he reflect on his practice. Freire says, "Thinking critically about practice, of today or yesterday, makes possible the improvement of tomorrow's practice" (Freire, 1998, p.44). Unfortunately, Professor A did not have the opportunity for reflection. He was not rehired by Waterview. That decision was independent of this research.

Although Professor B and C were well liked by their students and well-intentioned, their instruction fell short of meeting Waterview's stated mission of "teaching how you learn." Waterview's math students with LD are invited into a space that provides what I call "external accommodations" such as extra time on tests and

formulas. What is missing, however, is what I refer to as "internal accommodations." One example of an internal accommodation is an instructor's deep understanding of LD and how it relates to the instructor's subject matter. Waterview does not provide instructor training on LD prior to teaching. Professor A mentioned his training came from reading books; Professor B mentioned professional training from another institution; and Professor C said she had attended workshops years ago. I expected more from an institution that prides itself on the diversity of its population. A deep understanding of the population is missing.

In several respects, the lack of real world relevance in the mathematics program is a social justice issue. Freire (1998) says, "the school…cannot abstract itself from the socio-cultural and economic conditions of its students, their families, and their communities" (p. 62). Several math students mentioned they work thirty hours per week and attend college full time. Students are paying tuition, in many cases taking out loans, for a course that some may feel is not going to help them in their career. Waterview's students want mathematics that will be useful as they move forward in their careers and lives. College is expensive and math courses should provide something valuable to students.

It wasn't only students who commented on the lack of relevance. Two of the three instructors mentioned it also. Although Professor B added relevance to her course, there is a need for critical reflection on the curriculum. Despite instructors' attempts to engage students, the results of this study demonstrate that Waterview's math instructors employ what Freire (2000) describes as the banking concept of education. In the banking

concept, educators deposit information into student receptacles. At Waterview, each math class began with a lecture followed by student attempting problems. Students received, filed, and stored information. Information was then parroted back either in board work or assessments.

Freire (2000) refers to as "narration" in education where a narrator (teacher) talks and the objects (students) listen. The contents or topic "tend in the process of being narrated to become lifeless and petrified. Education is suffering from narration sickness" (Friere, 2000, p.71). This type of teaching is not unique to Waterview but the college should be held to a higher standard because of its positioning as a place for diverse learners. Students attending a college, such as Waterview, that advertises as "teaching the way you learn", should expect more than narration from mathematics courses.

Adult Learning Theory

The art and science of helping adults learn is called andragogy (Knowles, 1973). Andragogy provided another foundational theory for this research. The Literature Review chapter described Knowles' (1973) four assumptions regarding adult learners: 1) Adults are more self-directed learners; 2) Adults' experience is a rich learning resource; 3) Adults are ready to learn things they need to know; 4) Adults are more problem centered and want an immediate application of their learning. Two additional assumptions were added in 1984: Adults are driven by internal motivation and they need to understand why they are learning something (Merriam & Bierema, 2014). The following discussion will look at Waterview's mathematics program through an andragogic lens.

Self-directed learning in its purest form would happen without an instructor; however, very few college students would benefit from or pay for such an environment. Merriam (2014) describes an alternate to pure self-directed learning that is a "psychological climate of mutual respect and trust and an atmosphere of collaboration" (p. 49). As discussed earlier, mutual respect was not always present in Waterview's mathematics classrooms. Additionally, collaboration was not encouraged and one instructor explicitly told his students not to work together.

The second assumption Knowles posits regards adults' experience. Students' previous academic and work experiences are valuable. Professor B's special project took advantage of several non-traditional students' work experience. Professor C welcomed comments from students about their past academic experiences when she solicited their way of thinking about various topics. For example, one of Professor C's Math 103 students described the "rainbow" concept for multiplying polynomials. Although the mathematics in this example was not revelatory, respect for the learner's previous experience was present. Professor A missed an opportunity regarding students' experience. Many of Hudson transition students attended private schools, specializing in teaching students with LD. If Professor A had allowed students to collaborate, they could have shared their experiences and helped each other learn.

According to Knowles' (1973) third assumption, adults have a readiness to learn. Let's consider this in relation to Waterview's mathematics program and relevancy. Students want relevancy, particularly in Math 104, their terminal course. There is an old proverb that says, "When the student is ready, the teacher is there." Andragogy assumes

the student is ready. The teacher must be there with relevant topics to engage the learner. Merriam (2014) suggests that adult educator create the readiness for learning through experiential instructional techniques. Professor B special project attempted to put students in their career and "experience" how mathematics was used.

Problem centered learning and immediacy is the fourth of Knowles' (1973) assumptions. Let's examine Waterview's mathematics program with respect to problem centered learning. Again, the relevancy of the math courses comes into play. I'm thinking about the criminal justice major, Jamie, who was taking Math 104 and was confused by the topic of permutations. He said he would have preferred a math course that would "match my major…help [me] graduate knowing what I need to know." This student will most likely not use the formulas for permutation in his future. This student mentioned that he had taken a math for life course in high school and he "actually paid attention" because he felt it would be useful in his future. Problem centered learning, whereby students are examining real life problems and issues and developing solutions, would be more engaging for students than the current mathematics curriculum.

The last two assumptions deal with internal motivation and immediacy of learning. Internal motivation is a powerful force that can move people forward; lack of motivation can have the opposite effect. One way to demotivate a college student with LD is to make them go through the disability accommodation hoops. Additionally, the social stigma associated with formally identifying oneself as learning disabled can resurrect feelings from the past such as fear and frustration. The ethnographic research conducted by Gerber, Ginsberg and Reiff (1997) on successful adults with LD revealed

that their memories of school included feelings of fear, terror, and frustration. Those feelings can be demotivating for a student. Waterview's math students were fortunate that standard accommodations were provided to all. An adult with LD did not have to go through the formal accommodations process to be eligible for accommodations

Another layer of feelings may arise from the subject of math itself. Dirkx (2008) states that "the subject of math often evokes considerable anxiety among many adult learners" (p. 10). Anxious feelings have the potential to demotivate. One student, Kerry, commented on experiencing math anxiety while in high school and at the community college. The small class size and one-on-one help from Professor C helped her deal with her anxiety.

Internal motivation can be impacted when students find the topics irrelevant, or when the "why" of learning is missing. The "why" of learning was often missing in the mathematics classroom. Professors B and C realized that much of the material they were teaching was irrelevant. Students frequently mentioned the lack of relevancy. Professor B's students did find relevance with the special project of relating mathematics to their career choice and major. With respect to emotions and feelings about the instructors, Professors B and C's students spoke positively about their classroom experiences. As previously described, Professor A's students did not. Students used powerful words to describe their negative feelings about him. It wasn't the curricular content that drove the feelings, but the instructor.

Andragogic assumptions need to be included in Waterview's mathematics redesign. One concern with andragogy as a theory though is its lack of socio-cultural

concerns. The next section will address Waterview's mathematics program through the lens of socio-cultural theory.

Socio-cultural Theory

Socio-cultural theory supposes that development cannot be separated from social context. Vygotsky's (1997) theory can be extended to mathematics at Waterview. Students come to college with a variety of learning styles and backgrounds. Learning disabilities has its own sociolect. For example, Greg, a student discussed in the findings, talked about being bullied in high school and called "retarded." Fortunately, that word has been retired from the official learning disabilities lexicon but it has not been retired from society in general. Students with LD are referred to as special education students and the negative connotation associated with that label has already been discussed with respect to social justice. The term "slow learner" has been used to describe students with LD and that term can be offensive and insulting to LD students. The diagnosis of learning disabled can be literally translated to "not able to learn." Waterview's students are fortunate because the sociolect changes when they arrive at the school. Waterview is not advertised as a college for students with learning disabilities; rather the term different learning styles is used. Waterview does have a Disability Services coordinator as required by law; however, as we have discussed, mathematics students don't need to identify themselves as learning disabled to receive accommodations in their math classes. A new sociolect of "able to learn" is available to the math student.

Students made general comments on how they thought about themselves at Waterview. For example, Anna said that her "Autism doesn't really get in the way" of

learning. Another student informally mentioned that Waterview provided her with a sense of belonging. The potential for a culture shift happens at Waterview. Students are no longer part of the learning disability community but rather they are part of the larger community of college students.

I'd like to consider socio-cultural theory in another way with respect to Waterview. An organic social group is formed for many students when they arrive at the college. It's organic in the sense that a number of students have some type of disability, take the same classes, and live in close proximity. A community of adults with learning disabilities should help one another learn. This is particularly true of the Hudson Transition students who reside in the same dormitory complex. Most of Hudson Transition students attended private high schools geared towards students with LD, ADHD, or ADD. (Please note that not all Hudson Transition students are classified as having a learning disability.) Some of them have struggled with math in the past, but many have not. Several Hudson students mentioned that their math skills were strong but their writing and reading skills were lacking. The potential exists for students to serve as More Knowledgeable Others, a term Vygotsky (1978) used to describe someone with a better understanding of a concept than someone else. Students who are proficient at math could work with other students on group projects and assignments. Students expressed a desire to learn together but Hudson Transition students were explicitly told by Professor A to work separately on their mathematics assignments. Peer support should be bettered used in the Hudson Transition mathematics courses.

Professors B and C neither encouraged nor discouraged students from working together. I observed students in Professor B and C's classes working together on in-class problems, but not on a regular basis. There was one student in Professor C's course who could have been a help to other students. He was clearly an MKO. His classmates referred to him as "the wizard" –he seemed to have all the answers before other students had picked up their pencils. His placement in MA 104 was clearly incorrect based upon his ability. Nonetheless he could have been a resource for other students during the semester.

LD students' frame of reference, as a person who is "learning disabled", has the potential to change, to transform, and take on new meaning, that of a person who is able to learn. The next section will view Waterview's math program and students through the lens of Transformative Theory.

Transformative Theory

Mezirow (1997) states "adults have acquired a coherent body of experience—associations, concepts, values, feelings, conditioned responses—frames of reference that define their life world" (p.5). The process of making meaning from one's experience is the essence of transformative learning (Merriam & Bierema, 2014). Transformation happened at the individual level at Waterview. Waterview's LD students arrived from various academic backgrounds. Some students were fortunate to have attended high schools specializing in LD. Other students attended their local public high schools. Regardless of their schooling background, many of Waterview's math students had been classified as learning disabled in their high school programs. One math student, Jamie,

mentioned how he felt "dumb" in high school. Mark's high school math experience was discouraging; his instructor told him not to come to the final exam. He said, "How is that going to make me feel?" implying it did not make him feel confident about his ability. Waterview provided him and other students with an opportunity to change or transform their perspective, or feelings, about themselves and their abilities. No longer are they at a special LD school, or a public high school with special education, but they are included in a wider community of learners of all types. The meaning from their previous experiences had been transformed from being disabled to being capable or able. One student said, "Math class isn't so bad when you actually understand what's going on." He was able to learn.

Another specific incidence of transformation occurred with Joe, who described his high school math experience as one where instructors looked at his math skills as something that needed to be "fixed". At Waterview, Joe appreciated the confidence that Professor A had in his math abilities. However, this contrasts with another student, Andy, whose experience with Professor A was much different. Andy's experience left him disenfranchised from the classroom. Andy's transformation, or meaning from his experience, came from the fact that felt he was not welcome as a participant in Professor A's math class. He found the class and the instructor intimidating.

Professor B's special project provided an opportunity for transformation for students. One student, Sam, mentioned how the project "really opened my eyes" to mathematics in relation to his career choice, sports management. The special project transformed his thinking; his eyes opened to the usefulness of mathematics.

The meaning that students take away from Waterview's math curriculum is one of irrelevancy. This is a lost opportunity for transformation. The nature of the math instruction does not promote transformation of students' thinking. A more relevant curriculum which engages students in their own learning should be considered as the math program is revised. College is a time when students should examine their beliefs and quite often students believe they hate math. It's not hard to hate a course that's irrelevant. A relevant math course could transform math hatred into math appreciation. Instructors should think about ways that their math instruction can transform students' thinking for the better.

Summary

The post-secondary mathematics classroom is a challenging place for both instructors as well as students. Instructors are faced with students of varying abilities and learning styles. Those of us in the mathematics classroom know how difficult it can be to accommodate a variety of learning styles and abilities--and we may only have a handful of students who have self-identified as having a learning disability. Waterview instructors may have up to 40% of their students presenting with some type of disability. Waterview's professors want students to succeed and they defined success in terms not directly related to grades. The instructors described success as feeling confident and accomplished in math, and knowing enough math to function in society. The professors were willing to provide all students with the accommodations that the professors felt would help students succeed.

Waterview mathematics program is small, but its mission is large – teaching mathematics to a wide variety of adult learners. This is accomplished by a faculty with compassion for its students and some understanding of students' needs and abilities. The faculty are dedicated, seasoned professionals who give over and above what is required contractually. I found it surprising that Waterview College does not have professional development for their educators. A college that advertises as teaching the way students learn should have faculty training on learning differences.

Students perceive the mathematics they are learning as irrelevant. Additionally, many students had negative feelings about one instructor. Moving forward, Waterview plans on revising their mathematics program, making it more problem-centered and relevant. I have been asked by the college president and the academic dean to play a role in this transformation. I am teaching two math courses at Hudson Transition this semester (Fall 2016). I hope to gain additional insight into students' needs and concerns. Freiran Social Justice, Adult Learning Theory, Socio-cultural Theory, and Transformational Theory will play a large role in both the design and instruction of the mathematics program.

David Brooks wrote in The Road to Character (2015), "When you go to a school, it should offer you new things to love" (p. 211). It's doubtful that Waterview's math, in its current state of same old procedural methods taught in the same old way, will be a new thing for students to love. However, the potential as the mathematics program moves forward is considerable.

Contributions, Limitations, and Future Research

My desire to better serve adults with LD in the mathematics classroom prompted this research. As I began my study, it quickly became apparent that this field had very little existing research. There were many gaps in the literature particularly with respect to adults with LD in the post-secondary environment. This study contributes to the field by providing a rich description of a mathematics program at a college that matriculates adults with learning disabilities.

All research, regardless of the type, has limitations. One limitation of this study is the generalizability of all case studies. There is ongoing debate regarding generalizability along with other issues regarding case study research (Flyvbjerg, 2006; Merriam, 2009). This study considered only one case, and although I triangulated the data and methods and held a member check meeting, this research represents one semester at one college. I interviewed twenty math students so this study is not representative of all math students at Waterview. The findings would vary if they were repeated. That is the nature of qualitative research; people and situations change.

Student with learning disabilities are attending college in increasing numbers (Sweener, Kundert, May & Quinn, 2002; Orr & Hammig, 2009). This growth, however, is not accompanied by a growth in research. There are many areas that need to be explored and studied, and I will list a few of them. This is not a comprehensive list but instead represents a starting place for discussion.

There is a need for LD professional development (PD) at the college level. Waterview does not provide their instructors with PD prior to teaching. The community

college where I worked previously did not provide this type of PD either. Faculty teaching mathematics at a post-secondary institution need to understand the characteristic of mathematics learning disabilities and be made aware of ways to support all students.

Waterview mathematics instructors provided what I refer to as "external" accommodations such as extra time on tests and formulas. There is a need to research what I call "internal" accommodations. For example, what type of instruction best serves math students with LD? How can instruction be modified?

The focus group interviews I held with students were revealing. LD students have a voice that needs to be heard. Clinical interviews with those students would provide a deeper understanding of the feelings and issues that affect college students with LD.

Waterview's students discussed the relevance of their math courses. Mathematics researchers need to consider what type of mathematics is necessary for students who are not planning to enter a math or science field.

Math instructors can have a significant impact on student emotions. What type of instructor personality characteristics are necessary to instruct a diverse group of adult learners?

Universal Design for Instruction (UDI) provides for equal opportunity for all students to learn. How will this framework affect mathematics instruction at the college level?

These are only a few of the areas that should be explored. The opportunities for further research are many and the need is great. I hope my research motivates others to enter this field of study. Adult learners with LD and their instructors need and deserve it.

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ATTACHMENT I

Fall 2015
A Case Study of the Mathematics Program at Waterview College
Semi-structured Focus Group Interview Guide

1. **Tell me about where you are from.**
   How long have you been at Waterview
   What do you like about Waterview?

2. **How do you feel about the subject of math?**
   Why do you have those feelings?

3. **What kind of mathematics did you take in high school?**
   How many years of math?
   What were the classes like?
   What kind of extra help, if any, did you receive?

4. **What type of mathematics have you taken at Waterview?**
   What were the classes like?

5. **How were the Waterview classes different than your high school classes?**
   What, if anything, was helpful at Waterview?

6. **Do you have anything else to say about math?**
   What kind of math do you think you will use in the future?

Fall 2015
A Case Study ofthe Mathematics Program at Waterview College
Semi-Structured Faculty Interview Guide

1. **Tell me about your background and education.**
   Sub-questions
   How long have you been teaching? Where else have you taught?
   What did you study in college and graduate school? Any courses on pedagogy, adult learning, or special education?

2. **Tell me about what brought you to Waterview College**
   Sub-questions
   How do you feel about working at Waterview? What do you like or dislike?
   What is your teaching philosophy?

3. **How do you define learning disabilities?**
   Sub-questions
   What type of professional development have you found helpful in terms of understanding adults with LD? What was your understanding of LD before Waterview? What is it now?

4. **What types of accommodations do you make for students in the classroom?**
   Sub-questions
   Tell me about a typical mathematics class. Describe your instructional practices.
   How are your students assessed?

5. **What do you consider success in the mathematics classroom?**

6. **Is there anything else you can tell me today about your teaching strategies and philosophy that may help other instructors teaching diverse learners?**

Thank you so much for your time today. Do you mind if I contact you for a second interview (if needed)?

ATTACHMENT II

WATERVIEW MATHEMATICS COURSE DESCRIPTIONS

I have provided descriptions for the Mathematics courses that were observed during the spring semester 2016 at Waterview College. The descriptions are directly from the Waterview college catalog.

MATH 102

Fundamentals of Algebra: Includes a review of arithmetic and geometric concepts: operations on signed numbers, fractions, decimals, percent, exponents, perimeter, area, volume, surface area, use of formulas, variable expressions, linear equations in one variable, graphs of lines, word problems and time permitting, linear systems of two equal equations and two unknowns. This course is intended for students who have little or no background in algebra. Credit for this course does not count towards the Mathematics requirements for the Bachelor's degree at Waterview College. Credit for this course does count towards the Mathematics requirements for the Associate's degree at Waterview College.

MATH 103

Intermediate College Algebra: Intermediate Algebra is designed for the student who may need review or reinforcement in algebra concepts and problem solving. The course will cover solving and graphing linear equations, using and applying formulas, polynomials, exponents, radicals, factoring and quadratic equations. Credit for this course does not count towards the Mathematics requirements for the Bachelor's at Waterview College.

Credit for this course does count towards the Mathematics requirements for the Associate's degree at Waterview College.

MATH 104

Mathematics for Liberal Arts: MATH 104 is designed for students who will not pursue science or business careers. It covers logic, set theory, sets of numbers, summations, summation notation, functional notation, permutations, combinations, and, time allowing, other topics such as the Mathematics of finance and Mathematics and art.