5-14-2023

An Investigation of the Impact of Embedding Learning Strategies into Developmental Mathematics Curriculum

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Abstract

More than two-thirds of first-year community college students require remediation in reading and/or mathematics before they can take college-level courses. Among these underprepared students who take the recommended developmental mathematics courses to become college-ready, less than one-third successfully complete these courses, posing a barrier to their access to a college education. Developmental education has been criticized and has undergone various institutional reforms, but limited research has investigated the mathematical perspectives of community college students in developmental mathematics courses. The two research questions that I investigated were: what effects does taking a developmental mathematics course that incorporates learning and study strategies have on students' strategic learning skills; and how do students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences? The theoretical frameworks of social cognitive theory and the framework for student success (productive persistence) guided the design of my investigation.

To conduct this investigation, I used a mixed methods design, gathering both quantitative and qualitative data from 65 participants enrolled in a developmental mathematics course using a reform-oriented curriculum at a community college. Participants took the 60-item *Learning and Study Strategies Inventory (LASSI)* early in the course and again near the end of the course, completing written reflections on a brief survey after each LASSI. I examined quantitative data addressing the first research question, followed by a qualitative analysis of survey data that address the second research question. To gain further insights, I conducted interviews with 10 participants after each LASSI.

The quantitative analysis of the change in LASSI scores over the course of the semester revealed increases in some learning and study strategies. This was supported with comments from students in both written surveys and interviews. I present evidence of how taking a developmental mathematics course using reform-oriented curriculum both lowered Anxiety and improved Information Processing among the n=65, as well as improved Concentration and bolstered Using Academic Resources among the 10 interviewees.

The qualitative analysis of the written surveys and interview data revealed more insights about the students' learning experiences in the classroom both related to, and extending beyond, the 10 learning and study strategies assessed by the LASSI scales. Supporting evidence from written surveys and interview data led to five additional emergent themes impacting the student experience: Doing College, Barriers, Teacher Impact, Groupwork, and Growth Mindset. These factors were largely non-cognitive in nature, revealing psychological factors that influenced student persistence and student success. A discussion of limitations, suggestions, and recommendations for future research is also included.

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Submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy in Mathematics Education

Syracuse University

May 2023

Acknowledgements

Although my journey to completion of this doctoral endeavor was long and filled with challenges, it was also rewarding and one of my greatest accomplishments. I thank God for giving me the strength to persist through this experience and for bringing strong leaders and encouraging people into my path.

I would like to offer my dearest thanks to the supportive Mathematics Education community at Syracuse University. I am especially grateful for my dissertation advisor, Dr. Joanna Masingila, for her patience and support and for shaping my dissertation into what it is today. She is a fantastic mentor, and I have gained much wisdom from her. I also thank my dissertation committee members, Dr. Duane Graysay and Dr. Claudia Miller, both of whom provided recommendations as I prepared my dissertation for a defense. Dr. Graysay provided the direction I needed to refine and go deeper with my analysis. I offer thanks to my former advisor, Dr. Helen Doerr, who retired at the early stages of my studies. Above all else, she taught me that "slow and steady wins the race." I would also like to thank Dr. Charlotte Sharpe, Dr. Nicole Fonger, Dr. Bridgette Jacob, Dr. Grace Visher, and my fellow doctoral students in the Mathematics Education Seminar, all of whom provided constructive feedback on at least one stage of my analysis.

I also offer thanks to all the students and my team of professors who gave their time to participate in my study. None of this would have been possible without them. I am also thankful for all my friends and colleagues who encouraged me to persist along this journey. I especially thank my family for their support. My partner and our three daughters made huge sacrifices for me to accomplish this goal. I cannot thank them enough. Together, we won the race, and I hope they can appreciate it when they are older.

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Chapter 1 – Introduction

The United States is confronting a growing number of first-year college students underprepared to succeed in college-level coursework, particularly in mathematics. Throughout the first decade of this century, the proportion of students who lacked the skills needed to succeed in college, in one or more academic areas, continued to escalate each year (Howard & Whitaker, 2011; Taylor, 2008). More than one-third of the incoming freshman at four-year colleges (Attewell, Lavin, Domina & Levey, 2006; Taylor, 2008) and about two-thirds of first-year students at community colleges (Bailey, 2009; Clyburn, 2013; Rutschow et al., 2019; Zachry, 2008) require remediation. Each year, millions of students are placed into developmental education courses, or remedial courses, in reading, writing, and/or mathematics (Bailey, Jeong & Cho, 2010). Succeeding in these courses, however, poses barriers to many students, because they cannot begin college-level work until they have completed these developmental education courses. More than half of these students never go on to graduate from college (Bailey, Jeong & Cho, 2010).

Statement of the Problem

Anthony Bryk, former president of the Carnegie Foundation for the Advancement of Teaching, herein referred to as the Carnegie Foundation, said that "developmental math is the place where aspirations go to die" (Bryk, 2011). According to Merseth, Bryk had also called developmental mathematics the "graveyard of dreams and aspirations" (2011, p. 32). Stigler, Givvin and Thompson (2010) referred to the state of developmental mathematics education as a "crisis" for community colleges in the United States, because after multiple failures in mathematics, many students give up and drop out of college. Nationally, about 70% of students

successfully complete their developmental reading and writing courses, whereas only 31% of the students recommended to developmental mathematics courses successfully complete their sequence of courses, according to data from the National Education Longitudinal Study (NELS) (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009). The low success rates in developmental education courses are concerning because they pose barriers to many underprepared students.

Bryk's "graveyard" analogy brings attention to why developmental education became controversial and highly criticized for its level of effectiveness. "At the heart of the controversy lie vital policy questions concerning educational access, equity, and social mobility for a sizeable segment of the population" (Bahr, 2010). Those who support developmental education value preparing students with opportunities to learn prerequisite concepts necessary for success in college-level coursework, as well as preparing them with basic reading, writing, and mathematics skills to be informed, productive citizens. Opponents of developmental education, however, argue that high school content should not be taught in post-secondary settings, and by offering remediation in college, taxpayers fund education of the same material twice (Bahr, 2010). Further criticism comes because determining the success of developmental education is also difficult. Bahr asserts that while many studies exist, most have methodological flaws and cannot be used to support claims. Levin and Calcagno (2008) also addressed the lack of high-quality research on the effectiveness of developmental education, citing methodological flaws.

The *Community College Research Center* (CCRC) is a frontrunner, however, in the existing research on developmental education initiatives. Under Bailey's direction (2009), the CCRC set forth recommendations for both the reform of and future research pursuits in

developmental mathematics education, pushing for a combination of institutional and pedagogical changes. While many promising initiatives have been implemented or are currently underway, empirical studies are still needed on the effectiveness of the reform initiatives (Bailey, Jeong & Cho, 2010; Hodara, 2011; Hodara, 2013). Before examining the existing research on these initiatives, I present some historical perspective leading up to this moment.

Developmental Mathematics Education Reform

The following section provides a brief historical perspective on the conflict between traditionalist and reformist views of the teaching and learning of mathematics. I discuss the need for a pedagogical shift away from an emphasis on traditional symbolic manipulation to a more contextual-based focus on real-world problem solving and reasoning, particularly for students of developmental mathematics, in light of their dismal success rates. Experts call for community college faculty to develop new curriculum that addresses the needs and interests of students in developmental mathematics. These shifts and calls for change are urgent in the struggle to help community college students overcome barriers imposed by developmental education and to meet the needs of America's growing need for mathematical proficiency in today's global economy.

Historical Perspective on Learning

The traditional approaches of the 1960's and 1970's to teaching algebra were symbolically oriented, focusing on expressions and manipulation of mathematical symbols. Reformist views of algebra, which surfaced in the 1980's, with the rise of technology, advocate for emphases on reasoning, understanding, and modeling, with a focus on functions (Kieran, 2007). The shift toward function-based, real-world applications diminished the traditional focus on symbolic manipulations (Kieran, 2007), de-emphasizing traditional algebra tasks that required

memorization and procedures with no connection to the real-world. Reform-inspired tasks promote conceptual mathematics and problem solving that is connected to real-life scenarios (Stein & Smith, 1998) by providing students with opportunities to examine a function graphically, numerically, algebraically, and in words (Yerushalmy, 2000).

For several decades, the algebra traditionalists and the algebra reformists engaged in a "tug of war" (Kieran, 2007, p. 709) over the content of school algebra. Reformists were criticized for their de-emphasis of algebraic manipulation, whereas traditionalists were criticized for not providing meaningful contexts to accompany their focus on symbolic manipulation. Algebra curriculum varied from country to country and even across the United States. The functions-based approach to algebra gained momentum throughout the 1990s and early 2000s, and in 2000, The National Council of Teachers of Mathematics (NCTM) adopted standards regarding this functional perspective for K-12 mathematics curriculum (Kieran, 2007). According to Yerushalmy and Chazan (2002), many educators agree upon a fundamental set of competencies that every algebra student must master, such as performing operations on polynomial expressions and solving both linear and quadratic equations, but there is a vast division regarding what pedagogical approaches should be used to achieve these goals.

Recognizing the Need for Change

As this battle over algebra pedagogy waged at the K-12 level, postsecondary educators also began to debate approaches to teaching remedial algebra to underprepared, first-year college students. Pedagogical approaches in community college developmental mathematics courses tend to be more traditional. Grubb and Associates (1999) found that the use of "skills and drills" was the dominant approach in remediation. A decade later, an evaluation of remedial education

programs in community colleges found that the presence of "drill-and-skill" teaching approaches was still prevalent in both secondary and post-secondary classrooms (Levin & Calcagno, 2008, p. 185). In support of developing pedagogical approaches to deepen students' understandings of mathematical ideas, Oehrtman et al. (2008) stated, "we advocate that instructional shifts that promote rich conceptions and powerful reasoning abilities may generate students' curiosity and interest in mathematics" (p.1). Without the opportunity to solve real-world problems that reveal the usefulness of mathematics being taught, students are unable to extend and apply their new knowledge outside the context of the mathematics classroom (Levin & Calcagno, 2008).

Meeting the Needs of Today's Students

The American Mathematical Association of Two-Year Colleges (AMATYC) recommended that mathematics faculty examine the needs and interests of the student body at their institution, based on students' majors, to develop a curriculum suited to meet the realistic mathematical needs of the students (Cohen, 1995; Herriott & Dunbar, 2009). In past years, college algebra was intended solely to prepare students for calculus. This, however, is no longer the case (Zachry & Diamond, 2015). A study of 1,500 college algebra students at the University of Nebraska at Lincoln found that only 5% of the students were considering STEM majors, and only 11% of the students went on to take calculus (Herriott & Dunbar, 2009). In her work to bring about systemic change to K-12 and higher education, Michelle Cahill, then vice president of the Carnegie Corporation of New York, said, "The world is rapidly changing and today's young adults need higher levels of communications skills and quantitative reasoning than ever before to participate fully in civic life, earn a living wage, get on a career track or switch to another. We owe it to them to innovate in instruction, curriculum and program design to

accelerate their learning and competency" (Cahill, as reported in Parker, 2012, p. 3). Consistent with AMATYC's recommendation, Parker (2012) urges community colleges to offer innovative gatekeeper mathematics courses, other than calculus, to meet both the demands of the global society and the interests of the students.

A Call for Change

Unfortunately, in a time when the United States needs people with strong mathematical backgrounds, the number of college graduates in science, technology, engineering and mathematics, otherwise known as the STEM disciplines, is declining in the United States (Thiel, Peterman & Brown, 2008), and employers report struggling to find job applicants with strong problem solving and critical thinking skills (Golfin, 2005). With the growing need for mathematical proficiency in today's global economy, changes in the United States' educational system are long overdue. The report *Help Wanted: Projections of Jobs and Education Requirements Through 2018* (Carnevale, Smith, & Strohl, 2010) projected that the United States would need 22 million college educated employees by the year 2018, but the country was on track to supply fewer than 19 million college educated employees by 2018. For this reason, college completion is a national priority needed to sustain our economy. In 2008, the Lumina Foundation set an attainment goal that 60% of Americans between the ages of 25 and 64 would hold post-secondary credentials by 2025. Although attainment has risen more than 10% since this goal was established, as of 2020, only 51.3% of Americans ages 25-64 have met this target (Lumina Foundation, 2020). In 2011, President Obama supported the national priority by announcing a goal of increasing the number of community college graduates by five million by the year 2020 (Parker, 2012). For the students who enter community college underprepared and

require developmental education courses, however, only half of them will be able to complete these remedial requirements needed to gain access to college-level courses in pursuit of their associate degrees. Significant changes are needed to reach the Lumina Foundation's 60% attainment goal and to meet the needs of America's global economy.

Frameworks Influencing the Research

The critical state of developmental mathematics education will not improve unless we examine two important issues: 1) the needs of students who are underprepared for college-level work and 2) the pedagogical techniques used to teach developmental courses (Stigler, Givvin, & Thompson, 2010). Mesa (2010) argued that community college students' K-12 experiences do not necessarily foster the ability to think deeply about mathematics, and that adult learners need to be actively engaged in a realistic curriculum that is relevant to their life experiences and maturity levels. Perin (2011) claimed that "whether instruction is contextualized or integrated, the connection of basic skills instruction to applications and life goals is consistent with constructivism which places students' interests and needs at the center of education" (p. 10). Advocating for conceptualized curriculum that fosters thinking and serves the needs of students, the work of Stigler et al. (2010), Mesa (2010), and Perin (2011) is situated at the intersection of two theoretical perspectives on learning: social cognitive theory and the framework for student success. These perspectives provide the underlying framework for this investigation and I discuss them in Chapter 2.

Aims of the Research

To address the high failure rates, facilitate educational reform, and promote pedagogical change in developmental mathematics, leading researchers urge for an examination of both the

academic and non-academic needs of community college students of developmental mathematics. In addition to academic needs, non-academic factors influence student success and should be considered when examining any initiative in education (Bonham & Boylan, 2012; Clyburn, 2013). My dissertation study investigated two different aspects of a course in developmental mathematics that incorporated pedagogical changes on teaching techniques while incorporating attention to affective factors that research has shown to impact student learning.

First, I investigated the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills. Second, I examined the impact of this type of course on the learning experience of students of developmental mathematics. I was interested in how to best support this population of learners in developmental mathematics education, and I sought evidence of promising practices.

My two research questions were:

- Research Question #1: What effects does taking a developmental mathematics course that incorporates learning and study strategies have on students' strategic learning skills?
- Research Question #2: How do students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences?

Rationale for and Significance of This Research

While many national reform efforts are currently underway to address the problems facing developmental education, increased attention is being placed on the need to examine pedagogy and its connection to students' needs. Work has been done regarding the effects of institutional aspects of community colleges on students of developmental education (Grubb & Cox, 2005). According to Stigler, Givvin, and Thompson (2010), for instance, community

colleges have tried to provide various reforms such as study skills courses, advisors, instructional supplements, learning assistance centers, or redesigned curricula, but community colleges have not, however, instituted significant pedagogical changes. The shift to examining pedagogy is partly due to the failure of past institutional reforms to bring about widespread changes to developmental education success rates, and partly due to the changing needs of students in today's global economy (Bailey, 2009).

Goldrick-Rab (2007) reported that the emphasis on computational skills found in K–12 mathematics classrooms continues to dominate instruction at the college level. Grubb (2013) conducted an observational study of developmental mathematics courses at 13 community colleges in California and reported an emphasis on procedural fluency and a lack of contextualization or extension to future coursework. Classes consisted largely of a review of topics followed by individual practice of algorithmic processes. Grubb defined this type of instruction as "remedial pedagogy" (p. 50). My literature review will examine alternatives to this remedial pedagogy that will move students beyond procedural fluency.

Stigler et al. (2010) argued that "substantive improvements in mathematics learning will not occur unless we can succeed in transforming the way mathematics is taught" (p. 5). To make such pedagogical shifts in teaching students in developmental mathematics courses, we need to better understand the perspectives and needs of these students, as well as provide them with cognitively demanding tasks, also called sense-making tasks. Pedagogy that fosters conceptual understanding not only leads to deeper conceptual understanding but also leads to improved procedural skills (Boaler, 1998; Hiebert & Grouws, 2007). These learning opportunities will move students beyond the procedural nature of the "drill-and-skill" techniques toward a deeper

conceptual understanding of mathematical ideas. Research on sense-making tasks will be addressed in the literature review.

In 2005, the National Research Council identified three fundamental principles of learning (Edwards & Beattie, 2016): new learning builds upon prior learning, the brain forms a schema during learning, and the ability to monitor one's own progress enhances learning. Students need experiences grappling with complex problems (Hiebert & Grouws, 2007) in a productive struggle. Students need experiences making explicit connections between mathematical concepts and procedures, and they need help incorporating these new ideas into existing knowledge schemas (Hiebert & Grouws, 2007). Students also need opportunities for deliberate practice designed to improve understanding: "As opposed to massed repetition, deliberate practice consists of tasks that are invented to overcome gaps in understanding, apply what is learned, and deepen understanding and facility with key concepts. These activities are highly structured… and require effort (p. 31)" (Ericsson et al., as cited in Edwards & Beatie, 2016). I discuss this combination of three learning opportunities: productive struggle, explicit connections, and deliberate practice, further in Chapter 2.

In addition to understanding the academic needs of students in developmental education, non-academic factors, also called non-cognitive or affective factors, are critical to attend to when teaching developmental level courses (Bonham & Boylan, 2012; Boylan & Nolting, 2011; Mesa, 2010; Perin, 2011; Stigler et al., 2010). Developmental mathematics courses should involve services that incorporate learning support, support for non-cognitive needs, and help acclimating to college (Bailey, 2009). Bloom's oft-cited research on student achievement found that the relationship between a learner's affective traits and school achievement explained one-fourth of

the variance (p. 120, 1976). During an interview, Nolting told Boylan that Bloom's claims are the guiding factors of his work with students (Boylan & Nolting, 2011). Among specific factors discussed in the interview were the following affective characteristics of the student: self-efficacy, motivation, anxiety, study skills in mathematics, and learning styles. Further research on the impact of "affect" on learning is addressed in the literature review.

Two groups of researchers investigated the effectiveness of linking learning and study skills to the curriculum of developmental mathematics courses. These studies both suggested that incorporating learning strategies and study skills into mathematics curriculum positively impacts the fostering of learning strategies and study skills in students of developmental mathematics (Mireles, Offer, Ward, & Dochen, 2011; Wadsworth, Husman, Duggan, & Pennington, 2007). Beyond these studies, there is, however, limited empirical research available on the incorporation of learning strategies in developmental mathematics curriculum. More studies are needed to further investigate how students of developmental mathematics learn and how they develop new strategies for learning. This need led to the creation of the first part of my investigation.

The current study is also important, because as Stigler et al. (2010) also argued, more research is needed on what students need and how they think about their developmental mathematics education. In their work in developmental education, Grubb and Cox (2005) recognized that, "our knowledge of students and their attitudes toward learning is sorely lacking" (p. 95). Very little research has investigated the mathematical perspectives of community college students in developmental mathematics courses. Studies are needed to address the perspectives of this under-served population on their learning because the methods used in secondary schools have not been effective for more than half of these students**.** The findings of this study

contribute to the oft mentioned lack of empirical evidence at the community college level on students of developmental mathematics (Bahr, 2010).

In Chapter 2 I address the need to confront the under-preparedness, particularly in mathematics, of first-year community college students as well as examine some recent initiatives in developmental mathematics education. Many national reform efforts are currently underway to address this lack of college readiness. I discuss a variety of promising initiatives and discuss limitations of the available research and suggest areas for future research, in light of how they appeal to my intended study, guided by the theoretical perspectives of social cognitive theory and the framework for student success.

Chapter 2 - Related Literature

In the United States, for the last fifteen years or more colleges have confronted a growing number of first-year college students who are underprepared to begin college-level coursework. About 40 percent of the incoming freshman at four-year colleges and universities require developmental education (Attewell, Lavin, Domina & Levey, 2006). Additionally, it is estimated that almost 70 percent of community college students enter their first year needing remedial coursework in at least one subject (Attewell et al., 2006; Bailey, 2009; Clyburn, 2013; Zachry, 2008). In more recent research, 68% of all community college students took at least one remedial course, but it is suspected that a much higher percentage were placed at the developmental level but never enrolled (Jaggars & Stacey, 2014).

Students are placed into developmental education courses in reading, writing, and/or mathematics. Students must pass these courses before they can enroll in a gatekeeper course. The phrase gatekeeper course refers to the first college-level, credit bearing course that students can take. At many 4-year institutions, introductory calculus is considered the gatekeeper course in mathematics, but other schools may consider precalculus or other alternatives, such as statistics or quantitative reasoning. Students cannot pass through the analogous gate to begin their college-level work until they have completed these developmental education courses. Students who need to complete more than one level of developmental coursework, also known as a developmental sequence, are significantly less likely to graduate than those who only need one course to achieve college readiness (Bailey, 2009). More recently, the Center for the Analysis of Postsecondary Readiness (CAPR) conducted a survey of 1,000 two-year colleges that offer developmental education. They found that 76% of colleges still teach the traditional prerequisite sequence of

one to four developmental-level mathematics courses prior to the college-level, gatekeeper course (Rutschow et al., 2018). Only 16% of students requiring three developmental courses finish their sequence within three years (Bailey et al., 2015; Yamada, 2018). Less than 25% of all students requiring some amount of remediation complete their degree within eight years (Bailey, 2009). More recent data shows that only 28% of the community college students who take a remedial course complete their degree within eight years. (Jaggars & Stacey, 2014).

Since students cannot begin college-level work until they have completed these developmental education courses, these courses present a barrier to many underprepared students, restricting their access to higher education. Almost 20% of students requiring these courses never enroll in a developmental course (Bailey, 2009). Since these courses do not count towards a degree, the time required to complete a degree is extended, making it less likely for students to finish (Bonham & Boylan, 2010). A study by the Carnegie Foundation revealed that fewer than 15 percent of students recommended to developmental mathematics at 17 different community colleges earned their two-year degree within two years (Bryk, 2011). Developmental mathematics education is the area of focus for this review. It can include a sequence of up to four courses (typically: basic mathematics, prealgebra, beginning algebra and intermediate algebra). These four courses are often non-credit and are considered prerequisites to a gatekeeper course (Taylor, 2008). The low success rates in developmental education courses are concerning because they pose barriers to many underprepared students.

I situated this dissertation study at the intersection of social cognitive theory and a framework for student success. In subsequent sections of this chapter I examine existing literature on how these two perspectives relate to issues of student success in post-secondary,

developmental mathematics courses. After describing the two perspectives, I examine reform recommendations in developmental education and explore pedagogical shifts in the field of developmental mathematics.

Theoretical Frameworks Influencing the Research

Students who graduate high school with limited knowledge or understanding of mathematics need instructional shifts that will promote opportunities to think and to engage with concepts. Merely reteaching concepts for a second time will not foster sense-making. Dweck et al. (2014) asserted that academic success is less connected to cognitive ability and more significantly associated with psychological factors, also known as non-cognitive factors, affective factors, or motivational factors, including beliefs that students hold about themselves and their learning experiences. The level of persistence toward learning that students bring to the classroom, combined with the influence of non-cognitive factors, underlies their ability to learn and be successful. Yeager and Dweck (2012) argued that simply increasing curricular rigor, without attention to students' abilities to productively persist, would not lead to effective reform. The emphasis on the psychological aspects of student learning must be an integral part of educational reform (Dweck et al., 2014). The research of Stigler et al. (2010), Mesa (2010), Perin (2011), Yeager and Dweck (2012), and Dweck et al. (2014) is situated at the intersection of two theoretical perspectives on learning: social cognitive theory and the framework for student success. These perspectives provide the underlying framework for this investigation.

Social Cognitivism

The first theoretical perspective on learning that I examine is social cognitivism. Bonham and Boylan (2012) attested that:

> The importance of the relationship between the cognitive and affective factors influencing students' success in developmental mathematics cannot be ignored. Bandura's (1997) work in the area of social cognitive theory maintains that it is the students' beliefs about the value of the learning experience, their expectations of success, and their enjoyment of it that will motivate them to engage material actively and persist in spite of initial failures. (p. 4)

The high correlation between student success and attitudes toward mathematics is widely documented. Other components such as lack of confidence in one's self and one's mathematics abilities (growth mindset) or anxieties toward tests or toward mathematics in general can hinder success. These factors cannot be ignored while pursuing any initiative to improve student success in developmental education (Bonham & Boylan, 2012).

Pajares (2002) advocated for the use of social cognitive theory as a framework for working with students on the basis that "teachers can work to improve their students' emotional states and to correct their faulty self-beliefs and habits of thinking (personal factors), improve their academic skills and self-regulatory practices (behavior), and alter the school and classroom structures that may work to undermine student success (environmental factors)." Yeager and Dweck (2012) wrote that "as students move through our educational system, all of them will face adversity at one time or another, whether it is social or academic in nature. Thus, a central task for parents and educators is to prepare students to respond resiliently when these inevitable challenges arise" (p. 312). Students need support and strategies to be successful when facing challenging learning opportunities. Careful attention toward the affective factors impacting

students must be given to prevent them from becoming barriers to student learning, particularly among students of developmental mathematics (Bonham & Boylan, 2012).

Framework of Student Success (or Productive Persistence)

The psychological factors associated with learning, combined with institutional, curricular, and pedagogical initiatives, provide a framework for student success. According to the U.S. Department of Education, although college enrollments grew in the 2000s, completion rates remained stagnant (Nagaoka et al., 2013). The past decade has seen an increased emphasis on initiatives that foster non-cognitive skills necessary for achieving academic success. There are a variety of non-cognitive factors that impact student success in college. The University of Chicago Consortium on Chicago School Research (CCSR) conducted a literature review exploring this idea (Farrington et al., 2012). The CCSR urged for a heightened partnership between students and their colleges to attend to these non-cognitive factors while navigating the journey to college completion (Nagaoka et al., 2013).

Five major categories relating academic performance and non-cognitive factors emerged from the CCSR literature review (Nagaoka et al., 2013). Non-cognitive factors known to be associated with academic performance are 1) academic behaviors, 2) academic perseverance, 3) social skills, 4) learning strategies, and 5) academic mindsets (see Figure 1). The first factor, academic behaviors, refers to actions that students carry out to enable learning and lead to success, including attending class and completing assignments. The second factor, academic perseverance, examines a student's ability to overcome challenges, despite any obstacles that

Figure 1

Non-cognitive Factors: Examples & Synonyms

Academic Behaviors	Academic Perseverance	Social Skills	Learning Strategies	Academic Mindsets
Attend class	Focus, even in adversity	Cooperation	Mnemonics	Sense of belonging
Do homework	Effort	Leadership	Time management	Growth mindset vs. Fixed mindset
Participate in class	Self-control	Responsibility	Self-regulation	
Study for tests	Grit	Empathy	Motivation	
	Academic Tenacity		Using resources	
			Processing Information	

come along. Various researchers have different names for this, such as "academic tenacity" (Dweck et al., 2014), "productive struggle" (Clyburn, 2012), or "grit" (Duckworth & Seligman, 2005). The third factor, social skills, examines ways in which students interact with each other or how students and teachers interact. Lack of social skills has been linked to lower achievement (Nagaoka et al., 2013). The fourth factor, learning strategies, refers to the skills that students implement to process and make sense of knowledge. These strategies, when applied during deliberate practice, build explicit connections necessary for sense-making. The fifth factor, academic mindsets, considers how students perceive themselves in a learning context, how deep their sense of belonging is, and whether or not they have a fixed or growth mindset. This combination of psychological reforms can enable learning and lead to success.

In addition to the increased emphasis on how non-cognitive factors affect learning, pedagogical shifts away from typical remedial pedagogy are critical in developmental education. More than a century ago, Dewey (1926; as cited in Hiebert & Grouws, 2007), criticized traditional school pedagogy of the early 1900s for being too focused on producing fast answers instead of allowing students to wrestle with and make sense of complex problems. Dewey claimed that allowing students the opportunity to struggle led to deeper conceptual understandings (1929; as cited in Hiebert & Grouws, 2007). Throughout the decades, other cognitive theorists and mathematicians also argued that students need experiences resolving dilemmas in order to make connections, to develop deeper understandings, and to appreciate the learning process (Brownell & Sims, 1946; Festinger, 1957; Hatano, 1988; Polya, 1957; Vygotsky, 1978). While learning, struggle restructures and deepens existing connections by assimilating old knowledge with new (Hiebert & Grouws, 2007; Piaget, 1960).

Hiebert and Grouws (2007) claimed that "two features of classroom mathematics teaching facilitate students' conceptual development (and perhaps mathematical proficiency) -- explicit attention to connections among ideas, facts, and procedures, and engagement of students in struggling with important mathematics" (p. 391). While this act of grappling with concepts has taken on different names since the time of Dewey's work, more recently it has come to be known as productive persistence, or productive struggle. It is a process of thinking, making sense, and persevering in the face of not knowing exactly how to proceed or whether a particular approach will work (Merseth, 2011). Hiebert et al. (1996) proposed that allowing mathematics to be problematic for students is a key to reform in curriculum and instruction:

> Allowing the subject to be problematic means allowing students to wonder why things are, to inquire, to search for solutions, and to resolve incongruities. It means that both curriculum and instruction should begin with problems, dilemmas, and questions for students. We do not use 'problematic' to mean that students should become frustrated and find the subject overly difficult. Rather, we use 'problematic' in the sense that students should be allowed and encouraged to problematize what they study, to define problems that elicit their curiosities and sense-making skills. (p. 12)

As students engage is this productive learning struggle, they both develop their mathematical skills and deepen their conceptual understanding of fundamental mathematical ideas.

A pedagogical shift away from "drill and skill" teaching methods towards sense-making learning opportunities that problematize mathematics are crucial for improving success in students of developmental mathematics. Additionally, "the combination of structural, curricular, and pedagogical changes to a developmental mathematics sequence as well as the provision of non-academic supports can impact the college success of students in long-lasting, meaningful ways" (Hodara, 2013, p. 29). While educational research suggests both pedagogical and psychological reforms to improve achievement, institutions must also reform and improve how they guide and support students on that journey (Nagaoka et al., 2013). This combination builds persistence and establishes a strong framework for student success in developmental mathematics.

Reform Recommendations and National Initiatives

In 2009, the CCRC (*Community College Research Center)*, under the direction of Thomas Bailey, set forth three main recommendations for the reform of and future research pursuits in developmental mathematics education, pushing for both institutional and pedagogical changes (Bailey, 2009). The first suggested changes to placement policies and procedures. The second suggested elimination of the distinction between developmental and college-ready and the introduction of academic support for all. The last recommendation was to minimize the time it takes to achieve college readiness among the weakest students. In this section, I examine evidence from developmental reform initiatives to support the CCRC's recommendations.

Placement

Bailey argued (2009) that the use of placement scores to determine who needs remediation to become college-ready is flawed. There is no uniformity about what test to use, what score to use as a cut-off, or even what is really meant by "college-ready." He also acknowledges that two students receiving the same score on a placement test are likely to bring very different learning needs to the classroom. Three large-scale studies in three different states investigated the effects of remediation on students scoring near the cut-off scores. The findings reveal that the use of placement tests to label a student as developmental or college-ready is problematic and that the gains from remediation may not be worth the time and financial investment into the courses.

Three major quasi-experimental design studies examined state-wide, longitudinal data to investigate the effects of developmental education on community college students who scored close to their institution's placement cut-off score. In Ohio, Bettinger and Long (2005) compared

the outcomes of first-year students, ages 18-20, who were enrolled in a developmental course to the outcomes of students who were not enrolled in a developmental course. They found some positive results: students taking a developmental course had a 15% higher transfer rate and took ten additional credits of coursework than the other students. The results are limited, however, because the study only focused on young students, and it did not examine outcomes for students who scored well below the cut-off score. Both Florida and Texas had state-mandated cut-off scores. Texas found weak evidence that remediation helped improve outcomes in the subsequent college-level course (Calcagno & Long, 2008), whereas Florida found that remediation had no effect on this outcome (Martorell & McFarlin, 2007). Additionally, no effects on persistence toward a degree or completion were found due to students near the placement cut-off scores taking one developmental course (Calcagno & Long, 2008; Martorell & McFarlin, 2007).

Studies comparing placement scores and student outcomes in their courses revealed no distinct correlation. Due to the inconsistencies of placement testing and the weak correlation between placement test scores and outcomes in gatekeeper courses, Bailey (2009) recommended the abandonment of this distinction. Instead, colleges should determine what skills first-year college students need to succeed in college, and then work toward a better alignment of high school and college expectations. Education reformers hoped that the *Common Core State Standards for Mathematics* (2010) would help facilitate that collaboration.

Developmental vs. College-ready

Currently, students with borderline placement scores, and thus most likely weak skills, either take a developmental mathematics course to strengthen their skills, or they take a college-level course without any academic support. Bailey (2009) recommended that more students be

placed into college-level courses that are structured to incorporate support services to help them be successful. These services not only support students in the learning of mathematics, but they also help students acclimate to college, addressing the non-academic needs of the students.

Many of the initiatives being implemented today investigate the effects of the affective factors laid forth by Bonham and Boylan. Although Bandura's work focused on K-12, his findings draw parallels that can inform the direction of instruction with post-secondary students of developmental mathematics. He claimed that a teacher's self-efficacy significantly impacts the learning environment and outcomes for students. He reported that "teachers who believe strongly in their instructional efficacy create mastery experiences for their students. Those beset by self-doubts construct classroom environments that are likely to undermine students' sense of efficacy and cognitive development" (Bandura, 1993, p. 140). A teacher with high instructional efficacy will motivate and instill academic persistence whereas a teacher with low instructional efficacy will lose patience and criticize students for failures. Ashton and Webb (1986), as reported by Bandura, found that the instructional efficacy of a teacher was a statistically significant predictor of student achievements (in both mathematics and language arts).

Many existing initiatives have helped students in becoming ready for college-level work by providing support for both the academic and non-academic needs of the students. In particular, early assessment programs target students who are not college-ready prior to their start of college, and these programs strive to close the readiness gap before the students do begin college. Summer bridge programs, for instance, which date back to the 1960's (Sherer & Grunow, 2010), are "designed to improve students' math skills, as well as orient them to college culture, build their study skills, and provide them with an important network of support prior to

enrolling" (Hodara, 2013, p. 12). Bridge programs support both academics and the non-academic factors that influence persistence to completion. Boot camps are typically shorter than bridge programs, and they focus mainly on intensive math skills training (Sherer & Grunow, 2010). Brush-ups are workshops that last for one day or for a few hours. After a review of the literature on these early assessments, Hodara (2013) found that only two studies contained quantitative results pertaining to the effectiveness of early assessment: a quasi-experimental design study at California State University and a descriptive study conducted in El Paso, Texas. Both of these highly regarded studies found that remediation does improve the number of students who are able to place into college-level courses. Further research, however, is needed on what features of these programs are most beneficial to supporting students' academic and non-academic needs through completion (Hodara, 2013).

The following study links the concept of a summer bridge program to this revival of a focus on affective factors on the learning experience. Mireles, Offer, Ward, and Dochen (2011) investigated the impact of incorporating study skills instruction in an intensive summer developmental mathematics/college algebra course at a four-year college. They conducted a mixed-methods, quasi-experimental study to determine the effectiveness of the learning and study strategies that they were teaching. They gathered data using three survey instruments: *Learning and Study Strategies Inventory* (LASSI) second edition, LASSI Pre-Post Achievement Measure, and the Mathematics Information Survey.

The study involved 47 students who completed all surveys and received a passing grade in the course. Upon completing the initial questionnaire, or pre-LASSI, students received a report detailing their strengths and weaknesses as compared to other students nationally. They received

a percentile score for each of the 10 scales that were assessed. Near the end of the intensive summer course, the students completed a post-LASSI. Using the LASSI Pre-Post Achievement Measure, the students recorded both their pre-test and post-test scores for each of the 10 scales. After having both sets of scores, the students analyzed and reflected on the development of their own strategic learning using an open-ended questionnaire called the Mathematics Information Survey. The survey responses enriched the quantitative aspect of the study by providing qualitative data to support the numerical findings.

The researchers sought to assess if the summer intervention produced different LASSI outcomes. After conducting a statistical analysis of the data, the participants' scores revealed statistically significant, positive changes (on average) in all 10 scales. The results, as self-reported by students on both the pre- and post-LASSI questionnaires, support the effectiveness of the incorporation of learning strategies in this particular program. The findings of Mireles, Offer, Ward, and Dochen (2011) provided evidence that incorporating learning strategies within a mathematics curriculum positively impacts the fostering of learning strategies in students of developmental mathematics. The researchers further suggest that this practice will help these underprepared students succeed in future college-level courses, thus raising completion rates.

These findings are particularly significant, because "there is minimal evidence that supports the effectiveness of linking study skills in a mathematics-specific context" (Mireles, et al., 2011, p. 14). In a similar study, Wadsworth, Husman, Duggan, and Pennington (2007) investigated the development of learning strategies within an online developmental basic algebra course. Their findings from analyzing LASSI results revealed that four particular learning strategies (motivation, concentration, information processing, and self-testing), when combined

with self-efficacy, explained 42% of the variance in course grade achievement. Both teams of researchers, Wadsworth et al. and Mireles et al., advocated for more studies linking student success to learning strategies embedded in mathematics content.

To further support students, Bailey also argued for the use of the supplemental instruction model, or peer-assisted learning, which uses peer tutors to help students succeed in their first college-level mathematics course (International Center for Supplemental Instruction, 2006). Students who have previously been successful in a course serve as tutors to the current class, providing support for academics, note-taking, and non-cognitive needs. This research-based model has demonstrated great success. Many Achieving the Dream initiatives and the work of Carnegie Foundation have seen successes with this approach (Bryk & Treisman, 2010). Successful students tend to receive additional, comprehensive support from their institution during their enrollment.

Minimize Time

In addition to examining placement policies and providing supplemental instruction for all in gatekeeper courses, the CCRC's third recommendation for supporting students was to help them complete their gatekeeper course as fast as possible (Bailey, 2009). Students requiring the developmental education courses two to three levels below college-level courses are the least likely to complete their degrees (Attewell et al., 2006; Bailey, 2009; Bailey, Jeong & Cho, 2010; Clyburn, 2013; Zachry, 2008). Acceleration, compression, and mainstreaming are phrases associated with this idea (Edgecombe, 2011; Hodara, 2013). In this section, I examine both the reason behind this push and some empirical evidence to support it.

Bailey et al. (2010) examined two large-scale sets of national data, from Achieving the Dream and NELS, to analyze the success of developmental mathematics students. Their research revealed a significant difference between the success rates of students required to take only one developmental course and of students who needed to take a developmental sequence (two or more courses) to acquire the skills needed to complete college-level coursework. Since the sample of 57 participating community colleges in Achieving the Dream are mainly urban community colleges comprised of higher numbers of low-income students and minorities, thus representing a subset of community college students, Bailey et al. (2010) compared these data from over 250,000 students with the randomized NELS:88 data that was more representative of the United States' population. In their Achieving the Dream sample, 44% of students requiring one course completed it; 29% of students requiring two courses completed both, and 16% of students requiring three or more courses completed them. Bailey et al.'s analysis of NELS data found similar results: only three or four out of ten students requiring developmental mathematics go on to complete this requirement. Students needing only one course to become college-ready were more likely to complete the requirement than students who required a sequence of courses to reach the same status.

Another successful initiative was mainstreaming at Austin-Peay State University of Tennessee. The mathematics department cut two developmental courses and replaced them with two college-level courses with tutoring support. Their students passed more credits every semester and were more likely to persist than students who took two developmental courses prior to college-level work (Hodara, 2013). These schools provided instructional support that enabled students to complete their coursework in minimal time.

Other similar programs pair the college-level course with a supplemental, or corequisite, class that provides the academic support to weaker students, while still allowing them to earn college credits in the same semester (Bailey et al., 2021; Hodara, 2013). Logue et al. (2019) conducted a randomized controlled study across three different City University of New York (CUNY) campuses, comparing student outcomes from two groups: those enrolled in a traditional, non-credit, remedial elementary algebra course and those enrolled in a college-level, credit-bearing statistics course accompanied by corequisite remedial support. The corequisite groups had significantly higher course passing rates, increased success in other disciplines, and significantly higher graduation rates over the three-year time frame from enrolling in the developmental mathematics course. Logue et al. (2019) reported that additional quasi-experimental analyses at multiple CUNY colleges also found higher course passing rates in both college-level statistics with corequisite remediation and college-level quantitative reasoning with corequisite remediation compared to matched students in traditional remedial algebra courses. Boatman (2021) reported similar outcomes in a longitudinal study of Tennessee college students who took developmental mathematics courses in 2008. Students in either the accelerated or corequisite models experienced more positive outcomes over an eight-year period than students in traditional remedial courses. Although their findings were inconclusive about the impact of corequisites on future academic coursework in other subjects, Bailey et al. (2021) found promising evidence for the effectiveness of corequisite remediation to help students complete their developmental mathematics requirements.

Summary of Recommendations and Initiatives

While Bailey (2009) and the CCRC advocate for changes to placement policies, eliminating developmental courses and supporting college-level coursework instead, and minimizing the time it takes to achieve college readiness, developmental education reform also necessitates significant pedagogical changes. Bailey (2009) suggested that "in order to improve remediation, educators will have to improve the experience in the classes *and* get students to enroll and stay in those classes" (p. 20). According to the Mathematical Association of America (MAA) (as cited in Bonham & Boylan, 2010, p.6), "as mathematics teaching changes across the world, faculty teaching developmental mathematics courses must rethink both what should be taught and how it should be taught". Additional research on students' perspectives will help community college instructors design a more meaningful curriculum that will appeal to students' interests and needs, as well as provide opportunities for sense-making to students in developmental mathematics courses.

Exploring Pedagogical Shifts in Developmental Mathematics Education

Grubb and Cox (2005) asserted that "developmental education in community colleges is one of the most difficult challenges our entire education system has to face" (p.102). Developmental education in community colleges alone costs over $2 billion per year (Bailey, 2009; Parker, 2012), which led to recent scrutiny of the initiative and reform efforts. According to Stigler, Givvin, and Thompson (2010), community colleges have tried to provide various reforms such as study skills courses, advisors, instructional supplements, learning assistance centers, or redesigned curricula. Community colleges, however, have not instituted significant pedagogical changes.

In describing students in developmental mathematics courses, Stigler et al. (2010) hypothesized that "these students who have failed to learn mathematics in a deep and lasting way up to this point might be able to do so if we can first convince them that mathematics makes sense, and then provide them with the tools and opportunities to think and reason" (p. 5). Community college students who failed to learn mathematical concepts in high school will not learn them the second time around unless they see them through a new lens. Stigler et al. (2010) further argued that pedagogical shifts will require the use of cognitively demanding, sense-making tasks that will move students beyond the procedural nature of the "drill-and-skill" techniques.

Similarly, Mesa (2010) argued from a social constructivist learning perspective that students need to actively participate in learning opportunities if they are to acquire robust mathematical ideas. This theoretical view has permeated K-12 research, but Mesa's research revealed that adult students also learn by actively engaging in learning communities, particularly ones that are focused on a realistic curriculum that is relevant to their life experiences and maturity levels. Bailey (2009) noted enthusiasm for the potential of learning communities to positively impact student outcomes that extend beyond the first year, but most research on learning communities has been done at four-year institutions. Engstrom and Tinto (2008), however, conducted a longitudinal study of learning communities at 13 community colleges. Students in the learning communities experienced higher levels of engagement and persistence from their first to second year than students in the control group. The learning communities created supportive learning environments through the integration of collaboration with peers, collaboration amongst faculty, institutional support services, and building relationships. Overall,

the students described their experience while learning basic skills as foundational and transformative, not as remedial. Despite this glimmer of hope, there is little research indicating an advantage for students of developmental education in learning communities compared to other pedagogical interventions designed for developmental education. Given, however, that the students were transformed by the experience, elements of the learning communities model could be incorporated into other reform initiatives.

Using Mathematical Tasks to Promote Sense-making

Providing a new lens through which students can view material again requires a shift in teaching approaches from a traditionalist toward a reformist approach. It follows the continuum set forth by Stein and Smith (1998) regarding the use of mathematical tasks to grasp concepts and promote sense-making. Tasks can simply require *memorization* or possibly *procedures without connections*. More reform-inspired tasks, however, will call for the use of *procedures with connections* or for the most cognitively demanding approach, *doing mathematics* (Stein & Smith, 1998). Tasks requiring all these elements are difficult for students, according to reformists, but they build the deepest thinking and reasoning skills (Stein et al., 1996). Rich sense-making tasks build conceptual understanding.

Researchers examining K-12 mathematics instruction found a focus on activities that were cognitively *un*demanding (Mesa, 2010). Stigler et al.'s work (2010) with community college students revealed that students were most likely to respond to tasks procedurally whenever possible unless the task required them to engage in reasoning. When reasoning was required, the students struggled to complete the tasks, suggesting, as Mesa (2010) claimed, that

their K-12 experiences in mathematics have not fostered the ability to think deeply about mathematics.

While facilitating mathematical tasks requiring higher levels of cognition poses many challenges to teachers (Stein, Grover, & Henningsen, 1996), reformists call for more cognitively demanding, sense-making experiences that will engage students. Teachers must also learn how to implement tasks that require students to move beyond using *procedures without connections* toward making connections and *doing* meaningful *mathematics.* Active learning experiences that engage students in critical thinking and problem-solving have been found to be positively associated with undergraduate motivation, success in developmental and college-level coursework, and persistence to graduation (Bailey et al., 2021; Theobald et al., 2018).

Research also suggests that student collaboration in the classroom motivates students and generates a sense of responsibility to the group (Dweck et al., 2014). “Perceived collective efficacy fosters groups' motivational commitment to their missions, resilience to adversity, and performance accomplishments” (Bandura, 2000). Classroom goals that promote collaboration are associated with higher academic achievement compared to competitive learning environments (Dweck et al., 2014).

The Quest for a Solution

“Over the last two decades there has been a growing recognition among the mathematics community that the modern world demands an ability to use mathematics in ways that both build upon and transcend the traditional mathematical topics of algebra, geometry, and statistics. This ability has been variously labeled as quantitative literacy, quantitative reasoning, numeracy, and mathematics in use” (Merseth, 2011, p. 33). In 2009, Anthony Bryk, then president of the

Carnegie Foundation, brought together national organizations, researchers and educators to develop a new initiative (Bryk & Treisman, 2010; Clyburn, 2013). Together they joined ongoing, national reform efforts in the field of developmental education.

One group that they united with was Achieving the Dream: Community Colleges Count (Bryk, 2011). In 2004, the Achieving the Dream national initiative started work towards improving developmental education in community colleges in the United States by collecting data and making decisions based on inquiry and evidence (Bailey et al., 2010; Zachry, 2008). The mission statement of Achieving the Dream states that the initiative is "dedicated to community college student success and completion; focused primarily on helping low-income students and students of color complete their education" (www.achievingthedream.org). By May 2021, more than 300 community colleges across 45 states were involved with Achieving the Dream. Longitudinal data on first-year students at each participating school is collected over the span of at least six years (Bailey et al., 2010).

Pathways: A Non-STEM Alternative. In the fall of 2009, Carnegie Foundation launched its *Pathways* initiative, an ambitious program designed to enable students to progress through both their developmental mathematics and their gatekeeper course in one year (Merseth, 2011). In line with the CCRC's recommendation, and after realizing the dismal failure rates in developmental mathematics sequences, Carnegie Foundation began this work with nationally known educational researchers and organizations, as well as educators, to improve student success. Their initial research revealed that students found typical developmental mathematics courses "irrelevant, dull, and boring" (Merseth, 2011), and they committed to creating content relevant to students' lives. They set forth to "create a challenging, alternative math pathway that

emboldens students to realize their goals and prepares them well for life beyond the math classroom" (Bryk & Treisman, 2010, p. 1). The result was the creation of two rigorous, non-STEM pathways: *Quantway* and *Statway*. Each pathway was designed to offer a one-semester, developmental-level course that would prepare students for a college-level, subsequent, non-STEM course.

Description of Pathways Curriculum. The two pathways, *Quantway* and *Statway*, are flourishing and growing today, helping students become prepared for college-level mathematics. *Quantway (or Quantway I)* is a one-semester course in mathematical literacy, designed to incorporate topics from developmental mathematics, thus preparing students for a college-level course in quantitative reasoning. Carnegie Foundation later developed *Quantway II,* a credit-bearing, college-level quantitative literacy course. *Statway* is a year-long, two-semester course that moves students through the developmental mathematics topics and into a credit-bearing, college-level statistics course.

Both *Quantway* and *Statway* offer similar classroom experiences to students of developmental mathematics. Neither the content nor the delivery of the course resembles what most students experienced in former algebra-based courses. The lessons in each pathway require a high level of engagement as students work together to solve authentic problems, bringing in the mathematics skills when they are needed to invoke quantitative or statistical understanding. In *Quantway*, "students use numerical reasoning for decision making, argumentation, and sense making about real-world questions and problems in contexts of personal, social, and global importance. *Quantway* will require that students use mathematics and numerical reasoning to make sense of the world around them" (Merseth, 2011, p. 33).

The *Pathways* initiative was developed to provide students with three learning opportunities: productive struggle, explicit connections to concepts, and deliberate practice. On the Carnegie Commons Blog, housed on the website for the Carnegie Foundation for the Advancement of Teaching, Clyburn (2012) posted an excerpt from an essay read by Merseth at a summit, detailing these learning opportunities:

> The focus of the productive struggle is on the mathematical learning goals embedded in the problem or situation — it's not about guessing what the teacher wants to hear or about finding a particular answer. It is about the *process of thinking*, making sense, and persevering in the face of not knowing exactly how to proceed or whether a particular approach will work. Exploring, investigating one or multiple approaches, and articulating a chain of reasoning behind the approaches also characterize productive struggle. Within the Pathway materials the idea of explicit connections refers to the linkages or relationships among and between mathematical and/or statistical facts, procedures, and concepts. Explicit connections generally reference math ideas and concepts and may be about context as well. Connections may be drawn by students or faculty, but most often are presented and reinforced by faculty. Deliberate practice consists of a set of tasks for students that are created to overcome gaps in understanding, apply what has been learned, and/or deepen fluency with key concepts.

Productive persistence is especially emphasized in the first of four modules that are taught over one full semester, but the mindset continues to be developed throughout the course, demanding more tenacity as problems build in complexity over the semester. The curriculum is infused with

activities designed to specifically address the three key constructs of deliberate practice, explicit connections, and productive struggle.

The *Pathways* courses begin with a "starting strong" package of instructional activities that aim to foster resilient mindsets from the first day of class. Clyburn (2013) wrote, "We now know from extensive research that math ability is not a fixed attribute but malleable; with effort and deliberate practice, new skills and understandings can be acquired" (p. 20). During week one of class, students read and respond in writing to an article called "Grow Your Brain." This first growth mindset intervention was based on the mindsets work of Carol Dweck and developed by Carnegie Foundation researchers (Silva & White, 2013). The article informs students that with practice, effort, and persistence, the adult brain can actually grow, like a muscle, enabling new learning. Carnegie Foundation researchers then conducted a randomized experiment in which half of the students read "Grow Your Brain," and the other half read a control article that merely explained parts of the brain and their functions. Students who read about growing their brain were two times as likely to complete the course, and they also had average GPAs that were 0.26 points higher than those of the control group (Silva & White, 2013). This study was important, because it provided evidence for a best practice to use among students of developmental mathematics.

Yeager and Dweck (2012) advocated for scientifically tested instructional interventions. They wrote that "we have found that what most students need the most is not self-esteem boosting or trait-labeling; instead, they need mindsets that represent challenges as things they can take on and overcome over time with effort, new strategies, learning, help from others, and patience" (p. 312). Other activities in the "starting strong" package encourage the development

of a growth mindset. Explicit instructional materials, often with a researched script, were designed to help students learn that getting a question wrong does not mean they are not smart. Students learn to persist through their mathematical struggles until they are successful.

Collaborative learning is a key tenet of the Pathways model. The Pathways model embraces several key elements of the successful learning communities model, emphasizing a supportive learning environment, collaboration, and building relationships. A professor at Westchester Community College shared that her students told her that groupwork motivates them to actively participate in class. She said, "they are mostly feeding off each other in positive ways. They are changing the way they think about a math problem and whether they can really get through it" (Silva & White, 2013, p. 12). By struggling together and persisting together, students can strengthen their mindsets, find relevance in rigorous mathematical problem situations, and gain a sense that they belong in the class. Bryk, from Carnegie Foundation, said:

> It turns out the single strongest predictor of whether a student will persist to completion of the first year [of college] is how students responded to this one question: How often is it that you wonder, 'Maybe I don't belong here?' (2017, p. 5)

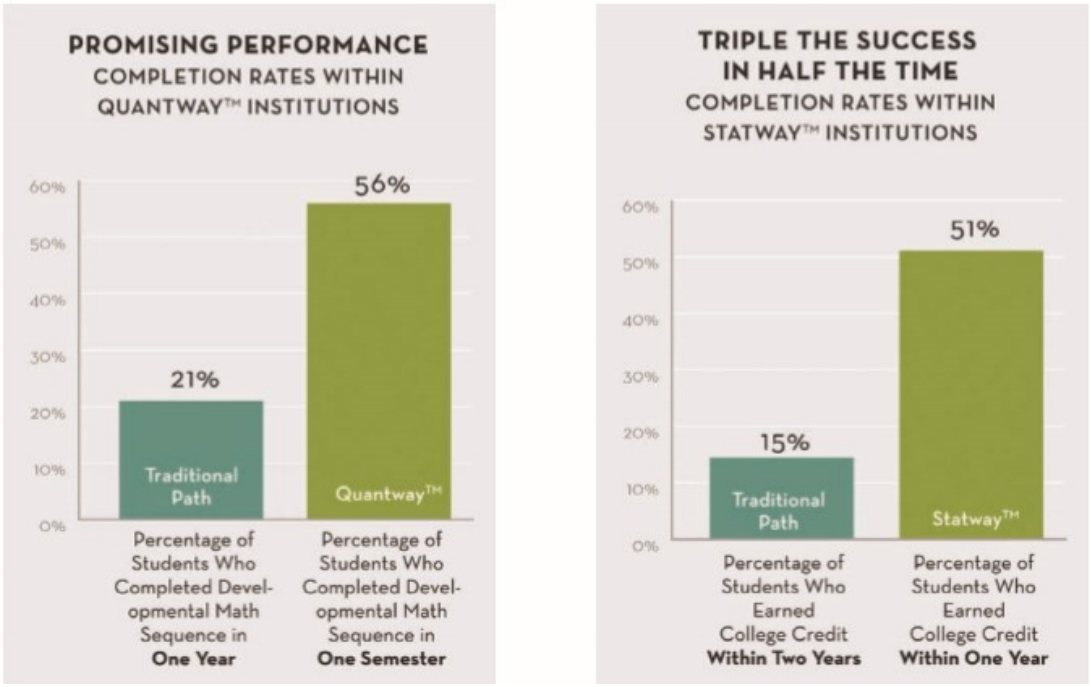
A student from the first offering of the Pathways courses shared that her group was like a family, and she worked harder so as not let down her group. The collaborative nature of the course, established from day one, aims to instill a sense of belonging in each student (Clyburn, 2013). The Pathways initiative strives to help every student find their purpose and come to believe that they belong, and are valued, in the classroom.

Success of the Pathways Initiative. Both the curriculum and the pedagogy developed for these pathways differ from the traditional developmental mathematics sequence, and

participating colleges are involved in ongoing data collection and educational reform of the national program through participation in a Network Improvement Community (Bryk & Treisman, 2010; Clyburn, 2013; Merseth, 2011). Figure 2 shows early findings from both of these pathways and demonstrates the potential of these courses to positively impact students in developmental mathematics. In the first year of *Pathways*, more than half of the students enrolled in *Quantway* and *Statway* successfully completed their developmental-level course, which

Figure 2

Early Success Rates for Pathways



Note. This figure illustrates the potential impact of *Quantway* and *Statway* on students. Reprinted from Strother, S., Van Campen, J., & Grunow, A. (2013). Community college pathways: 2011-2012 descriptive report. Stanford, CA: Foundation for the Advancement of Teaching. Retrieved from http://www.carnegiefoundation.org.

exceeds the national 30% passing rate (Attewell et al., 2006) for developmental mathematics courses.

More promising results soon followed. Yamada et al. (2018) extended this research by using propensity score matching to conduct a large-scale assessment of the first six semesters of *Quantway I*, the developmental-level course in the quantitative reasoning two-course pathway. Using 37 student characteristics, students in *Quantway I* were compared to students in a traditional developmental mathematics course. The *Quantway I* students successfully completed their developmental mathematics requirements and went on to complete college-level mathematics courses the next year at significantly higher rates than their matched counterparts. The researchers also found that the results were positive across all gender and race subgroups, indicating an equitable learning experience to all students enrolled in the course. A later analysis of the first six years of the *Pathways* revealed annual enrollment increases of 64% on average. From 2011 to 2017, despite the tremendous growth and ongoing expansion efforts of *Pathways*, more than 27,000 students achieved consistently higher success rates than those in traditional developmental mathematics sequences (Huang, 2018).

Bailey et al. (2016) refer to Carnegie Foundation's *Pathways* as holistic models aligned with modern-day research initiatives in developmental mathematics. Not only do *Quantway* and *Statway* focus on a new curriculum and new approaches to presenting mathematics to students, but the *Pathways* are also built around a framework for student success, which Carnegie Foundation calls "productive persistence" (Clyburn, 2013; Merseth, 2011), a student's ability to struggle through a problem-solving experience until achieving an understanding of the solution. Merseth described productive persistence as "the set of relevant student engagement behaviors

(attendance, working hard, working smart) along with skills and mindsets that support student success" (2011, pg. 36). "The team used results from previous surveys (from both students and faculty) and the research literature to identify three specific concerns that affect students' social ties in the classroom: a sense of belonging, a sense that professors care about them, and their comfort in asking questions" (Clyburn, 2013, p. 22). These factors were linked to successful completion of the first *Pathways* course and to student persistence through enrollment into the subsequent college-level course. "The *Pathways* multifaceted interventions packages are effective alternatives to the traditional developmental mathematics sequence, and accelerates the ability of a diverse range of students to complete their developmental mathematics requirements and achieve college mathematics credit" (Yamada et al., 2018). The *Pathways* incorporate and continue to assess the impact of key, non-academic factors on the level of productive persistence exhibited by students.

New Mathways Project. Upon realizing the early promise of the *Pathways* initiative, Uri Treisman and the Charles A. Dana Center at the University of Texas at Austin, who were partners in the creation of the *Pathways*, extended the work of Carnegie Foundation. In 2012, the Dana Center developed the *New Mathways Project* (NMP) (Zachry & Diamond, 2015). Students with basic arithmetic skills can complete a developmental and college-level course in one year through NMP. The Dana Center developed a college-level course called *Frameworks for Mathematical and Collegiate Learning* that is recommended as a student success course to be offered as a corequisite with the student's first NMP course, *Foundations of Mathematical Reasoning*. Like the Carnegie Foundation *Pathways*, NMP offers a quantitative literacy pathway and a statistical reasoning pathway, but NMP also offers a STEM pathway. All three options of

the NMP begin with the pairing of the *Foundations* and the *Frameworks* courses. The different NMP pathways were carefully designed around specific majors, thus appealing to all students at their institution (Zachry & Diamond, 2015).

Like the early findings of Carnegie Foundation, the results from the first year of NMP reveal positive outcomes for NMP students as compared to students in traditional developmental courses. Completion rates (earning a grade of "C" or higher) for the first course were 25% in traditional courses and 65% in NMP's *Foundations* course. The Dana Center cautioned that they did not control for potentially confounding variables that might skew the results. They suggested that future comparative studies controlling for differences in students were needed before crediting the NMP as the reason for these outcomes. The data, however, were promising for future students of developmental mathematics. (Zachry & Diamond, 2015).

Guided Pathways. The Dana Center's focus on student majors is also consistent with a recent national initiative called *Guided Pathways*. In this systemic movement to redesign community colleges, focus is placed on giving every student a strong start. Specific programs of coursework, or maps, are established for every major or certification program. Onboarding procedures ensure students are connected to advisors to correctly choose the right pathway of interest and then connect them to other students, faculty, and career communities in their field of interest. Students are placed in courses of interest their first semester, leading to increased persistence. Remediation and academic support are provided in all disciplines and all levels, not just in introductory mathematics, reading, and writing courses. Faculty in all areas collectively work on teaching new students a variety of strategies for becoming successful college students. Students, however, who require remediation in mathematics, for example, are guided toward the

course best suited for their chosen pathway: algebra, statistics, or quantitative literacy. Throughout their college experience, students also participate in active and experiential learning in their field. This whole-college reform has shown promising results in persistence to graduation (Bailey et al., 2021). Despite this growing body of evidence regarding promising practices, more research is still needed on what students think about their educational experiences.

Conclusion of the Literature Review

This review of recent literature in the field of developmental education addressed the need to confront the lack of college readiness of first-year college students, particularly in mathematics. I examined a sampling of recent and ongoing initiatives in developmental mathematics education. Many national reform efforts are currently underway to address this problem. Pedagogical changes are a main focus of ongoing national initiatives in developmental education. This is partly due to the failure of past institutional reforms to bring about widespread changes to developmental education success rates, and partly due to the changing needs of students in today's global economy. I also addressed the recommendations of the CCRC: advocating for changes to placement policies, eliminating developmental courses and supporting college-level coursework instead, including support for non-academic factors, and lastly, minimizing the time it takes to achieve college readiness. I examined the *Pathways, New Mathways Project*, and *Guided Pathways* initiatives as three major reforms that gained popularity due to initial descriptive and empirical data supporting their potential to bring about deep educational reforms. The significant pedagogical changes proposed necessitate increased professional development for faculty of not only developmental education courses, but also introductory courses in all fields.

While many promising initiatives have been implemented, a large percentage of those have only anecdotal data to contribute at this stage, whereas others found were backed with empirical research. Limited studies had been designed with a randomized control trial (RCT) or quasi-experimental design (QED), and the abundance of descriptive studies, while contributory to the growing body of knowledge about reform initiatives, provide only inconclusive evidence about the effectiveness of the initiative (Hodara, 2013). More research is needed in the field of developmental mathematics education.

Implications for This Study

My own research interests are driven by social cognitivism and a fascination with how non-cognitive factors affect the learning process both in and outside of the classroom. These components underlie how the *Pathways* curriculum is taught, with the teacher facilitating only as needed to help students make meaning and build connections on their own. Both the *Pathways* curricula from Carnegie Foundation and the work of Stigler et al. (2010), Mesa (2010), and Perin (2011) are situated at the intersection of two theoretical perspectives on learning: social cognitive theory and the framework for student success/productive persistence. Social cognitive theory underlies both the concept of a productive struggle, described above, and the broader framework for student success / productive persistence that *Quantway* was built upon. I situated my investigation at the intersection of these two underlying frameworks. I wanted to learn more about what students think about this type of program, in search of promising practices with students of developmental mathematics. My study contributes empirical evidence for the effectiveness of a quantitative literacy course built on the focus of student success initiatives.

The findings of this study will add to the growing body of research on the needs of students of developmental mathematics and what factors influence their learning experiences.

Chapter 3 - Methods

Research Design

The purpose of this investigation was to gain insights into how students in developmental mathematics use learning and study strategies and how they describe their learning experiences. I sought to answer the following research questions:

- Research Question #1: What effects does taking a developmental mathematics course that incorporates learning and study strategies have on students' strategic learning skills?
- Research Question #2: How do students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences?

To answer these research questions, I used a mixed methods design, gathering both quantitative and qualitative data. Creswell (2014) described the mixed method approach as a technique for collecting and analyzing these two types of data. Furthermore, I implemented the strategy that Creswell termed as a sequential procedure. I examined quantitative data addressing the first research question, followed by a qualitative analysis of interview and survey data that address the second research question. By implementing a mixed methods strategy, I hoped to find insights from students' reflections that would shed light on the findings from the quantitative analysis. Additionally, I adapted this study from the mixed methods, quasi-experimental investigation by Mireles, Offer, Ward, and Dochen (2011), using a similar three-instrument protocol administered in their study. They conducted their study with an intensive summer algebra course, while my study was conducted with a full semester, non-STEM quantitative literacy course. My study also differed from that of Mireles et al. by incorporating

interviews with students. The theoretical frameworks of social cognitive theory and the framework for student success (productive persistence) guided the design of my investigation.

Research question #1 is rooted in social cognitive theory. Learning strategies, or the skills with which students process and make sense of knowledge, underlie student success. My study examined the extent to which taking a developmental mathematics course that incorporates learning and study strategies impacted students' strategic learning skills. The LASSI provided a tool to measure this effect. I then extended my study beyond the purpose of the study by Mireles et al. (2011). The focus of their study was to investigate the effectiveness of incorporating study strategies in a developmental mathematics course, and their results highlighted a positive, significant impact on student learning. As a limitation of their study, they cited the self-reporting nature of the LASSI scores and suggested additional data collection measures to strengthen their claims. This led to the inclusion of an interview phase of my study. Since acquisition of learning strategies is linked to student success, I probed students on their learning experiences in this developmental mathematics course that incorporated learning and study strategies.

Research question #2 is rooted in both frameworks. The non-cognitive factors of social cognitive theory are important to the student learning experience, and they lay the foundation of a strong framework for student success. Since learning strategies, when applied in the context of mathematical tasks, help students make connections, I sought to determine what students think about their learning experiences in this developmental mathematics course. Using the data provided by the LASSI as a starting point, I probed students on aspects of their learning experience, seeking evidence of factors that impacted their ability to succeed. The emergent

themes in my study were largely non-cognitive in nature, revealing psychological factors that influenced student persistence and student success.

Instruments

Mireles et al. (2011) gathered data using three survey instruments: The *Learning and Study Strategies Inventory* (LASSI, second edition), the LASSI Pre-Post Achievement Measure, and the Mathematics Information Survey. My study utilized three similar instruments; however, I used the more recent third edition of the LASSI (Weinstein, Palmer & Acee, 2016). I describe each of the three instruments in this section.

LASSI. The LASSI questionnaire is a self-reporting instrument designed to assess "students' awareness about and use of learning and study strategies related to skill, will, and self-regulation components of strategic learning. The focus is on both covert and overt thoughts, behaviors, attitudes and beliefs that relate to successful learning and that can be altered through educational interventions" (Weinstein et al., 2016 pg. 4). The second edition of the inventory contained 80 items that equally represented 10 scales. (The third edition contains 60 items that equally represent the 10 scales.)

The skills component is related to three scales: Information Processing, Selecting Main Ideas, and Test Strategies. The will component is related to three scales: Attitude, Motivation, and Anxiety. The self-regulation component is related to four scales: Concentration, Time Management, Self Testing, and Using Academic Resources. The table shows how the scales are referenced by an abbreviation, or code, provided by LASSI (see Table 1).

Table 1

LASSI Components and Scales

Main Components of Strategic Learning	Related LASSI Scales	Code
Skill	Information Processing	INP
	Selecting Main Ideas	SMI
	Test Strategies	TST
Will	Anxiety	ANX
	Attitude	ATT
	Motivation	MOT
Self-Regulation	Concentration	CON
	Self Testing	SFT
	Time Management	TMT
	Using Academic Resources	UAR

The LASSI is a statistically valid and reliable, vetted instrument. It is a norm-referenced assessment that uses percentile ranking to help students diagnose their strengths and weaknesses in comparison with other college students nationwide (Weinstein, Palmer, & Acee, 2016). The questions followed a 5-point Likert scale, requiring students to select the most appropriate phrase for each item: not at all typical of me, not very typical of me, somewhat typical of me, fairly typical of me, or very much typical of me. Reverse scoring is used on half of the items to lower response bias from test takers. For all scales except for Anxiety, a high score indicates strong skills in the scale, and a low score indicates need for improvement or intervention in the scale. For the Anxiety scale, however, a low score indicates a high level of anxiety, and a high score indicates a low level of anxiety. I used the third edition (Weinstein et al., 2016) for my study.

Between the creation of the second edition in 2002 and the revisions leading to the 2016 LASSI edition, feedback was gathered from students and test administrators, and contemporary

research on learning and study strategies was reviewed. The feedback led to the creation of a shorter assessment and changing the name of one scale from Study Aids Scale (STA) to Using Academic Resources (UAR). The change from the STA scale to the UAR scale aligned better with new research that reflected students seeking academic help, an area that received increased attention and resources in education since the second edition of LASSI was released. The new scale has a stronger Cronbach's alpha reliability coefficient, and all scales range from 0.76 to 0.87, maintaining the psychometric quality provided by all versions of the LASSI. Minor wording changes were made in 2016 to avoid confusion noted by some questions on the previous survey. Based on developments in research on student motivation and attitude, seven new questions were field tested in these scales, but only one measuring motivation was selected for use in the new edition. The new edition was piloted with a representative sample of 1,386 post-secondary students from 23 institutions. Based on those results, new national norms were created to reflect a demographically different student body in 2014 than that of 2002.

Upon completion of the LASSI, students receive a report containing their individual item responses, their raw score for each scale, and their national percentile ranking for each of the 10 scales being assessed. An example LASSI report from Danielle, one of the interviewees, is provided in Appendix A. The first page of the report presents the student's pre- and post-scores as both percentiles and raw scores. The subsequent pages of the LASSI report indicate the questions associated with each scale being assessed, as well as the student's score, according to the Likert scale. Additionally, students receive a bar graph which gives them a visual interpretation of their scores. A description of each of the 10 scales is provided for the student. Based on the resulting scores, the report informs the student if they are adept in a scale, in need

of improvement on a scale, or possess severe deficiencies that need to be addressed to succeed in school. In addition to utilizing this self-reporting instrument (LASSI) once early in the semester and again late in the semester, I also used written reflection components in my study as direct ways of gathering information about students' thoughts pertaining to the results. I refer to the first iteration of the LASSI questionnaire as the Pre-LASSI, and the second iteration of the LASSI questionnaire as the Post-LASSI. Participants of the study completed both components.

LASSI Pre-Post Achievement Measure. This second instrument was used to track participants' scores on both iterations of the LASSI. I created it from the description provided by Mireles et al. (2011). After completing the Pre-LASSI, participants recorded their percentile scores for each of the ten scales assessed, by completing the column labeled "LASSI One" on the Pre-Post Achievement Measure form (see Appendix B). This same form was returned to participants after taking the Post-LASSI, and they completed the column labeled "LASSI Two."

Mathematics Information Survey. This third instrument was used to gather participants' reflections about their scores on both iterations of the LASSI. I created the survey from the description provided by Mireles et al. (2011). I created two different versions. After completing the Pre-LASSI, the participants provided written feedback on the first version of the Mathematics Information Survey (see Appendix C), reflecting on which scales they believed to be strengths and weaknesses. They reflected on how their strengths might help them succeed and how they might overcome their weaknesses. After completing the Post-LASSI, recording their scores, and comparing their Post-LASSI scores to their Pre-LASSI scores, the participants provided written feedback using the second version of the Mathematics Information Survey (see

Appendix D). They reflected on which scales they believe they made the most and least progress in. They reflected on reasons that could explain changes, or lack of changes, in their scale scores.

Procedures

Setting

The research site for this study was a community college in the outskirts of an urban area in central New York. The institution is a public two-year school serving approximately 10,000 students. About half of the students are enrolled full-time, and the other half attend part-time. The institution offers both associate degrees and certificate programs.

Quantway was first offered at this institution in Spring 2012 when the course was piloted nationally. College faculty from across eight states, including a team of three professors of developmental mathematics from the institution in this study, joined in the work of the Carnegie Foundation and collaborated with educational researchers, psychologists, and teachers to create lessons for the *Quantway* pathway (Merseth, 2011). All *Quantway* faculty received mandatory pedagogical training before teaching this course.

Participants

All students enrolled in *Quantway* during the Spring 2017 semester were invited to participate in the study. Prior to soliciting student volunteers for my study, I consulted with the eight professors who were teaching *Quantway* during the Spring 2017 semester to ensure their willingness to participate. Those who consented to participate then completed the Faculty Information Sheet (see Appendix E).

Next, I recruited volunteers from the total student population of 195 students enrolled in all 13 offered sections of *Quantway*. Each section of *Quantway* visited a computer lab early in

the semester. I had all consenting participants complete a Student Information Sheet (adapted from Canfield, 2013) during the initial recruitment meeting (see Appendix F). This form also had a question to indicate if the student was interested in being interviewed for the study. In most instances, I administered this form directly to the students. Almost half of the potential participants were absent on the day of the Pre-LASSI. Most in attendance agreed to participate in the study, and the professors of those students not in attendance were able to recruit some of the absentees to participate. For all students who granted consent, I gathered additional demographic data from the college's database, as well as information about prior coursework taken and grades earned in those courses. Although this information is not directly related to my research questions, it may provide insights for further research or be pertinent to the generalizability of the findings to this study.

A total of 65 student participants, or one-third of all 195 *Quantway* enrollees, completed all components of the study. This is partially attributed to high levels of attrition in developmental mathematics. Nationally, only 31% of the students recommended to developmental mathematics courses successfully complete their sequence of courses. Initially, 130 students had agreed to participate in the study, but half of them withdrew from the study before the completion of all required components. Of the 65 students who did not complete all components, some were absent on the day of the post-LASSI, some had withdrawn from the course or ceased attending, and some elected not to complete the post-LASSI. Each of the eight professors had students who completed all components of the study. From the 65 student participants who completed the study, 10 students also completed both the phase one and phase

two interviews of the study. Only six out of the eight professors had students who completed the interview sequence.

Data Collection

All consenting participants were invited to take the 60-item *Learning and Study Strategies Inventory (LASSI,* 3rd ed.) during the recruitment class meeting in week two or three of the semester and again in week 13 or 14 of the semester, dependent upon computer lab availability to accommodate the data collection sessions. At the recruitment class meeting, consenting participants completed the first iteration of the *LASSI* questionnaire, or Pre-LASSI, on a computer in the lab. Upon completing the Pre-LASSI students received immediate results at the computer. Each student printed their results and then used the LASSI Pre-Post Achievement Measure (see Appendix B) to record percentile scores in all ten scales measured by LASSI under the "LASSI One" column. The participants then completed a Mathematics Information Survey containing five reflection questions about their Pre-LASSI results.

During the final weeks of the semester, this LASSI process was repeated. Participants completed the second iteration of the *LASSI* questionnaire, or Post-LASSI, during class, printed their results, and recorded them on the same LASSI Pre-Post Achievement Measure that they completed the first time, but this time under the "LASSI Two" column. The participants then completed a Mathematics Information Survey containing five reflection questions about their Post-LASSI results. The reflections on the post survey asked participants to compare their pre and post scores. At the time of the post-LASSI administration, a total of 65 participants completed the questionnaire.

Throughout the semester, 10 students completed a sequence of two semi-structured interviews. All students who had volunteered to be interviewed and who were present in class on the day of my visit were invited to participate in my study as interviewees. A total of 13 students committed to begin their interview process in early March. During the last week of the semester, I interviewed 10 of the 13 students who were still enrolled in *Quantway*. The other three students had ceased attending class. The 10 interviewees were enrolled in classes with 6 out of the 8 *Quantway* faculty. I audio recorded all interviews per student consent.

I assigned pseudonyms to consenting students and consenting faculty. Here is a chart showing which student interviewees were enrolled in which professor's class (see Table 2).

Table 2

Pseudonyms of Professors and Interviewees

Teacher	Student Interviewees
Gretchen Cambria	Joe Lydia
Melissa Franklin	Rachel
Allen Montgomery	Jennifer
Kate Sullivan	Anna Keesha
Tom Warren	Jamie
Dianne York	Chelsea Danielle Mark

Note. Two participating *Quantway* professors are not listed here, as they did not have any students complete the interview sequence.

In addition to the demographic data provided by most of my participants at the beginning of the study, I also gathered periodic grade progress from the participants' professors. At the end of the semester I collected final course grades for consenting participants, Satisfactory (S) and

Unsatisfactory (U) from the instructors. (Some professors further delineated a satisfactory grade with an A, B, or C.) Student responses from the written reflection surveys and from interviews provided further insights to this study, as well. I analyzed the data in multiple stages.

Data Analysis

Quantitative Component. My first research question investigated the effects of taking a developmental mathematics course that incorporates learning and study strategies on students' strategic learning. I measured students' strategic learning and study skills at two points in the semester using the LASSI questionnaire.

Analysis of Pre-LASSI scores. The scores on the first iteration of the LASSI questionnaire provided an indication of the participants' strengths and weaknesses in strategic learning and study skills at the beginning of their developmental mathematics course. I calculated descriptive statistics on the three main components of the LASSI and on each of the 10 scales measured by the LASSI for all 65 participants. The same statistics were calculated for the cohort of 10 interviewees.

Analysis of Post-LASSI scores. The scores on the second iteration of the LASSI questionnaire provided an indication of the participants' strengths and weaknesses in strategic learning and study skills near the end of their developmental mathematics course. I again calculated descriptive statistics on the three main components of the LASSI and on each of the 10 scales measured by the LASSI for all 65 participants. I calculated the same statistics for the cohort of 10 interviewees.

Analysis of Change in LASSI scores. To answer my first research question and determine if taking this developmental mathematics course had an effect on student's strategic

learning and study skills, I compared mean scores from the Pre-LASSI and Post-LASSI. When analyzing data from all participants (n=65), the data passed tests of normality. I used paired t-tests to analyze the changes in students' mean scores and to identify areas of significant change. I also used paired t-tests to analyze the data from the 10 interviewees. Since the means comparisons for the interviewees involved smaller samples (n=10), the data were more sensitive to the shape of each LASSI scale's distribution of scores. I viewed histograms, Normal Probability Plots, and examined the Anderson-Darling goodness-of-fit statistic to determine if the data sets for the change in means of each scale were nearly normal. Since they all passed the Normality tests, I used paired t-tests to determine if the changes in mean scores for each scale were significant. To better understand how the LASSI scales relate to each other, I ran Pearson correlations to examine relationships between these scales for the participants. This analysis helped me determine if the course had an effect on student's strategic learning and study skills.

My second research question investigated how students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences. Since the course instructor and elements of a course, such as homework and grades, impact students' learning experiences, I examined Pearson correlations between the professor a student had, whether or not the participant purchased the online homework platform, what percentage of homework the participant completed, percent of classes attended, midterm grade, and final grade. I present the results of the quantitative analyses in Chapter 4. I carried out further investigation of my second research question using qualitative methods described in the next section.

Qualitative Component. To further investigate my second research question, I conducted an analysis of the reflections provided in the pre- and post-Mathematics Information

Survey administered to all 65 participants and from the pre- and post-interviews conducted with 10 interviewees. I transcribed all interviews and used NVivo to code both the survey data and interview data. I also analyzed both the written reflections and the interview transcripts in search of themes that support the numerical data available.

A Priori Codes. Initially I used the ten learning and study strategies, identified as scales by LASSI, as a priori codes; however, some other key concepts emerged in the interview transcripts that I also analyzed (see Table 3). Appendix G contains my Codebook that provides a more detailed explanation of how LASSI defined each of the ten related scales that became my a priori codes. I used these descriptions to identify evidence of these scales within my data.

Table 3

Coding Scheme: A Priori Themes

A Priori Themes	Code Names
Skill	Information Processing Selecting Main Ideas Test Strategies
Will	Anxiety Attitude Motivation
Self-Regulation	Concentration Self Testing Time Management Using Academic Resources

To add validity to my study, I enlisted a fellow doctoral student to help triangulate my a priori coding scheme. Given a partial transcript and my codebook, she used the list of descriptions of each code to conduct her own coding analysis. We then met to compare our coding results, and where discrepancies occurred, our discussions led to the refinement of a few descriptions in our personal notes about the codebook, which were based directly on LASSI

descriptions. For example, we reached an agreement that "information processing" refers to the incorporation of new learning into an existing schema. My peer proposed a name change from Information Processing (INP) to Learning New Information (LNI), but I wanted to maintain the direct association with the LASSI scales. In another example, my peer struggled with the description provided for Attitude. The descriptions of attitude and interest were too vague. We determined that "attitude" refers to a student's outlook or perspective toward one's interest in college and interest in learning. The interest also referred to a state of wanting to learn about something. These clarifications allowed us to align our pieces of the interview transcript that we had initially coded differently from each other.

Emergent Codes. The first additional themes to emerge were the impact of both the teacher and groupwork on the student learning experience. Both of these factors were given significant importance in the interviews, and the participants attributed their personal growth within the LASSI scales to the teacher and the groupwork aspect of their developmental mathematics course. I made "Teacher Impact" and "Groupwork" my first two emergent codes. I also added a temporary code called "Evidence of Change," which I used to identify statements primarily appearing in the post-interviews that indicated a shift in perceptions from those expressed in the pre-interviews.

I conducted another round of coding, focusing on identifying evidence for the new "Evidence of Change" code. Students shared about their difficulties with learning how to be a college student. They spoke about the many barriers they faced in life and in school. These statements were often intertwined with students' responses about Anxiety, in both the pre-interviews and post-interviews. I have labeled these two themes "Doing College" and "Barriers."

Many students also experienced changes throughout the semester that exhibited a "Growth Mindset," which became my final emergent theme. The codes of Doing College, Barriers, and Growth Mindset replaced the temporary "Evidence of Change" code. Altogether I coded 10 a priori themes and five emergent themes, using each theme name as the subsequent code.

After establishing the five emergent codes, I performed another iteration of coding on all 20 interviews to identify sub-themes within the five main coded themes. I divided each of the five emergent themes into sub-themes. The first theme, Doing College, includes Attendance and Homework, Class Participation, Test Preparation, Academic Support, and Purpose. The second theme, Barriers, includes Classroom Barriers, Homework, Learning Disabilities, Mathematical Content, Health and Well-Being, and Balancing Acts. The third theme, Teacher Impact, includes Teaching Techniques, Student Success, and Mutual Response. The fourth theme, Groupwork, includes Buy-In, Pretenders, Sense of Community, and Synergy. The fifth theme, Growth Mindset, includes Open Mind, Confidence in Ability, and Productive Persistence (see Table 4).

Table 4

The Five Emergent Themes and Sub-Themes

Emergent Themes	Sub-Themes
Doing College	Attendance and Homework Class Participation Test Preparation Academic Support Purpose
Barriers	Classroom Barriers Homework Learning Disabilities Mathematical Content Health and Well-Being Balancing Acts

Teacher Impact	Teaching Techniques Student Success Mutual Response
Groupwork	Buy-In Pretenders Sense of Community Synergy
Growth Mindset	Open Mind Confidence in Ability Productive Persistence

Once I determined the sub-themes from the interview data, I also coded the written responses again, seeking more evidence to support the interview findings. Although the interviews provided significantly more description of the students' learning experiences, the written data also provided further support for many of the sub-themes.

Merging the Data. The purpose of this mixed methods investigation was to gain insights into the strategic learning skills of students in a developmental mathematics course that incorporates learning and study strategies and to learn how the students describe their learning experiences. This study used a self-reporting instrument (LASSI), as well as reflection components, that were both direct ways of gathering information, from the students, on their perceptions of themselves and learning. The LASSI served as a measurement instrument and not an intervention. The LASSI scores provided data for a quantitative analysis of if learning and study strategies were affected by taking a developmental course that incorporated such skills. The LASSI scores also provided a conversation piece on which students could begin to share, in their interviews, about their learning experiences in their developmental mathematics classes. My analysis examined whether or not the students' reflections shed light on the findings that

emerged from the quantitative analysis. Furthermore, both the quantitative and qualitative analyses from this study revealed insights as to whether or not the mathematical literacy curriculum, *Quantway,* supported the development of various learning and study strategies in students of developmental mathematics at this community college, as evidenced by changes in their LASSI scores and their perceptions.

Strengths and Limitations in Design

One limitation of this design is that it was not a randomized group of students. Due to historically high levels of attrition in the United States among community college students of developmental mathematics (Mireles et al., 2011), the anticipated pool of approximately 200 students at the start of the semester was expected to dramatically decrease in size by the time the post-test was administered. My final analysis focused on data collected from participants who completed the study, representing about one-third of all eligible students at the time of recruitment. Also, the participants may possess higher levels of motivation than non-participants, given that they voluntarily took part in and completed the full study.

Since the data collected were self-reported by students, there was potential response bias that could have interfered with the results. Duncan and McKeachie (2005) reported that "although social desirability response bias should always be kept in mind (p. 124)," their analysis of a study using a self-reporting inventory similar to LASSI revealed no significant amount of variance due to this bias. Wadsworth et al. (2007) recommended increasing validity by having a control group to compare to. This would have been problematic at this community college, since the other developmental course, beginning algebra, had recently started incorporating study skills

strategies into the curriculum in the fall of 2016. For that reason, I decided not to use a control group.

The requirement that all *Quantway* faculty receive mandatory, pedagogical training before teaching this course levels the playing field and adds strength to the findings. The fact that the LASSI is a statistically valid and reliable, vetted instrument used to help students diagnose their strengths and weaknesses, in comparison to other college students nationwide (Weinstein, Palmer, & Acee, 2016), also adds to the reliability of the findings and adds to the strength of this study.

Chapter 4 - Results

The twofold purpose of this study was to investigate the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills and to gain insights about the learning experiences of these students. I gathered data through interviews and three survey instruments: The Learning and Study Strategies Inventory (LASSI), LASSI Pre-Post Achievement Measure, and the Mathematics Information Survey. I was interested in how to best support this population of learners and was seeking evidence of promising practices in developmental mathematics education that will both contribute to the research literature and to my work in the classroom. The two research questions guiding this study were:

- Research Question #1: What effects does taking a developmental mathematics course that incorporates learning and study strategies have on students' strategic learning skills?
- Research Question #2: How do students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences?

This chapter begins with an examination of quantitative data addressing the first research question, followed by a qualitative look at interview and survey data that address both the first and second research questions.

Research Findings

For my first research question, I investigated the effects of incorporating learning and study strategies in a developmental mathematics course. I utilized LASSI, or Learning and Study Strategies Inventory, as a tool for measuring changes in students' strategic learning skills. LASSI measures strategic learning in three components: skill, will, and self-regulation. Each of the three

main components of strategic learning is broken down into three or four related sub-categories called scales, which are referenced by an abbreviation, or code, provided by LASSI (see Table 5).

Table 5

LASSI Components and Scales

Main Components of Strategic Learning	Related LASSI Scales	Code
Skill	Information Processing	INP
	Selecting Main Ideas	SMI
	Test Strategies	TST
Will	Anxiety	ANX
	Attitude	ATT
	Motivation	MOT
Self-Regulation	Concentration	CON
	Self Testing	SFT
	Time Management	TMT
	Using Academic Resources	UAR

Appendix G contains my Codebook that provides a more detailed explanation of how LASSI defined each of the ten related scales. Participants took the 60-item, computerized LASSI early in the course and again near the end of the semester. The students immediately received their scores in the form of percentiles for all ten scales of the LASSI.

For my second research question, I investigated what insights can be gained from students' descriptions of their learning experiences in a developmental mathematics course that incorporates learning and study strategies. Upon receiving their numerical scores from each LASSI, the participants completed written reflections about both their pre-test and post-test results, self-identifying their strengths and weaknesses, and indicating insights about any growth or lack of changes. Many students commented on elements of their mathematics class in these

reflections, providing evidence of how the course may have affected students' learning strategies. The analysis of these investigations follows in the next section.

Quantitative Analysis

In this chapter, I provide a quantitative analysis of the participants' demographic data and LASSI scores, followed by a qualitative analysis of the students' written reflections. In addition to these written reflections, I also present interview data with my analysis from 10 participants whom I interviewed about the LASSI and about their developmental mathematics course.

Analysis of Demographics

I examined the extent to which study participants and interviewees are representative of the total class enrollment for *Quantway.* I collected and analyzed demographic data on the 65 participants. In the following table, I provide a demographic comparison of the sample of 10 interviewees, the sample of 65 survey participants, and the overall population of 195 Quantway course enrollees, when available (see Table 6). Lastly, I conducted Chi-Square Tests to determine if there were significant differences between the distribution of demographics for the 65 LASSI participants and all 195 enrollees in Quantway.

My analysis of the demographics, as summarized in Table 6, presents similarities and differences among the 65 LASSI participants, the 10 interviewees, and the 195 enrollees. The data in the table reveal that the LASSI participants' demographics reflect those of the interviewees for enrollment status, age, race, mathematics placement, first generation status, and final grades. Differences between the LASSI participants and the interviewees occurred with gender, higher education history, English placement, ESL status, and OAR services.

Table 6

Comparison of Participant, Interviewee, and Enrollee Distributions

	LASSI Participants		Interviewees		Total Enrollees	
	n	%	n	%	n	%
Gender						
Female	39	60	8	80	115	59
Male	26	40	2	20	80	41
Enrollment Status						
Full-time	51	86	8	80	180	92
Part-time	8	14	2	20	15	8
Age						
18-29	47	80	8	80	Not Available	
≥30	12	20	2	20	Not Available	
Higher Education History						
Continuing	41	69	6	60	133	68
First-time	14	24	4	40	52	27
Transfer	4	7	0	0	10	5
Race						
White	35	59	5	50	77	40
Black/African American	15	26	3	30	71	36
Other [a]	9	15	2	20	47	24
English Placement						
College-Level	31	60	8	80	68	38
1 Level Below	21	40	2	20	110	62
Math Placement						
College-Level	2	3	0	0	8	4
1 Level Below	48	83	8	80	156	82
2 Levels Below	8	14	2	20	26	14
First Generation Status						
Yes	23	35	3	30	97	49.7
No	42	65	7	70	98	50.3
ESL Status						
ESL	4	6	0	0	9	5
Non-ESL	61	94	10	100	186	95
OAR Services						
Yes	9	14	1	10	25	13
No	56	84	9	90	170	87
Final Grade						
Pass	50	77	9	90	85	44
Fail	15	23	1	10	110	56

The interviewees had a larger female presence, more first-time college students, higher incidence of college-level English placement, no ESL students, and only one student receiving services.

An analysis of the interviewee demographics compared to the total Quantway enrollees revealed similar demographics except for four areas. The interviewees had a larger female presence, twice as many college-level English placements as all enrollees, 20% less students with first-generation status, and more than double the passing rate for final grades.

In the table above, I utilized these demographic data on the 65 participants, combined with academic information collected, to examine the extent to which the study participants and interviewees were representative of the total class enrollment for *Quantway.* Next, I present the analysis of the Chi-Square Tests used to determine if there were significant differences between the distribution of demographics for the 65 LASSI participants and all 195 enrollees in Quantway (see Table 7).

My hypotheses were:

- Ho: The LASSI sample has the same demographic distribution as all enrollees in Quantway.
- Ha: The distribution of demographics differs between the LASSI sample and all enrollees in Quantway.

My null hypothesis was that the LASSI sample has the same demographic distribution as all enrollees in Quantway. My alternative hypothesis was that the distribution of demographics differs between the LASSI sample and all enrollees in Quantway. In cases where I fail to reject the null hypothesis, this is not evidence in support of the null hypothesis, but rather an indication that there is not enough evidence to conclude that the 65 LASSI participant population was significantly different from the total population of 195 enrollees.

Table 7

Comparison of Participant and Enrollee Distributions

					Chi-Squared Tests	
	LASSI Participants		Total Enrollees		χ^2-statistic (df)	p-value
	n	%	n	%		
Gender					0.021 (1)	0.884
Female	39	60	115	59		
Male	26	40	80	41		
Enrollment Status					1.893 (1)	0.169
Full-time	51	86	180	92		
Part-time	8	14	15	8		
Higher Education History					0.386 (2)	0.825
Continuing	41	69	133	68		
First-time	14	24	52	27		
Transfer	4	7	10	5		
Race					7.265 (2)	0.026*
White	35	59	77	40		
Black/African American	15	26	71	36		
Other [a]	9	15	47	24		
English Placement					7.909 (2)	0.019*
College-Level	31	60	68	38		
1 Level Below	21	40	110	62		
Math Placement					0.067 (2)	0.967
College-Level	2	3	8	4		
1 Level Below	48	83	156	82		
2 Levels Below	8	14	26	14		
First Generation Status					4.044 (1)	0.044*
Yes	23	35	97	49.7		
No	42	65	98	50.3		
ESL Status					0.243 (1)	0.622
ESL	4	6	9	5		
Non-ESL	61	94	186	95		
OAR Services					0.045 (1)	0.832
Yes	9	14	25	13		
No	56	84	170	87		
Final Grade					21.699 (1)	0.000*
Pass	50	77	85	44		
Fail	15	23	110	56		

Note. * $p < 0.05$
[a] The "Other" category of Race includes Asian, Native Hawaiian or Pacific Islander, American Indian or Alaska Native, Hispanic, Multiple races, and Non-Resident Aliens. Individually, the counts of each group were too small to meet the condition of at least 5 data values per cell in chi-squared tests.

The p-values for Gender, Enrollment Status, Higher Education History, Math Placement, ESL, and OAR are all greater than 0.05 significance level, so I fail to reject the null hypothesis that the LASSI sample has the same demographic distribution as all enrollees in Quantway. I have insufficient evidence that these demographics differ significantly across both groups of students. Since, however, the p-values for Race, English Placement, First Generation Status, and Final Grade are all less than 0.05, I reject the null hypothesis. This indicates that there is a significant difference between the 65 LASSI participants and all 195 Quantway enrollees for racial diversity, English language proficiency, first generation status, and final grade results.

In the previous section, I provided a quantitative analysis of the participants' demographic data. The next section will analyze the LASSI scores of all participants, followed by a qualitative analysis of the students' written reflections.

Analysis of LASSI Data

I analyzed the three main components of strategic learning, as measured by LASSI: Skill, Will, and Self-Regulation. The Skill component consists of the Information Processing, Selecting Main Ideas, and Test Strategies scales. The Will component consists of the Anxiety, Attitude, and Motivation scales. The Self-Regulation component consists of the Concentration, Self Testing, Time Management, and Using Academic Resources scales. To address my first research question, I examined the change in LASSI scores for all 65 participants who took both the Pre-LASSI and Post-LASSI surveys.

To further analyze these changes, I conducted paired t-tests to identify areas of statistical significance. Paired t-tests at the α=0.05 level did not indicate a statistically significant mean differences between the pre and post LASSI scores for the Skill component, the Will component, or the Self-Regulation component (see Table 8).

Table 8

LASSI Pre-test & Post-test Data with Paired t-test Results by Main Component

LASSI Component	Pre		Post		Difference		Test	
	Mean	SD	Mean	SD	Mean	SD	t	p
Skill	63.231	10.535	64.569	9.808	1.338	7.166	1.510	0.137
Will	63.831	9.753	64.108	9.581	0.277	7.432	0.300	0.765
Self-Regulation	75.277	14.885	75.939	15.067	0.662	10.566	0.500	0.615

Note. n=65. All values were rounded to the nearest thousandth.

I then examined the ten individual scales measured by LASSI. First, I calculated every participant's relative change in score for each of the 10 scales of LASSI, and then I calculated the average of all participants' relative changes per scale (see Table 9). I calculated relative change (as a percent) using the following formula:

$$Relative\ Change = \frac{(postLASSI\ score)\ -\ (preLASSI\ score)}{(preLASSI\ score)}\ x\ 100$$

Anxiety shows both the largest positive change (57% of students) and average relative change (11.5%) over any other scales. For the Anxiety scale, a low score indicates a high level of anxiety, and a high score indicates a low level of anxiety. The second highest positive changes

Table 9

LASSI: Relative, Positive, and Negative Changes

LASSI Scale	Average Relative Change	Positive Change	Negative Change	No Change
		Number of Students (%)	Number of Students (%)	Number of Students (%)
Anxiety	11.46%	37 (56.9%)	18 (27.7%)	10 (15.4%)
Attitude	-1.03%	23 (35.4%)	34 (52.3%)	8 (12.3%)
Concentration	2.92%	30 (46.2%)	32 (49.2%)	3 (4.6%)
Information Processing	8.79%	31 (47.7%)	29 (44.6%)	5 (7.7%)
Motivation	-0.97%	25 (38.4%)	30 (46.2%)	10 (15.4%)
Selecting Main Ideas	3.20%	33 (50.8%)	27 (41.5%)	5 (7.7%)
Self Testing	6.05%	26 (40%)	29 (44.6%)	10 (15.4%)
Test Strategies	3.35%	26 (40%)	30 (46.2%)	9 (13.8%)
Time Management	3.58%	24 (36.9%)	29 (44.6%)	12 (18.5%)
Using Academic Resources	3.69%	33 (50.8%)	25 (38.4%)	7 (10.8%)

Note. n=65.

were seen in Selecting Main Ideas (SMI) and Using Academic Resources (UAR) for over half of the students, but since approximately 40% of students experienced negative changes in these scales, the relative change for both showed small gains. Information Processing came in third for positive change (48%), but I found the second highest relative change (8.8%) in the Information Processing scale over SMI and UAR which both had relative changes around 3%.

I also examined the Pre-LASSI means, Post-LASSI means, and the differences in means for all 65 participants (see Table 10). I found the greatest increase in the Anxiety scale,

indicating a statistically significant decrease in overall anxiety amongst students, with an average relative

Table 10

LASSI Pre-test & Post-test Data with Paired t-test Results by Individual Scales

LASSI Scale	Pre		Post		Difference		Test	
	Mean	SD	Mean	SD	Mean	SD	t	p
Anxiety	17.062	5.897	18.123	5.795	1.062	4.123	2.08	0.042*
Attitude	23.246	4.348	22.877	4.998	-0.369	3.542	-0.84	0.404
Concentration	19.169	4.752	19.231	4.53	0.062	3.566	0.14	0.890
Information Processing	21.215	4.456	22.138	3.952	0.923	3.714	2.00	0.049*
Motivation	23.523	3.993	23.108	3.981	-0.415	2.904	-1.15	0.253
Selecting Main Ideas	21.092	4.461	21.338	4.317	0.246	3.7	0.54	0.594
Self Testing	17.738	4.966	17.877	4.547	0.138	4.486	0.25	0.804
Test Strategies	20.923	4.236	21.092	3.694	0.169	3.625	0.38	0.708
Time Management	17.846	5.004	17.862	4.818	0.015	3.672	0.03	0.973
Using Academic Resources	20.523	4.331	20.969	4.576	0.446	3.606	1.00	0.322

Note. n=65. * $p < 0.05$

change of 11.5% and $\alpha<0.05$. I found the second highest increase in the Information Processing scale, indicating a statistically significant increase in students' abilities to process information, with an average relative change of almost 9% and $\alpha<0.05$. I found the third highest relative change in the Self Testing scale, rising 6% on average; however, this gain was not statistically significant.

Next, I examined the changes in the 10 individual scales measured by LASSI for the 10 interviewees. Normal probability plots and the Anderson-Darling test, with $\alpha=0.05$, revealed that the mean differences are normally distributed. Therefore, I conducted paired t-tests on the data to find significant differences in mean scale scores. Concentration (CON) ($p=0.055$) and Using

Academic Resources (UAR) (p=0.073) were significant at the significance level of 0.10 (see Table 11).

Table 11

LASSI Pre-test & Post-test Data with Paired t-test Results by Individual Scales for Interviewees

LASSI Scale	Pre		Post		Difference		Test	
	Mean	SD	Mean	SD	Mean	SD	t	p
Anxiety	15.6	5.400	17.2	5.996	1.6	3.565	1.42	0.190
Attitude	25.6	3.502	26.3	3.020	0.7	2.908	0.76	0.466
Concentration	19.5	4.673	21.7	5.438	2.2	3.155	2.20	0.055*
Information Processing	22.2	3.882	23.2	4.442	1.0	2.828	1.12	0.293
Motivation	25.7	4.138	25.8	3.458	0.1	2.183	0.14	0.888
Selecting Main Ideas	21.7	6.093	23.1	6.027	1.4	2.547	1.74	0.116
Self Testing	18.2	5.846	21.0	6.446	2.8	5.613	1.58	0.149
Test Strategies	20.6	4.993	22.8	5.029	2.2	4.566	1.52	0.162
Time Management	20.5	4.673	22.0	5.982	1.5	4.552	1.04	0.325
Using Academic Resources	19.3	5.579	21.2	6.286	1.9	2.961	2.03	0.073*

Note. n=10. * $p < 0.10$

The areas of statistically significant increases were different among the interviewees than among the n=65 participants. In the qualitative analysis of this investigation, I examined survey data for evidence of how taking a developmental mathematics course lowered Anxiety and improved Information Processing among the n=65. I also examined both survey and interview data for evidence of how taking a developmental mathematics course improved Concentration and bolstered Using Academic Resources among the 10 interviewees.

To further the analysis of research question #1 on what effects taking this course had on students' strategic learning skills, I used Pearson's Correlation to determine relationships between homework completion, attendance, professor taken, and grades earned. Purchasing the homework platform and using it to do homework are examples of Using Academic Resources.

Completing homework and attending class are also learning and study strategies that could be influenced by taking this course. These factors also impact grades received and can be influenced by the teacher of the course.

These variables relate to the two underlying frameworks of this investigation. In the first guiding framework, social cognitive theory, teachers can influence academic behaviors and mindsets (Pajares, 2002; Bonham & Boylan, 2012). Non-cognitive factors known to be associated with academic performance include the academic behaviors of attending class and completing homework (Nagaoka et al., 2013). The role of the teacher to encourage class attendance and participation in homework, as well as encourage persistence, can impact student success, measured here in the form of grades. Student success, also referred to as productive persistence, is the second guiding framework of this study.

I analyzed the available data from those who consented among the 65 participants who completed both the Pre-LASSI and the Post-LASSI surveys. I examined correlations between the professor a student had, whether or not the participant purchased the online homework platform, what percentage of homework the participant completed, percent of classes attended, midterm grade, and final grade (see Table 12).

Whether or not a student purchased the online homework platform was related to which professor they had. This moderate ($r=0.445$) and statistically significant ($p=0.000$) relationship suggests that some professors may have placed more importance on usage of the homework platform than others. The percentage of homework that a student completed indicated a weak ($r=0.251$), yet statistically significant ($p=0.057$) relationship with purchasing the homework

platform. Homework completion had a moderate and statistically significant (p=0.000) relationship with class attendance.

Table 12

Correlations between the Professor, Homework, Attendance, and Grades

Variable	Buy HW platform [a]	% HW attempted	% Classes attended	Midterm average	Final Grade Earned [b]	Prof. taken
Buy HW platform [a]	--					
% HW Attempted	0.251 *	--				
%Classes Attended	X	0.445 ***	--			
Midterm Average (%)	X	0.678 ***	0.295 **	--		
Final Grade Earned [b]	X	0.492 ***	0.266 **	0.772 ***	--	
Professor Taken	0.445 ***	X	0.254 *	X	X	--

Note. n=59. / * 0.05 < p < 0.10 / ** 0.001 < p < 0.05 / *** p < 0.001
[a] 1=purchased homework platform, 0=no purchase
[b] 3=A, 2=B, 1=C, 0=U (unsatisfactory)

Students' class attendance data also indicated a weak, yet statistically significant relationship with which professor they had (p=0.054). In addition, students' class attendance data indicated a weak, yet statistically significant relationship with both their midterm and final grades (both below the 0.05 level). Not surprisingly, there was a strong (r=0.772), statistically significant correlation (p=0.000) between midterm and final grades. Those students who were doing well midway through the semester were more likely to do well on their final exam and successfully complete the course. Homework completion had a moderately strong and statistically significant (p=0.000) relationship with midterm grades, too. Homework completion

also had a moderate and statistically significant (p=0.000) relationship with final course grade. In my qualitative analysis, I used students' written survey responses and interview data about the classroom experience to provide further insight into these findings.

Summary of Quantitative Research Findings

For my first research question, I investigated the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills. These skills were defined and measured by LASSI. My analysis of the three main components of strategic learning individually, for all 65 participants who took both the pre and the post LASSI, did not indicate statistically significant changes in LASSI scores.

When analyzing the ten individual scales measured by LASSI, the mean differences of significance were not the same for the 65 survey respondents and the 10 interviewees. I found statistically significant changes in the mean differences of pre-test and post-test scores for the 65 participants' Anxiety scale and Information Processing scale over the course of the semester. When limiting the analysis to just the 10 interviewees, I found statistically significant changes in the mean differences of pre-test and post-test scores with respect to the Concentration scale and the Using Academic Resources scale.

The Pearson's Correlation analysis indicated evidence of an association between the professor a student had, whether or not the participant purchased the online homework platform, what percentage of homework the participant completed, percent of classes attended, midterm grade, and final grade. Further evidence arose in participant surveys and interviews. I discuss the implications of these correlations in Chapter 5.

Qualitative Analysis

In addition to investigating students' perspectives on the effects of their mathematics course on their strategic learning skills, I also investigated what insights can be gained from students' descriptions of their learning experiences in a developmental mathematics course that incorporates learning and study strategies. In the next section, I examine both written reflections and interview data about the classroom experience to provide further insight into the quantitative findings. First, I provide an analysis of the written reflections on the Skill, Will and Self-Regulation components of strategic learning provided in the survey data, followed by the reflections of the interviewees on these components. Then I provide an analysis of the available data on students' learning experiences, addressing the additional themes that emerged from the data.

During this qualitative investigation, I analyzed two different bodies of evidence: (a) the written reflections provided by all 65 participants in the pre- and post- Mathematics Information Survey administered to all participants immediately upon completing their LASSI, and (b) the pre- and post-interviews conducted with the 10 interviewees who completed both the Pre-LASSI and Post-LASSI surveys. I compiled all survey responses into a spreadsheet and transcribed all interviews for further analysis. Using NVivo to code both the survey data and interview data, I analyzed these documents in search of themes that support the available numerical data.

Initially, I used the 10 components of LASSI as a priori codes (originally presented in Table 5), however some other key concepts emerged in the interview transcripts that were also analyzed (see Table 13). The first additional themes to emerge were "Teacher Impact" and

Table 13

A Priori Codes and Emergent Themes

Main Components of Strategic Learning and Emergent Themes	Codes
Skill	Information Processing Selecting Main Ideas Test Strategies
Will	Anxiety Attitude Motivation
Self-Regulation	Concentration Self Testing Time Management Using Academic Resources
Emergent Themes	Teacher Impact Groupwork Doing College Barriers Growth Mindset

"Groupwork." Both themes were given significant importance in the interviews, and the participants attributed their personal growth within the LASSI scales to the teacher and the groupwork aspect of the course. I also added a temporary "Evidence of Change" code, which I used to identify statements primarily appearing in the post-interviews that indicated a shift in perceptions from those expressed in the pre-interviews.

After recoding all survey responses and interview transcripts for "Evidence of Change," I noted three unique types of change within the data. These students of developmental mathematics faced many challenges, including learning how to be a college student and overcoming a variety of barriers. I labeled these two themes "Doing College" and "Barriers." Amidst these challenges, however, many students also experienced changes throughout the

semester that exhibit evidence of a "Growth Mindset," which is the fifth theme that I identified from my data. The qualitative analysis of the available data will address the themes of Teacher Impact, Groupwork, Doing College, Barriers, and Growth Mindset.

Analysis of Written Reflections on the Components of Strategic Learning

In the next section, I present evidence of student perspectives by examining their reflections from written surveys. To answer my first research question, I investigated the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills by analyzing students' written reflections about their LASSI results. I address these according to my 10 initial codes, which are the 10 LASSI scales (see Codebook in Appendix J). Since the 10 scales are classified into three main components of strategic learning by LASSI, I separated my data accordingly, addressing Skill, Will, and Self-Regulation, respectively. The LASSI scales align with learning skills that are important factors in social cognitive theory.

Although the overall tone of the pre-surveys was positive and optimistic, the post-surveys provided evidence of a broad range of perspectives about one's strategic learning skills. At the beginning of the semester, the majority of the 65 participants (n=57; 88%) conveyed a positive outlook or high level of motivation toward the class, while five seemed neutral, and two focused only on their weaknesses. In the post-surveys at the end of the semester, students reflected on areas of progress or lack of change. About one-third of the participants addressed gains and about half of the participants articulated reasons for lack of change in certain areas. A total of 22 participants (34%) provided explanations for gains revealed by LASSI. One student referenced their mathematics course, two attributed gains to their instructor, four students wrote about

learning how to be a better college student, and 15 mentioned personal factors such as confidence, motivation, concentration, seeking help, and changing effort or study habits. From the 22 participants who wrote about their gains, 12 of them, plus an additional 20 participants (n=32; 49%) also provided reasons for a lack of change. Three main reasons were given: not working toward change (n=17; 50%), change is not possible (n=8; 25%), and personal issues (n=8; 25%). Among those who said they did not work toward change throughout the semester, half wrote that they did not make an effort to improve the skills, and half wrote that they already have successful strategies and did not need to change. One student who did not do anything to try to improve also shared that life stressors and concerns about money may have thwarted his progress. Seven other students cited personal issues as reasons for not making improvements in skills. The remaining quarter of the reflections addressed that change may not be possible. Four students wrote that some characteristics, like Anxiety, are innate and cannot be changed. Four other students wrote comments revealing a fixed mindset with an unwillingness to make changes. This section of my results chapter will explore the participants' responses in detail.

The participants wrote reflections on both their Pre-LASSI and Post-LASSI surveys. On the Pre-LASSI survey, the participants identified their strengths and shared how they can use these throughout the semester. Then they identified their weaknesses and shared how they might overcome them during the semester. For example, in discussing what she learned about herself by taking the LASSI, Naomi wrote, "This will help me know more about myself. This will help me do really great [in the] upcoming semester now [that] I know my strengths and weaknesses." As I present evidence of a wide range of student viewpoints, I refer to my 10 interviewees by their assigned pseudonyms (refer to Table 2 in chapter 3). The other 55 students in the survey

were originally assigned a student number, but those who were not interviewed and are referenced in this chapter were also assigned a pseudonym (see Table 14).

Table 14

Pseudonyms of Non-Interviewees (sorted by Professor)

Professor	Student	Age	Gender	Race	Course Grade
Kyle Bradford					
	Cassandra	28	F	White	SA
	Charlotte	19	F	White	SB
	Lisette	36	F	White	SA
	Maeve	20	F	White	SB
	Muhammed	22	M	Black/African American	SC
	Nyla	20	F	Black/African American	SB
	Omar	19	M	White	SC
	Savannah	20	F	American Indian/Alaska Native	U
	Scott	x	M	x	x
Gretchen Cambria					
	Alicia	57	F	White	U
	Hans	19	M	White	SA
	Ishmael	19	M	Black/African American	U
	Jasmine	24	F	White	SC
	Jonathan	25	M	White	SA
	Lenora	46	F	White	SB
	McKenna	20	F	White	SB
	Nate	19	M	White	SA
	Serena	23	F	Black/African American	SB
Melissa Franklin					
	Tyler	19	M	Hawaiian/Other Pacific Islander	U
Allen Montgomery					
	Aryana	20	F	Black/African American	SC
	Molly	32	F	White	SA
Kate Sullivan					
	Brian	19	M	Multiple Races	SC
	Charlie	27	M	White	SC
	Heather	19	F	Black/African American	SC
	Jamar	x	M	x	x
	Rebecca	25	F	White	SA
Tom Warren					
	Amira	21	F	White	SB

	Karl	36	M	White	SA
	Mariah	36	M	White	SA
	Patrick	x	M	x	x
Dianne York					
	Destiny	x	F	x	x
	Josephine	20	F	White	S
	Naomi	19	F	Black/African American	S
	Nikita	x	F	x	x
	Tammy	38	F	White	S
	William	57	M	Black/African American	U

Note. The "x" denotes information that participants did not consent to provide. A grade of "U" is unsatisfactory. A grade of "S" is satisfactory. Some professors further delineate a satisfactory grade with an A, B, or C. (SA for 90-100. SB for 80-89. SC for 70-79.) A minimum overall average of a 70%, as well as a 70% minimum on the final exam, is required to pass Quantway.

Many students discussed how acknowledging these traits about themselves extend into other subject areas they are taking. Many stated a goal of "forming better habits" or trying to motivate themselves this semester. They saw characteristics they need to work on and were inspired to find new ways to improve themselves. Several wrote about how they will use their strengths to work through their weaknesses and already began to envision that happening. On the Post-LASSI survey, the participants identified the areas in which they experienced the most growth or areas in which they lacked progress. Table 15 below summarizes the number of participants who self-identified strengths and weaknesses from their Pre-LASSI survey and areas of growth and lack of progress in their Post-LASSI survey (see Table 15). A detailed explanation of each of these components of strategic learning follows in the upcoming section. In this next section, I provide the results of my analysis of the data that supported me in answering my first research question regarding the effects a developmental mathematics course that incorporates learning and study strategies has on students' strategic learning skills.

Table 15

Frequency of Self-Identified Performance from LASSI results

Components of Strategic Learning	Pre-LASSI		Post-LASSI	
	Strength (%)	Weakness (%)	Growth (%)	Lack of Progress (%)
Skill				
Information Processing	23	17	17	5
Selecting Main Ideas	14	8	14	5
Test Strategies	17	14	17	11
Will				
Anxiety	11	28	12	17
Attitude	26	17	14	23
Motivation	22	12	14	22
Self-Regulation				
Concentration	11	22	15	11
Self Testing	15	11	8	14
Time Management	17	23	12	20
Using Academic Resources	23	18	28	9

Note. n=65

Skill. I first examined the Skill component, consisting of three scales: Information Processing, Selecting Main Ideas, and Test Strategies. While the mean differences of pre-test and post-test scores with respect to the Skill component were not statistically significant, participants' mean differences with respect to the Information Processing scale, a subcomponent of Skill, did display statistically significant gains at the 0.05-level over the course of the semester among the 65 participants who completed both the pre-LASSI and the post-LASSI. Refer to Table 15 for the summary of how many participants self-identified strengths and weaknesses from their Pre-LASSI survey and areas of growth and lack of progress in their Post-LASSI survey. When limiting the analysis to just the cohort of 10 interviewees, neither the mean

differences of pre-test and post-test scores with respect to the Skill component nor its three subcomponents were statistically significant among this cohort. I present evidence from written survey data to show evidence of change, or in some cases, reasons students shared for why no change occurred in the Skill component of strategic learning.

Information Processing. The Information Processing scale assesses a student's ability to take in and make sense of new information by connecting it to what they already know. Most students who identified this as a strength or experienced growth with Information Processing stated that they already had this ability or worked to improve. In the pre-LASSI survey reflections, 15 out of 65, or 23% of students, reported Information Processing as one of their strengths. Brian wrote, "I have no problem processing information, so that will be a strength for me this semester." Post-LASSI survey reflections indicated that 11 out of 65, or 17%, felt that Information Processing was an area of progress. Three-fourths of these students were unable to provide explanations for their progress. Patrick, who experienced gains in Information Processing, attributed the Information Processing increase from 1 to 60 to "doing the work" and to "the instructor." Lenora, whose score in the Information Processing scale rose from 20 to 75 points, simply wrote that she improved at "retaining information."

The students who had a weakness or lacked growth with Information Processing stated disabilities, a need to ask for help, and lack of effort as reasons. In the Pre-LASSI survey reflections, 11 students out of 65 (17%) reported this scale as a weakness. Rachel, an interviewee and student identified with learning disabilities in both reading and mathematics, wrote, "I can't comprehend anything I read or write. It's very hard. I need to work on it." In the Post-LASSI survey reflections, three students (5%) reported this scale as one in which they had made the

least progress. Mackenzie explained a lack of progress at processing information by writing, “I didn’t apply that much effort to some aspects of my learning.” The other two students with the least progress in this area also addressed their lack of effort, plus a need to study more. Natural ability, asking for help from the teacher, and putting forth effort were the main reasons for growth in this area.

Selecting Main ideas. The Selecting Main Ideas scale assesses a student’s ability to identify key ideas in a problem situation or discussion and to recognize information provided that is not important. The students who wrote about this scale as a strength did not provide reasons besides studying for their strength or any growth they experienced. In the pre-LASSI survey reflections, nine out of 65, or 14% of students, reported Selecting Main Ideas as one of their strengths. In the Post-LASSI survey reflections, nine out of 65, or 14% of students, felt that Selecting Main Ideas was an area of progress for themselves. Josephine, who improved from a 55 to a 90, noted “studying more for tests” as the reason for her improvement with Selecting Main Ideas.

The students who wrote about this scale as a weakness mentioned lack of effort for why they did not improve at identifying important information. Reports from five students (8%) noted this scale as a weakness in the Pre-LASSI survey, but none of them elaborated on it. In the Post-LASSI survey, three students (5%) reported this scale as one in which they had made the least progress. Muhammed, who made little progress, said the course was hard and he did not put forth enough effort. Despite these brief comments, no specific insights were provided by any other students regarding the selection of main ideas. Additionally, these responses seem to indicate that the students attributed changes (and lack of change) to their personal actions (or

inaction), like studying (or not), and not to any specific elements of their mathematics course. This will be further discussed in Chapter 5.

Test Strategies. The Test Strategies scale assesses a student's ability to both prepare for various types of tests and to use test-taking strategies during a test. The students with strengths and growth in this scale focused on studying key information and getting better at knowing what to study. In the pre-LASSI survey reflections, 11 out of 65, or 17% of students, reported Test Strategies as one of their strengths. In response to the survey question about how they will use knowledge of this strength to help them during the semester, four students noted that they will apply their testing strategies to do well on tests. Five students did not comment on how this will help them. Two students, however, addressed how this skill would help them. Nyla wrote, "I use a lot of different ways to study [and will] use all the ways I can to make sure I'm successful." Anna, an interviewee, wrote, "Motivation, time management, and [test] strategies, when paired together, will help me succeed." Her reflection acknowledges that not only are testing strategies useful, but also that multiple learning strategies and study skills can be effective when applied together.

Post-LASSI survey reflections indicated that 11 out of 65, or 17% of students, felt that Test Strategies was an area of progress. Charlotte wrote that her Test Strategies score increased "because I think I got better at pointing out main points and knowing what was important out of my readings or the lectures." Josephine attributed test strategy progress to studying more for tests and felt this will carry over into future courses. Ishmael changed the way he studied and felt he had improved his testing strategies. Danielle, an interviewee whose score in the Test Taking scale rose from 50 to 95, acknowledged that she prepared better for tests by the end of the

semester, writing, “I became more disciplined and kept my mindset on the idea of having a degree.”

The students with weaknesses and lack of growth on this scale mentioned lack of effort and the need to seek help. In the Pre-LASSI reflections, nine students (14%) reported Test Strategies as a weakness. Two students wrote that they intended to study more. Three other students planned to seek help from either their professor or a tutor. In the Post-LASSI reflections, seven students (11%) reported this scale as one in which they had made the least progress. Omar wrote “I haven’t progressed mentally with my efforts. I will learn from this mistake,” as if accepting blame for a lack of change. The students who addressed their weaknesses in Testing Strategies acknowledged the need to study more and seek help. Students who initially had strong testing strategies and students who developed stronger testing strategies over time recognized the importance of studying, and some students connected their testing success to combining studying with other learning strategies.

Will. I next examined the Will component, consisting of three scales: Anxiety, Attitude, and Motivation. While the mean differences of pre-test and post-test scores with respect to the Will component were not statistically significant, participants’ mean differences with respect to the Anxiety scale, a subcomponent of Will, did display statistically significant gains at the 0.05-level over the course of the semester among the 65 participants who completed both the pre-LASSI and the post-LASSI. This increase indicates an overall drop in anxiety for this population over the course of the semester. For the summary of how many participants self-identified strengths and weaknesses from their Pre-LASSI survey and areas of growth and lack of progress in their Post-LASSI survey, refer to Table 24. When limiting the analysis to just the cohort of 10

interviewees, neither the mean differences of pre-test and post-test scores with respect to the Will component nor its three subcomponents were statistically significant among this cohort. In the following section, I present evidence from written survey data to show evidence of change, or in some cases, reasons students shared for why no change occurred in the Will component of strategic learning.

Anxiety. The Anxiety scale measures the degree to which students worry about school and their performance on academic tasks. The students with strengths and growth in this scale highlighted a readiness for success and persistence through stressful situations. In the pre-LASSI survey reflections seven out of 65, or 11% of students, reported Anxiety as one of their strengths. Post-LASSI survey reflections indicated that eight out of 65 students (12%) felt that Anxiety was an area of progress. Joe, an interviewee who was attempting to pass developmental mathematics for the fifth semester in three years, initially said that Anxiety was a weakness, but by semester's end, Anxiety was an area where he experienced the most progress. He wrote, "My mind is set on completion. I've had setbacks, but I'm ready now." Only one other student provided insights about the Anxiety scale. Molly gave a rich explanation of why she thought she made gains in this area. First, she wrote, "We (her class) read an article about good stress, and I try to remember that during exams. My anxiety isn't gone, but it's better." The article she referenced is a component of the Quantway curriculum, utilized by all professors. She went on to acknowledge her teacher's role in her progress. She wrote, "Professor Montgomery has really helped lower my anxiety. Also, the no-person-left-behind attitude helps bring down stress."

The students who reported weaknesses and lack of growth in this scale mentioned test anxiety, a need to seek help, and beliefs that they will have lifelong struggles with anxiety that

will always pose challenges. In the Pre-LASSI survey, 18 out of 65 students (28%) reported Anxiety as a weakness. Although many did not provide insights as to how they might overcome their anxiety, several referenced test anxiety specifically, and Molly was anxious because passing this class is a requirement to graduate. Tyler wrote "Anxiety would be my weakness because I have low confidence in my education career." Mariah acknowledged this weakness and set a plan to "take things one step at a time and ask for help from professors." In the Post-LASSI reflections, 11 students (17%) reported this scale as one in which they had made the least progress. Danielle initially said that Anxiety was a weakness for her, too. She, however, did not make progress in this area. She wrote, "I feel like I will always have anxiety, because although I can be prepared for a lot of things, I always question the outcome." Chelsea echoed Danielle's comment about always battling anxiety. She wrote the following thought-provoking response: "I will never overcome my anxiety, but I use it in other ways. If I am studying for a test and have anxiety about it, then I know it's because I am not fully prepared." While some students felt they will always have anxiety, others lowered their anxiety with self-motivation, stress relief, and seeking help or taking more time to prepare for exams.

Attitude. The Attitude scale assesses a student's overall will to be in school and the importance they place on engaging in academic work. The students with strengths and growth in this scale described themselves as motivated, open-minded people with positive attitudes in life. In the pre-LASSI survey reflections, 17 out of 65 students (26%) reported Attitude as one of their strengths. Jennifer said her attitude gives her motivation. Similarly, Mark said his positive attitude makes him want to do better over time. Rebecca cited both Attitude and Motivation as key elements for successfully coming back to school after working full-time for five years.

William wrote that his positive attitude helps him "stay open-minded" and to "keep on striving." Students Heather and Josephine both pledged to always come to class with a positive attitude for learning. Lydia stated that her positive attitude "changes (her) outlook on all situations good and bad, personal and academic." Post-LASSI survey reflections indicated that nine out of 65, or 14%, felt that Attitude was an area of progress. Most students were unable to provide explanations for their progress. Karl wrote "I became more confident in myself." Brian acknowledged that doing some things differently may have led to an improved attitude, but he offered no specifics.

The students with weaknesses and lack of growth in this scale mentioned loss of both effort and stamina, especially late in the semester, as well as personal issues that interfered with school. In the Pre-LASSI, 11 students (17%) reported Attitude as a weakness. While most of these students wrote little more than "try harder" or "study more," a few had some subtle insights about their attitudinal weakness. Amira pledged to "stay positive, even when my grades aren't." Post-LASSI survey reflections indicated that 15 students (23%) reported this scale as one in which they had made the least progress. Interestingly, several students who did not show gains in attitude offered reasons for their lack of progress. Jennifer blamed "personal stuff" and health issues. Jonathan also cited personal reasons. Savannah noted "personal relationships and stress." When asked what area she made the least progress in, Tammy wrote, "My attitude, as I am struggling finding time between my family (husband and 6 kids), work, & school. This semester has been challenging." Her response detailed a common student struggle of balancing school and family. Charlotte wrote, "Attitude went down because since it's the end of the year. I just want to be done, and I get frustrated and more distracted." Although Attitude was a strength for some

and a weakness for others, students from each group noted that having a positive outlook, even during adversity, could lead to change. Balancing life with studies, however, made it difficult for some students to improve their attitudes.

Motivation. The Motivation scale assesses a student's level of discipline and commitment to putting forth the necessary effort to succeed on academic tasks. Although the students who experienced growth in Motivation were unable to explain this change, those starting out with motivational strength had positive attitudes and were driven by their goals to succeed. In the pre-LASSI survey reflections 14 out of 65 students (22%) reported Motivation as one of their strengths. In their surveys, three of my interviewees discussed how motivation was their personal strength going into this course. Rachel wrote, "I'm always motivated to do work. And try my best." Jamie wrote, "I will use my motivation to keep my attitude positive & push myself to succeed." Chelsea wrote, "I stay focused and set a goal for myself. I am very motivated to always obtain my goals." Lisette elaborated on why she thinks motivation is one of her strengths. "Motivation is very high because I really want to do well and to learn the material to help me be successful at my career. My strengths will help me because I want to learn the material that I am being taught and because I have a goal to be successful." Cassandra, who was also very driven, shared this personal response. "Being 27 and putting off school for nearly ten years has given me time to find my absolute career goal. I will use my motivation to push me to get the best grades and keep my GPA up!" Rebecca spoke of how she is motivated by the balance of work and school. She wrote about both her strong motivation and positive attitude. "Going from a full-time job to back to school full-time and working part-time, I have had to keep a positive attitude and keep myself motivated. Motivation will keep me going and working hard to succeed." Post-

LASSI survey reflections indicated that nine out of 65 (14%) identified Motivation as an area of progress for themselves. Heather said her motivation got better during the semester, but she offered no insights as to why. Josephine wrote that she, “started studying more for tests, and got really motivated for all of my classes.”

Some students with weaknesses and a lack of growth in the Motivation scale cited reasons for their low scores, while others explained that their lack of change was due to already high levels of motivation or complacency with initially low motivational levels. In the Pre-LASSI survey, eight out of 65 students (12%) reported this scale as a weakness. Charlie claimed he would “stop being lazy and apply myself.” While he did go on to pass the course, he did not offer a follow-up in his post-survey. Post-LASSI survey reflections indicated that 14 students (22%) reported this scale as one in which they had made the least progress. Naomi explained why her motivation did not progress. “I always try my best to motivate myself, no matter how hard it is.” Her score changed from an 85 to a 90. She began the course as an already highly motivated student. There was not much room for improvement. Serena is unique in that her motivation level remained low all semester. In the pre-survey, she shared that college wasn’t very important to her at that time. At the end of the semester, she shared “I feel like I don’t need school to succeed in life.” Jamar seemed to resonate with Serena; he wrote that “college really knocks the motivation out of a person.” Ironically, motivation was one of the scales in which he made the most significant gains, increasing his score by 25 points. Jasmine and Aryana each indicated decreases in both motivation and attitude. Jasmine cited stress, family issues, personal issues, and finances as the reasons. However, she said she will focus on “more of my stronger areas that all help me be the person I am today and grow and move in life.” Aryana wrote, “I lost

my motivation for school, so I plan to take a semester to a year off and save money so I'm not so stressed and see if I want to go back (to school)." She added that her LASSI results "help me know that I am happy with my choice to take a break!" For some students, the lack of progress was eye-opening. Students seemed to understand their motivational levels, whether low or high, and articulated these in their explanations of their scores.

Self-Regulation. Lastly, I examined the Self-Regulation component, consisting of four scales: Concentration, Self Testing, Time Management, and Using Academic Resources. Neither the mean differences of pre-test and post-test scores with respect to the Self-Regulation component nor the mean differences for any of the four associated scales were statistically significant over the course of the semester among the 65 participants who completed both the pre-LASSI and the post-LASSI. An analysis of each of the 10 scales for just the cohort of 10 interviewees, however, indicated that the mean differences of pre-test and post-test scores with respect to the Concentration scale and the Using Academic Resources scale, both subcomponents of Self-Regulation, did display statistically significant gains at the 0.05-level. For the summary of how many participants self-identified strengths and weaknesses from their Pre-LASSI survey and areas of growth and lack of progress in their Post-LASSI survey, refer to Table 24. In this section, I present evidence from written survey data to show evidence of change, or in some cases, reasons students shared for why no change occurred in the Self-Regulation component of strategic learning.

Concentration. The Concentration scale assesses a student's ability to focus on academic tasks without being distracted. The students with strengths and growth in this scale discussed goal setting, staying focused, and paying attention. In the pre-LASSI survey reflections, seven

out of 65 students (11%) reported Concentration as one of their strengths. Chelsea, one of my interviewees, wrote, “I stay focused and set a goal for myself. I am very motivated to always obtain my goals.” Karl said that his strengths will help him be able to concentrate in class and on homework. Scott said that his concentration abilities will help him get things done, try to learn difficult work, and do his best. Post-LASSI survey reflections indicated that 10 out of 65 students (15%) felt that Concentration was an area of progress for themselves. Only one student shared about his gains. Hans shared that he is focusing more and can pay attention better in class.

The students with a weakness in Concentration often linked this to other weak scales, provided reasons for this weakness, and offered suggestions for improvement. In the Pre-LASSI survey reflections, 14 students (22%) reported this scale as a weakness. Several students wrote that they intend to try harder and study more. Four students provided very specific insights on how to improve Concentration. Tammy also suggested a quiet study area. She wrote, “My main concern is my main weakness which is my concentration. This goes along with my attention deficit disorder.” She planned to “seek help when needed. Make a more quiet [sic] study area and have study times when my children are at school or away.” Jamie said, “I can work on taking time out and shutting myself from everyone so I can focus on concentrating so that I can process information better.” (Information Processing was also a weakness for Jamie.) Anna wrote, “When topics are boring or hard, I have a hard time with concentration and selecting main ideas.” During an interview, she told me that she takes notes to help in these cases. Hans said that he gets easily distracted when studying, and he decided that he would “plan a study guide. That way I can follow it and not get distracted.” While these students all struggle to concentrate, they had many productive ideas for how to make improvements.

In contrast, the students indicating a lack of growth in this scale either could not explain it or blamed it on a personal character trait. In the Post-LASSI survey, seven students (11%) reported this scale as one in which they had made the least progress. Most students were unable to provide explanations for their progress. Cassandra was unsure why she did not improve in this scale. She wrote, "I thought I was doing better in these. Maybe because the semester is coming to an end." Jennifer shared that her scale probably did not change because, "I've always had trouble concentrating." Mark wrote about his "deep rooted bad habits of being a mediocre person who has concentration and test issues." He added a plan for improvement: "Look at my bad habits and eliminate them. Also, I know that progress is doable. I believe that through time, I will get better at not only being a better learner, but also a better, more confident person." Although change has not happened yet for these students, Mark provides a view that change is still possible, in time. Students with strong Concentration discussed their goals and ability to stay focused, while most students who lacked growth in this area were able to identify barriers to making gains and then suggest improvements.

Self Testing. The Self Testing scale assesses a student's ability to monitor their level of comprehension by reviewing or paraphrasing to check for understanding. The students with strengths and growth in this scale wrote little, but they described Self Testing as being prepared with the material. In the pre-LASSI survey reflections, 10 out of 65 students (15%) reported Self Testing as one of their strengths. Naomi said that she will "make sure I know what I am doing before the tests in my class. So yes, I would consider Self Testing as one of my strengths. I will use my strengths to help me succeed this semester by improving my Self Testing. Preparing myself and feeling ok with what I am learning." Post-LASSI survey reflections indicated that

five out of 65, or 8%, felt that Self Testing was an area of progress for themselves. No students provided explanations for their progress.

The students with weaknesses and lack of growth in this scale either did not know Self Testing was important or did not consider this weakness to be an issue. In the pre-LASSI survey reflections, 7 students (11%) reported this scale as a weakness. Cassandra shared that she does not test herself and she "did not know that that was an important piece to success." Lisette acknowledged Self Testing as an area of weakness, according to the survey, but wrote, "I don't consider it one, because I challenge myself in different ways to know that I understand the information." In the post-LASSI survey reflections nine students (14%) reported this scale as one in which they had made the least progress. William, however, gave a reason for the lack of gain in his Self Testing score. "I think it's a combination of things such as working full-time, along with going to school." This balance of school and life's responsibilities outside of the classroom is a common source of conflict for students. Students who used Self Testing worked to improve this practice, while those who did not know about it were able to start using the new learning strategy.

Time Management. The Time Management scale assesses a student's ability to strategize use of time to complete academic tasks and avoid procrastination. The students with strengths and growth in Time Management linked the trait to being motivated for success. In the pre-LASSI survey reflections 11 out of 65 students (17%) reported Time Management as one of their strengths. Maeve linked her ability to manage time with her high motivation to do well in school. Post-LASSI survey reflections indicated that eight out of 65, or 12%, felt that Time Management

was an area of progress for themselves. No students, however, provided explanations for their progress.

The students with weaknesses and lack of growth in Time Management largely cited non-academic, life responsibilities as deterrents, but they also proposed solutions to this challenge. In the pre-LASSI survey reflections, 15 students (23%) reported this scale as a weakness. Several of them elaborated and provided insightful comments about their lack of progress with Time Management. Some cited the school versus life balance noted above by William. Lisette wrote, "I think my biggest weakness is Time Management because I have a lot of responsibilities at home. I can overcome my Time Management by setting time aside to study away from home, so I am not distracted. I feel like I am doing well with my studying and learning. I am going to keep doing what I am doing and continue to work on Time Management" Two different students, Omar and Nikita, wrote about the need to plan and make a schedule for studying. Lydia, William, and Amira all acknowledged that they procrastinate with schoolwork. Serena wrote about how she will try to focus more and utilize her time more efficiently.

The post-LASSI survey reflections indicated that 13 students (20%) reported this scale as one in which they had made the least progress. Keesha acknowledged life events were interfering with her ability to manage time, because she was expecting her second child on the last day of the semester. Jamie wrote that "It has been a very trying semester between school, doing an internship, work and homework. It's been hard." Tammy, who previously shared her difficulties balancing work, school, and time with her husband and six children, wrote that "[Time Management] has been a big issue for me. Next semester I plan on attending classes on Tuesday and Thursday, instead of Monday-Wednesday-Friday, and working one day less a week to help

with my [Time Management] issues. That should help raise these numbers." She identified her conflicts and proposed a solution moving forward. Students' struggles to balance life, work, and school presented major challenges with Time Management.

Using Academic Resources. The Using Academic Resources scale assesses a student's willingness to utilize available resources (like support services or tutoring) and seek help when needed. The students with strengths and growth in this scale valued the importance of seeking help and using the resources available to help them succeed. In the pre-LASSI survey reflections 15 out of 65 students (23%) reported Using Academic Resources as one of their strengths. Destiny said that she would use the Learning Center for help if she needed assistance, and Nate said he would "continue to get tutoring and extra help when I need it." Post-LASSI survey reflections indicated that 18 out of 65 students (28%) felt that Using Academic Resources was an area of progress for themselves.

Here are some additional insights from those who made progress in this scale. Keesha and Alicia acknowledged that they would reach out for help when needed. Joe learned to take advantage of available resources when needed. Maeve said, "now I go to the prof when I need help." Similarly, Serena said she raised her score because if she needed help, she wrote, "I always ask questions." Nyla provided an explanation for her growth in Using Academic Resources: "You learn different things over the semester, so you change your way of thinking." After the survey, William came up to me. I wrote a short memo immediately following our conversation. He told me that he always keeps striving. He now realizes the importance of connecting with two or three people in class, to get together with them or visit the Learning

Center together for tutoring. Utilizing the human resources of classmates and tutors has been especially beneficial to him this semester.

The students with weaknesses and lack of growth in this scale either discussed why they did not utilize the resources, or they explained why they do not need to utilize these resources. In the pre-LASSI survey reflections, 12 students (18%) were not as willing to seek help and reported this scale as a weakness. Jennifer listed Using Academic Resources as a weakness, but in our interviews, I learned that this was due to not needing to use those resources. She already earned a college degree and is taking some classes but does not struggle in them. When reporting her weaknesses during an interview, Lydia stated, “Utilize Resources. (pause) I should,” acknowledging her awareness of this need. I discuss in a later section that Lydia spoke of how her teacher prodded her to follow through on going to a tutor.

In the post-LASSI survey reflections, 6 students (9%) reported this scale as one in which they had made the least progress. Those who did not make progress in Using Academic Resources shared a different story. Mark confessed, “Socially, I hid my frustrations by making lite jokes about my lack of understanding certain subjects, instead of asking for personal help. Also, instead of constantly holding up the class, I've pretended to understand subjects, too.” Mark was afraid to use resources available to him. Nate explained his decreased Using Academic Resources score by sharing that he was getting overloaded with work, school, and volunteer firefighting. Molly shared, “I work full time and go to school, so it's just really hard to use services offered, like tutors.” For this reason, her score did not improve. Karl gave another reason for a lack of progress. “I think I have a good grasp on those areas (Time Management & Using Academic Resources) and don't need to change them.” For him, a lack of progress was not

a negative scenario. Although some students chose not to use the available academic resources, many students noted that they benefitted from taking advantage of these services.

Summary of the Analysis of Written Reflections on the Components of Strategic Learning. In the previous analysis of the written reflections, I explored students' strengths, weaknesses, areas of progress and areas that did not experience progress, as perceived by the students themselves. As described in my previous quantitative analysis, I found statistically significant changes in the mean differences of the pre-LASSI and post-LASSI scores for the 65 participants' Anxiety scale and Information Processing scale over the course of the semester. I summarize these below. I also found statistically significant changes in the mean differences of the pre-LASSI and post-LASSI scores for the 10 interviewees with respect to the Concentration scale and Using Academic Resources scale over the course of the semester. I address these in more detail in the next section of this chapter with my analysis of the interview data.

Some students shared that certain scales could not be changed by anything in a class, because some of them measure innate characteristics, as opposed to a malleable trait, of a person. A few students wrote that they felt that anxiety cannot be overcome by elements of a course. Some attributed this to a long-term struggle with anxiety. Molly in Prof. Montgomery's class, however, wrote that she made the most progress with the scale of Anxiety. This student alluded to both elements of the course and aspects of her teacher that contributed to her positive change in anxiety.

Another area that some students referred to as an unchangeable characteristic was one's ability to process information. Chelsea wrote, "my scores stayed the same because they (my strategies) work for me, so I continue to use them in the same ways." A student in Prof.

Cambria's class, Lenora, noted that her largest gain (of 55 points) was in retaining information. When asked what contributed to this gain, however, she wrote, "Not sure, but I understand more material now and my confidence has increased."

Like Lenora, many students were unable to identify reasons for changes they experienced throughout the semester. Many said they motivate themselves and are driven by their own attitudes. Nyla attributed changes in how she thinks to having learned new things during the semester. Only one student mentioned his teacher in the pre-survey. In the post-survey, only two students mentioned their teachers. Patrick attributed his gains to his instructor and working hard, although he did not provide specific examples. The other was Molly, mentioned above, who credited Mr. Montgomery and his no-person-left-behind attitude for helping her to lower her anxiety. Aside from these sparse examples, students' written responses tended to attribute gains to themselves and not to the teacher or any aspect of the course.

The written reflections about the LASSI surveys exposed some underlying perspectives from students, and my analysis of the interviews following up with 10 students after the LASSI study provided deeper insights about students' experiences. Did a specific element of the course curriculum or pedagogy lead to a particular change or lack of change? Did the teacher have an impact on this outcome? Are changes due to interactions with other students? Did interference from students' lives impact the results? The interviews demonstrated more specific perspectives regarding the students' experiences in developmental mathematics class, as well as insights to how they view their strategic learning. I discuss these themes and descriptions of the learning experience in the following two sections analyzing interview data.

Analysis of Interview Data on the Components of Strategic Learning

In the next section of my qualitative analysis, I further investigated the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills by analyzing students' interview data about their LASSI results. This analysis focused on both the non-cognitive factors affecting student learning (social cognitive theory) and the framework for student success (productive persistence). First, I discuss my analysis of the Skill, Will, and Self-Regulation components of strategic learning, broken down by their subsequent scales. Each interviewee's LASSI scores (pre/post) are provided under his or her name in every chart. I used the 10 scales of LASSI as my a priori codes; however, some other key concepts emerged in the interview transcripts that I also analyzed. After examining the 10 scales in this section, I provide a discussion on the emergent themes of Doing College, Barriers, Anxiety, Teacher Impact, Groupwork, and Growth Mindset in the next section of my qualitative analysis, detailing their impact on the interviewees' learning experiences in their developmental mathematics course. Since the importance of the teacher's role emerged as a theme in my interviews, I present my analysis of the interview data by examining the data in clusters according to teacher (see Table 16). The teachers' last names are listed in alphabetical order. If they had more than one student interviewee, their students' first names are alphabetized. All student and teacher names are pseudonyms. I organized key data into charts of thematic quotes from my interviews.

Table 16

Quantway Teachers of Interviewees

Teacher	Student Interviewees
Prof. Cambria	Joe Lydia
Prof. Franklin	Rachel
Prof. Montgomery	Jennifer
Prof. Sullivan	Anna Keesha
Prof. Warren	Jamie
Prof. York	Chelsea Danielle Mark

Skill. This section presents charts and further reflections from interviews that demonstrated insights about the Skill component of LASSI. I present data related to Information Processing in Table 17, Selecting Main Ideas in Table 18, and Test Strategies in Table 19.

Information Processing. Although written at an eighth-grade reading level, there is much reading in the Quantway problem situations. Students often struggle to understand what the question is asking. Every lesson begins with a problem situation that will lead to a need for mathematics. Typically, students work on the situations alone for a few minutes, then they join with a group to discuss possible approaches. After the group members share their ideas and help each other reach a solution, the teacher facilitates a whole-class discussion, recording all possible solutions that arose, and prompting the class to discover additional techniques if necessary. Throughout the course, emphasis is placed on solving problems in various ways. Students are not only encouraged to learn multiple methods, but they are frequently asked to explain more than one possible solution to questions. Improvement to the Information Processing scale was

statistically significant among the full population, but not with the interviewees. As seen in the table, many of their scores remained fairly stagnant, although Mark increased by 30 points and Danielle increased by 45 points (see Table 17).

Table 17

Information Processing: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 99/99	Quantitative reasoning is not a vague subject. You have to include all the details (in your work).	Not Available
	Lydia 85/80	Not Available	There was more ways than one way to look at stuff. The teacher gave us freedom to 'show me how you are thinking to do it.'
Prof. Franklin	Rachel 50/35	Reading comprehension is not my strong suit, so like, trying to figure out what it's asking is pretty hard.	I'll understand stuff for a day, and then I'll come back the next day and it'll be gone. When I do math, I have to have a guide.
Prof. Montgomery	Jennifer 45/50	Anything with a lot of information that I have to break down takes me a second to process what I'm reading.	I have to read things multiple times to get it in my head.
Prof. Sullivan	Anna 25/50	I just reread everything until it makes sense. (Math) needs to be broken down into pieces for me.	It (the course) is really easy. They (the materials) break it down for you.
	Keesha 50/50	There's so many ways of getting one answer… it's tough. I will get lost at what the question is asking me, and I have to pay attention … and understand what I'm reading.	I'm coming along … There's so many different ways to get an answer. It's okay. It works your mind.
Prof. Warren	Jamie 05/05	There's a lot of information thrown at you … but knowing what you need to do with the	For a non-credit class, this is so hard … you really have to focus on the question and

		information … that part, for me, is what's confusing.	what it's asking … I can pull the information out, but then doing something with it is really frustrating and confusing.
Prof. York	Chelsea 50/45	Some questions are worded pretty difficult, and I think that stumps people, and they're not really sure what it's asking them to do.	The whole, like, teaching it to yourself process is harder . . . but it definitely sticks with you better.
	Danielle 50/95	I learn more by analogies, so if I can put them somewhere, I'll remember it more.	You can give me another problem, and I'm like, "Ok. This is another way to do it."
	Mark 45/75	I don't even know how to take notes correctly. I have to use this information later, but later (at home) it's like, "this isn't what I need!"	I process things better now. I can make sense of them. The questions are meant for you to think… they don't want this cookie cutter answer. They want organic answers.

Note. The interviewees' pre/post LASSI percentile scores for the Information Processing scale appear under their names.

The comments noted from the pre-interviews described the challenges of making sense of the problems in the course. Although most of the interviewees found the course to be difficult, their post-interview comments expressed an appreciation for the methodology of learning by exploration and using multiple strategies to solve problems. They described learning as a process that requires deep thinking.

Selecting Main Ideas. Many talked about struggling to know what was important in a question or what the question was requiring them to do. Five interviewees gained between 10 and 40 points, which seems to provide evidence that certain elements of the Quantway course transformed students' abilities to select main ideas. Four interviewees saw no change, but they started out more confident in this scale. One student, Chelsea, dropped by 25 points. No one

directly addressed either their stasis or their growth in Selecting Main Ideas during our post-interviews (see Table 18).

Table 18

Selecting Main Ideas: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 99/99	Not Available	Not Available
	Lydia 80/90	Not Available	Not Available
Prof. Franklin	Rachel 01/01	Trying to figure out what it's asking is pretty hard. I underline the numbers… and look for the key words.	Not Available
Prof. Montgomery	Jennifer 85/85	Not Available	Not Available
Prof. Sullivan	Anna 20/60	When things are boring or hard, I have a hard time selecting main ideas. Taking notes helps.	Not Available
	Keesha 40/70	I'm struggling with understanding exactly everything that needs to be done.	Not Available
Prof. Warren	Jamie 70/70	Selecting main ideas is just something that comes naturally to me.	Not Available
Prof. York	Chelsea 70/45	Not Available	Not Available
	Danielle 70/85	If I have to pick and choose something that's around the main idea, to get to another step, then I have a hard time.	Not Available
	Mark 30/45	Not Available	Not Available

Note. The interviewees' pre/post LASSI percentile scores for the Selecting Main Ideas scale appear under their names.

The comments noted from the pre-interviews showed that most interviewees struggled to select main ideas in problems. It did not come naturally to them, and they had difficulty with this skill. Although no one directly addressed this scale during their post interview, half of the interviewees improved their scores over the semester, indicating changes in their ability to select the main idea in problems.

Test Strategies. The cohort of Quantway teachers used a variety of strategies to review for tests. Some provided review packets and answers. Some used these during class time, while others provided them online as an optional resource. Some used the Quantway curriculum materials that provide a checklist of skills from the module, and students used that to assess their own learning and gaps. The materials then provide suggestions for how to go back through the lessons and review necessary topics independently. While two students' scores remained stagnant and two saw a decrease, seven students experienced gains in Testing Strategies. Keesha, Danielle, and Mark made the largest gains in this scale, and each acknowledged their growth in this area during our post-interview. Danielle, in particular, spoke about the LASSI and how she didn't expect to see any differences between her pre-test and her post-test. She went from 50 to 95 on Testing Strategies. She recalled something her advisor had said to her. "'Well, this is your first semester in college. Next semester you'll be a better college student.' And I kind of understood what he meant by that, but then I'm like, 'I can't be better than that. I'm just taking classes, just to pass and get my degree…' Now I understand what he meant, because it's like, I *did* [emphasis added] build studying strategies for tests, and I didn't even realize it! I guess I basically," she laughed, "grew my brain." She attributed her score increase to her "becoming a better college student" by the administration of the post-LASSI. Danielle's reference to how she

grew her brain is consistent with a growth mindset activity from the Quantway curriculum (see Table 19).

Table 19

Test Strategies: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 95/95	I rush through tests…overthinking… and second guess myself.	Not Available
	Lydia 75/80	Not Available	Not Available
Prof. Franklin	Rachel 05/01	Not Available	I feel like if I reviewed like 3 days before the test, instead of the night before, I'd probably do better.
Prof. Montgomery	Jennifer 40/75	Not Available	Not Available
Prof. Sullivan	Anna 05/65	I can't just look at notes and say, 'OK, I know this.' I need to test myself and question myself.	I realized that I'm not bad at taking tests, if I study. Before, I didn't study. And I tried flashcards. That worked well.
	Keesha 15/55	Not Available	I'm getting points marked off for not finishing it (a test question). I just have to pay attention a little bit more, but I'm coming along.
Prof. Warren	Jamie 50/30	I'm not a very good tester.	Not Available
Prof. York	Chelsea 95/65	There are review sheets at the end of every subject… it sums up everything we've learned.	She gives us a review packet…we'll put a check if we know how to do it, and if we don't, then we know what to work on. That helps-knowing your strengths and weaknesses before a test.
	Danielle 50/95	She gave us packets a week before the test… helped me refresh my memory.	As soon as I get the review, I would make sure I understand absolutely

			everything. I did build studying strategies and didn't even realize it.
	Mark 30/75	Every time I've taken a test, no matter how good I can study, if it's not verbatim what I studied, I get nervous.	I still get intimidated during testing, but I feel better prepared when going into testing.

Note. The interviewees' pre/post LASSI percentile scores for the Test Strategies scale appear under their names.

The pre-interview comments showed the importance of taking time to prepare for tests. For some, this was to overcome weaknesses and process the material. For others, it was a way to further solidify their understanding. Post-interview comments revealed more confidence in their abilities to demonstrate that they have learned and understood the material from the course.

Will. This section presents charts and further reflections from interviews that showed insights about the Will component of LASSI. I present data related to Anxiety in Table 20, Attitude in Table 21, and Motivation in Table 22.

Anxiety. Improvement to the Anxiety scale was statistically significant among the full population, but not with the interviewees. Many students in both the surveys and the interviews shared about their struggles with anxiety. Some speak of overall anxiety or anxiety disorders, others have mathematics anxiety, and some have general test anxiety. Joe, Rachel, Keesha, Danielle, and Chelsea all noted experiencing test anxiety. Joe said he overthinks questions. Keesha and Danielle are both motivated to take advantage of the opportunity to retake exams if they are not successful on the first attempt. Rachel linked content difficulty and lack of test preparation to heightened anxiety over tests, and she gets very nervous asking for help. Chelsea acknowledged in both her survey and our interview that she has struggled with anxiety her whole life. She has generalized anxiety and a panic disorder requiring medication. She has learned how

to mitigate the challenges these pose for her, for instance, by studying more when course material causes her to worry. She has learned that being more prepared for tests does not eliminate her anxiety, but it does lower her anxiety during tests. Jennifer has also dealt with lifelong anxiety and having classmates stare at her while they worked in groups made it harder for her to think and problem solve.

Lydia discussed how she feels more comfortable with this kind of math. She said it was "because I do have an understanding of it that I never had." She has struggled with algebra in the past, but quantitative reasoning draws on her life experience with mathematics, and she is no longer afraid of math. She confessed that "math is what I've dodged," leaving it to the end of her time at college. Her confidence was boosted when she entered a test feeling a bit anxious, but upon opening it she said, "Well I know this!"

Jamie became less anxious in math once she learned the routine and knew what to expect. The final exam raised her anxiety, though, and she cited the 70% requirement. Students must have an overall average of 70% to pass the class, as well as at least a 70% on the final exam. Other students noted elevated anxiety as final exams approached.

In Quantway, learning to cope with stress is a theme that surfaces multiple times throughout the curriculum. Danielle and Mark both had Prof. York. They both appreciated how their professor often provided stress relief tips. Prof. York once shared a YouTube website that played sounds from a national park. Sometimes she played it during class, and Mark often used it to study from home. Mark, returning to college after quitting twenty years ago, struggled with how to be a college student. He did not know how to take notes effectively and then use them for his benefit. He did not know how to study. He was uncomfortable putting himself out there in

class. He said, “It’s a mentality thing. I just have to get over it and out of it. And that’s really me. So, all of this (referring to Quantway class)—being outspoken, to actually write stuff or to volunteer, raise my hand—all this is new to me.” These classroom experiences were all sources of anxiety for Mark.

Realizing that he needed help in school was also anxiety provoking for Mark. When I asked him if he used the Learning Center, here is what he told me. “I understand that the learning center is there for people, too, but I just figured… Maybe I am someone that don’t need it if I just pay more attention and try to focus harder, so-- that’s where I’m at.” Not only was the thought of going to tutoring a source of additional anxiety that Mark avoided by not seeking help, but it was also a moment of humility for Mark. He said, “Yeah, but it goes back to—this.” He pointed at the Anxiety result on his graphical LASSI report, where he had received a score of 1, indicating that he had extremely high anxiety. Going for tutoring “means going to meet new people, to ask questions. I don’t know… I don’t do too good with just meeting people and saying, ‘Hey, I need help.’ Yeah, I don’t know. Like, I’m telling you.” Mark paused before continuing. “Like, I had to go to the food pantry, because we really didn’t have any food. And I’ve never done that in the history of my life!” He shared how his professor told his class about the college’s food pantry, and he described his journey to the moment when he had no other options but to go there for food. He and his wife had to send their child with special needs to live with a relative, because they were unable to provide enough food for her. He was afraid and embarrassed to ask for help, and he didn’t feel entitled to the help, but he finally realized he had no other choice. For Mark, seeking tutoring involved more than just overcoming some stigma about going to the Learning Center, but it meant stepping out in courage to ask for help. It

represented a surrender of control when he realized he could not learn the course content on his own (see Table 20).

Mark and five other interviewees experienced gains in the Anxiety scale, indicating a lower level of anxiety near the end of the semester compared to the beginning. Three interviewees stayed the same and one decreased, finishing the semester with higher anxiety.

Table 20

Anxiety: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 75/90	Anxiety for me is before a test. I know it, but anxiety is kicking me up, to not know it.	When I took the retake (at my professor's office), I realized how easy it was, without me being pressured inside the classroom.
	Lydia 75/75	I was always standoffish with math, but I am comfortable with this kind of math.	My anxiety was the same both days. (at the pre-test and the post-test)
Prof. Franklin	Rachel 15/01	I always feel bad, because I always have to ask questions.	I thought I lost a lot of anxiety, but then I saw the number and was like, 'Wow!' But I didn't feel like my anxiety got worse.
Prof. Montgomery	Jennifer 55/65	I don't like when there's one answer, because there's more chances to get it wrong… I have a lot of social anxiety, so like when there's other people looking at me, I can't think.	Groupwork makes it harder to concentrate sometimes. Like, it's just personal social anxiety (laughs).
Prof. Sullivan	Anna 10/55	Not Available	I was afraid of not doing well, but once I realized I was doing pretty well, I was like, 'Oh, I've got this. I can do it.'
	Keesha 50/60	Not Available	Not Available
Prof. Warren	Jamie 40/50	Not Available	I know the routine, and I know what's going on, so I'm

			not as anxious about what we'll be learning… but now that finals are rolling in, I'm like, definitely very anxious.
Prof York	Chelsea 30/30	I have a horrible, horrible panic disorder, and I'm on medication for it… If it (the test material) is freaking me out and making me nervous, I know I need to continue to go over it.	It (anxiety) is something that I've dealt with for a long time, and I kinda know how to deal with it without freaking out. I don't think it's gonna go away.
	Danielle 20/20	We had our first test, and I was freaking out over nothing. Last class we went over ways to deal with stress.	I'm a perfectionist, so if I don't get a 100, I'll be sad. I think that's how I'll always be. It's just anxiety with test taking.
	Mark 01/15	I don't do good with just meeting people and saying, "Hey, I need help."	Before, everything was big and intimidating for me. Now, at least I know my way around.

Note. The interviewees' pre/post LASSI percentile scores for the Anxiety scale appear under their names. (A higher number indicates a lower level of anxiety.)

The comments from the pre-interviews described prevalent test anxiety and social anxiety among the interviewees. By the end of the semester, many still had their life-long battles with anxiety, but the class experience had alleviated certain anxieties in many students, particularly around test anxiety.

Attitude. Chelsea gave me several excuses for why she scored terribly low on her placement test, landing her in this class. She seemed bitter throughout the semester, never really allowing herself to give the pedagogical approach a chance. She worked alone as much as possible, and resisted the intended, group discovery-like nature of the curriculum. She did, however, like that any method was acceptable. She said, "Prof. York is just trying to tell us that whatever one way works for you, you can do it. I like it, because that's how I think of math, too.

There's a million ways to do it." So at least Chelsea found one thing to like about the course. Danielle was also unhappy about being placed into Quantway, but she enjoyed the nature of the course. She said, "I liked their analogies to like the real world, and their questions and their problems that they have. It makes math easier and more willing to do." She made a choice to not complain, and she made the most of being in the course. Joe enjoyed Quantway. He had attempted developmental mathematics several times over the years, and he said that he is finally mature enough and ready to do what it takes to succeed. Although balancing work, school, a child, and a pregnancy, Keesha kept a positive attitude, pushed through her life struggles to make extra trips to campus for tutoring on her academic struggles, and she never gave up on succeeding in school.

For Lydia, Quantway offered the first experience with mathematics in which she readily understood the content. She explained, "This math relates to where we see math everyday… this math talks about and focuses on how we live math, you know? It gives a clarity that I didn't think I could have. I feel comfortable with this kind of math because I do have an understanding of it that I never had in a math class, because I have the experience." She described needing to come to terms with the fact that content is no longer her hurdle, but that she herself is her own obstacle. She started to see that the construct of "math" has not been holding her back from finishing her education, but how she studied and approached school had been her road block.

Lydia also provided an insightful explanation for why her Attitude scale decreased over the semester. She said, "It's based on when these surveys were administered: at the beginning and at the end. You know, at the beginning you're the most optimistic. At the end, you're in the middle of it, where most of the stress is coming into play. So, you should change. It makes sense

that they (the scale scores) would." Jamie also experienced a large drop in her Attitude scale, likely linked to her increased anxiety about upcoming final exams. Like Lydia, she mentioned the additional stress on her near the end of the semester, attributing her negativity, and subsequent lower Attitude score, to that stress. For Rachel, her drop in attitude came as the course material became more difficult. She said, "I can handle a challenge, but sometimes when things get too hard, my attitude will change toward it, and I'll be like, 'Well I don't care anymore,' but I really do care."

Mark shared a detailed story of the many obstacles he has had to overcome to finally return to college, as well as major life stressors he was dealing with while coming back to school. Unable to work for two years due to a job-related injury, his family experienced financial difficulties that clinched his need to go back to school. In addition to his family's struggle with food insecurity, Mark had another unexpected life event to handle. He missed his first Quantway test because his 39-year-old wife had a stroke that day. Some days he also struggled to focus in class because of his injury-related pain. He never told his professor about his pain or what had happened to his wife. He said, "I wanna be recognized as a student. I have all these issues, but I don't want everybody to know this. I don't need any of their eyes on me, or anything like that. I'm fine. I will be fine." Mark did not want any pity or special treatment (see Table 21).

Five of the interviewees experienced gains of 30-35 points over the semester. One student stayed the same, and four students dropped 20-25 points.

Table 21

Attitude: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview

Prof. Cambria	Joe 99/99	I always push myself to do more… I'm gonna come out winning this time.	This is like the most committed I've been to math, period. It's a fun course. You have to be open to take this class. You have to learn different ways of doing it.
	Lydia 99/80	Math was always an issue, but now it's not. Like, the content is not the problem. I think the issue for me is me now… Just do it.	I never felt confident in a math class. And now I do. I'm not lookin' at everything like it's foreign. That's a big deal, because math has bested me for most of my life.
Prof. Franklin	Rachel 55/35	When I understand something, I'm more like, happier to do it. When I don't understand, I sit there and feel bad.	My attitude went down toward school. I don't know, like everything just got harder and harder.
Prof. Montgomery	Jennifer 80/65	I always liked learning. I just like taking in more information. I'm always open to it, and that's just how I've always been.	Not Available
Prof. Sullivan	Anna 10/45	I didn't do well in high school. I failed a quiz (in college) and it makes me feel like I'm not good enough for this.	I came in thinking, 'I'm gonna be really bad at this,' and it wasn't like that. I don't totally dislike math now. I did before, but now I don't.
	Keesha 35/65	I need more time with math… You want something, you gotta give. Take time to step outside the box, and do it.	I have to do this. So I'm like, "Put a smile on your face. It's a lot of great things that could come from school. You've got this." It makes me feel good- as a person, as a woman, as a mom.
Prof. Warren	Jamie 45/20	I know I have to get through this class. So, it's more of a push.	I've been pretty negative this semester. There's just so much work… and it blows my mind we're stuck taking these non-credit math classes we'll never use.
Prof. York	Chelsea 35/65	I'm pretty good at math, but I got stuck in this really low	I don't like it (*Quantway*). It's horrible.

		math course. But, oh well. I'll get out of it soon.	
	Danielle 65/99	I'm just hungry for success. Whatever it takes for me to be successful, I'll do it.	I used to complain a lot in the beginning. I was like, 'why am I in this class?' I realized I was rough on some spots, and we'd take this class, get better, and go to the next class.
	Mark 80/90	I'm here, and it's really hard, and it's daunting, but I don't wanna leave. So, this is like my sport, I guess. I just gotta get better at it.	Every single day that I think I'm making progress, if an issue happens or if I feel embarrassed, I actually get frustrated and let it all go. I have to restart myself.

Note. The interviewees' pre/post LASSI percentile scores for the Attitude scale appear under their names.

All interviewees addressed their feelings on taking this required course. Some were excited to conquer it. Others were terrified of failing in math, again. While a few students still complained near the end of the semester, most of the interviewees had positive outlooks about their progress over the semester.

Motivation. Several students talked with me about what motivated them to stay and about their perceptions of what happened to their classmates who ceased attending. Danielle started and ended the semester with the highest possible Motivation score. She settled for nothing less than her best, and she remained positive, all semester, on her pursuit for success. During our post-interview, she told me how a large portion of her class stopped attending, but she believed that those who stayed cared about succeeding and became a stronger, more dedicated cohort. She shared something her professor did to motivate students. "There was one of our professor's kind of like stress relievers: 'Know your why and know what you're here for'." She perceived those who remained as being focused, like her, on earning their degrees. Jamie shared a similar

experience in her class. Only five students were attending classes near the end, and she felt that all of them were determined to help each other succeed. Jennifer said that the ones who stopped coming to her class were all younger. She perceived those who remained as all in their late twenties and early thirties. She said, “This is our second go around, and it’s like, we gotta do this!” Jennifer took this course for the mathematics requirement of her master’s degree program. She brought a level of emotional and academic maturity that is not common among Quantway students.

Joe spent five years at this college attempting to complete his mathematics requirements. In his first semester, he successfully completed a course in Arithmetic. Next, he made three unsuccessful attempts at Beginning Algebra, and then he failed Quantway once before retaking it this semester. Joe reported that he had finally reached a level of maturity, emotionally and academically, where he was able to be successful. He shared that he was motivated by the useful nature of the course material to both his present-day life and to his intended career, giving him the drive to put in the time needed to thrive in this class.

Keesha’s Motivation scale jumped from 15 to 60. She did not feel that her original score accurately reflected her true motivational level. She was highly driven to succeed, largely to provide a better life and future for her family. She had a daughter and was pregnant with her son at the time. She knew that her associate’s degree in drug and alcohol counseling would not lead to a job with a lucrative salary, so she spoke of her plans to work in her field upon receiving her degree while also continuing her education to advance her career. A pivotal moment for her came when she failed a quiz. She had a talk with her professor and went to office hours. She also sped up her plans to get a car, so that she could come to campus more often and more readily to

receive tutoring. She thought to herself, “It’s not high school no more. We’re paying for this. We gotta do what we have to do. If that means getting help, you gotta get the help!” When she talked to me about her class, she said, “It was very different at the beginning. You had people still figuring out if they wanted to be there. So, at the end, you have the people who were there, and they were there for a reason, so it’s more of a learning class. We’re gonna get this. We’re gonna work through this.”

Mark and Lydia, both adults in their forties returning to school for a career change, were motivated by life goals and life challenges. They both also drew motivation to continue from their professors, Prof. York and Prof. Cambria. I discuss this in more detail in a future section on Teacher Impact (see Table 22).

Four interviewees increased their motivation scores over the semester. Two stayed the same, and four dropped by no more than 15 points each.

Table 22

Motivation: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 99/90	I see myself using some of the stuff we learn in math (for his career in homeland security).	I just made sure I put the time in to get it, because without time and concentration, you won’t succeed.
	Lydia 65/75	There’s an objective, and I’ll reach it.	Not Available
Prof. Franklin	Rachel 85/60	I want to get out of college and start my career working with kids.	My motivation dropped when I got really sick. It was kind of hard to come back.
Prof. Montgomery	Jennifer 75/85	This class focuses on real world math. I think it invests people more, when it’s	My motivation is self-driven. I think it’s just a change in myself with age.

		something that applies to your life.	
Prof. Sullivan	Anna 15/20	I feel I am motivated, but if something goes wrong, it can easily bring me down.	Not Available
	Keesha 15/60	I work good under pressure. I have to succeed. I will.	All of us are in it to win it. We helpin' each other.
Prof. Warren	Jamie 75/75	I'm very motivated to get my degree. I've been in school, on and off (for 8 years), and I figured out what I wanna do.	My motivation is pretty good. I'm gonna make sure I do it (schoolwork), to the best of my ability. Even if I really don't want to.
Prof. York	Chelsea 90/75	Not Available	Not Available
	Danielle 99/99	I retook a test. I had an 89, but I'm a perfectionist, and I wanted a 100.	We became more focused on the bigger picture. It was just, to get the degree, and like remind ourselves why we were there.
	Mark 15/10	The only thing I could think of is trying to better myself for my family. I really want this.	I was always motivated to be here, but I never thought that I could do math as much as I did! I do belong!

Note. The interviewees' pre/post LASSI percentile scores for the Motivation scale appear under their names.

The pre-interview comments showed different types of motivation. Some students were driven by the relevant content, others by a goal to get a degree, and some by a desire for self-improvement. Although a few students reflected on the difficulties they had during the semester, most post-interview comments revealed either a sense of camaraderie about finishing strong with the class or a sense of pride in reaching their personal goals.

Self-Regulation. This section presents charts and further reflections from interviews that indicated insights about the Self-Regulation component of LASSI. I present data related to

Concentration in Table 23, Self Testing in Table 24, Time Management in Table 25, and Using Academic Resources in Table 26.

Concentration. In Quantway, investigation of the problem situation for the lesson usually begins with time to work alone. After a few minutes, individuals come together and share ideas to reach a collective solution. Some teachers skip the individual portion of the problem solving, but even if time is allotted to work alone, some students need more time than others and may not be ready for discussion. Jennifer shared that she has some mental health issues that made it hard for her to concentrate. With reading, she needed to read things several times "before it sinks in." She found it especially difficult to concentrate in class when others were talking about problems, because she needed to read and process the questions, slowly, on her own first.

For Jamie, although she did not particularly enjoy the work, she wanted to succeed and would do what was needed to succeed, but she had to want to do it, or "be in the mood" to concentrate. She described her study ritual this way, "Like at night, it's nice to unwind and be like, 'Ok, I have like a schedule. I have a routine.' And part of my routine is homework. I have come to a part where that is calming to me, because I'm like in my own zone. I put my headphones on and listen to like, instrumental music, which is super helpful to me. I know I have to get it done, and I really focus on getting it done."

Improvement to the Concentration scale was statistically significant among the cohort of interviewees. Mark experienced the greatest gain in the Concentration scale amongst my interviewees. Early in the semester he thought that he could focus on his schoolwork, except for when he had pain. "I was in an accident, so I have this pain, but you know, coming in there (to class), it's like, I wanna concentrate, and I can do it." At the end of the semester, however,

looking back, he realizes that he had "concentrated the wrong way." He proceeded to explain the way he used to study and approach homework and how he came to study in a much different way, utilizing better learning strategies that were more effective. His score rose 35 points (see Table 23). Six other interviewees experienced gains in Concentration, while three interviewees went down by no more than 15 points.

Table 23

Concentration: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 65/95	I get sidetracked a lot. I have trouble paying attention.	Not Available
	Lydia 80/65	Not Available	Not Available
Prof. Franklin	Rachel 20/25	Not Available	Not Available
Prof. Montgomery	Jennifer 35/25	It's easier for me to concentrate when I'm not pressured to think in front of other people.	I like groupwork, but with the concentration, it makes it harder to concentrate.
Prof. Sullivan	Anna 25/60	It's really hard to focus on something I'm not interested in.	Not Available
	Keesha 30/65	Not Available	Not Available
Prof. Warren	Jamie 05/10	I am very high energy, but when I sit down and actually take the time to concentrate, it works out.	I have to be in the mood to concentrate, which I really have to focus myself on doing that.
Prof. York	Chelsea 85/80	Not Available	Not Available
	Danielle 90/99	Not Available	Not Available
	Mark 50/85	I can pretty much, ah, focus.	I had concentrated the wrong way…now, I actually take time to remember how I got my answers.

Note. The interviewees' pre/post LASSI percentile scores for the Concentration scale appear under their names.

In the pre-interviews, only half of the students reflected on their ability to concentrate. Post-interview comments do not reveal much, beyond Mark who learned how to concentrate the right way. Individual changes in LASSI scores for Concentration, however, reveal overall improvements in this area, despite lack of mention here.

Self Testing. Although Jamie scored extremely low in Self Testing, she shared that the review packets provided by her professor were useful. "I can go through and like, look at what I'm doing, and then check it against his answers online, which I really like being able to test myself before going in, so that I know what areas I need to work on." They did not review during class time, so Jamie liked using the reviews to identify any misconceptions she may have had so that she was prepared by test day.

Keesha who scored 15 in the beginning and 85 at the end, said she used to think "Ok, I've been in class. I got it." She did not see a need to prepare for a test. Later in the semester, she would go through her materials and try to determine what would be on the test. She reviewed solving techniques and tried to figure out alternate solutions. She also used review packets from her professor. They would start these during class and then finish them at home. One week later, the professor posted the answers online. Keesha liked being able to check her work, step by step, with the detailed answer key (see Table 24). Like Keesha, Anna and Danielle experienced large gains in Self Testing, while two others saw a smaller gain. Four interviewees dropped by 30 points of less. Joe stayed the same with a score of 95 each time.

Table 24

Self Testing: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 95/95	I use the review sheet.	Not Available
	Lydia 85/80	Not Available	Not Available
Prof. Franklin	Rachel 55/25	Not Available	Not Available
Prof. Montgomery	Jennifer 20/50	Not Available	I'm not a huge studier, but I do make sure that I get it, so I'm not coming in (to class) not knowing what I'm doing.
Prof. Sullivan	Anna 40/90	I'll make notecards… I need to test myself and question myself.	In high school I would just get by. But now, I actually understand it. I know how to test myself.
	Keesha 15/85	Not Available	I actually go through and ask what will be on the exam.
Prof. Warren	Jamie 05/01	Not Available	He gave us these packets, and I think it's been super helpful.
Prof. York	Chelsea 90/70	Not Available	Not Available
	Danielle 50/95	Not Available	I'll keep doing more (review) to make sure that I'm 100% ready.
	Mark 20/25	Not Available	Not Available

Note. The interviewees' pre/post LASSI percentile scores for the Self Testing scale appear under their names.

Although very little was mentioned in pre-interviews about Self Testing, concluding interviews reveal that about half of the students valued reviewing for tests. Specific methods for testing oneself were not proposed, but several students used review packets provided by their instructors.

Time Management. Jennifer was surprised that she made big gains in Time Management. She felt like it comes from being an older student now. In high school and early college, she put things off all the time. During this class, she hated to procrastinate. She did things immediately, whenever possible, otherwise they became a source of anxiety for her. She also shared that she was taking a class in Adolescent Psychology and she felt the explanation is cognitive. "I think when you're younger, you're more likely to not be able to effectively manage your time, because it's just the ability is less inherent, I guess."

Keesha, an adult student around Jennifer's age, wanted to find more time to spend on schoolwork, but her life circumstances did not allow for her to do that. Before she got a car, she had to leave class right away to catch the bus to pick up her daughter from school. After getting a car, Keesha could at least stay after class to ask questions and get help. Once leaving campus, however, it was hard for her to study. "I'm working. I'm getting my daughter to school. I'm getting me to school. I'm getting me to sleep and her to sleep, just to get up to go to work, to feed us, to- everything." The responsibilities of parenting and working at night, made it hard to find study time. She did say, "When I'm helping my daughter with her homework, I like to let her see me doing mine." She also said, "And now I'm with child, so I be like tired. I'll set an alarm to get up at 5 to study, and I roll over and turn it off. I be draggin' myself."

Mark's professor helped him learn how to use his study time more efficiently. He told me that he had been studying this material for two hours a day. She told him that he was over studying. "Actually, she taught me, um—she was saying about studying all day, like you can't do that. Like, you have to dedicate time slots. Um, so she was like, just a half hour. She said, after you come home—this is actually what SHE taught me. She said, 'after you get home from

school, while the stuff is fresh in your mind, do something.'" He started reviewing his notes for 30 minutes upon coming home, and then once more in the evenings. He said his confidence grew and he was understanding the material better after establishing this routine (see Table 25).

Table 25

Time Management: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 80/99	Not Available	Not Available
	Lydia 55/60	Not Available	I probably could have put more effort into my schedule and all of that.
Prof. Franklin	Rachel 40/35	Not Available	Not Available
Prof. Montgomery	Jennifer 75/90	I used to procrastinate, but now (that I'm older) that makes me anxious. I wanna just get it over with.	If I can help it, I do it to get it done immediately.
Prof. Sullivan	Anna 75/75	Not Available	Not Available
	Keesha 20/45	I need more time with math, honestly.	It's not that I didn't want help, but I had to find the time.
Prof. Warren	Jamie 35/05	I'm not a procrastinator. I'll just crunch everything at one time, which I think works for me.	I'm a visual person. I make a list. I have to check a box off to see the progress.
Prof. York	Chelsea 99/85	Not Available	I'm still getting all my stuff done, but attendance could definitely be improved.
	Danielle 85/99	Not Available	Not Available
	Mark 45/85	Not Available	I've been able to dedicate my time to subjects better.

Note. The interviewees' pre/post LASSI percentile scores for the Time Management scale appear under their names.

Six interviewees gained up to 40 points in Time Management. One interviewee dropped 25 points, while two interviewees dropped by five and 10 points, respectively. One interviewee stayed the same.

In the pre-inteviews, two students shared that they like to do things right away and avoid procrastination. One student acknowledged a need to carve out time for practice and studying. Post-interview comments were split between students who successfully managed their time and others who struggled with that skill throughout the semester.

Using Academic Resources. Early in the semester, Jamie explained that she does not need to seek outside help, because her professor provided so many resources online for additional support. At the end of the semester, she said that she would never go for tutoring. She said, "I just, A, don't have time, and B, I just, I don't know, I guess I don't have the ambition, or I'll like figure it out myself." Several students preferred to figure it out on their own, ask their group, or ask their professor over going to tutoring. Some attributed this to time constraints, others pointed out anxiety concerns earlier, and some students just did not need help beyond the classroom (see Table 26). Improvement to the Using Academic Resources scale was statistically significant among the cohort of interviewees. Six interviewees gained in Using Academic Resources: two started in the nineties and the other four rose 10 to 55 points. One interviewee's score dropped, while three scores stayed the same for this scale.

Several interviewees did not feel that they needed additional help outside of class. A few of the interviewees who needed help sought tutoring at the Learning Center, after prodding from their teacher. Others preferred to visit their professor during office hours if they needed more help.

Table 26

Using Academic Resources: Interviewee Comments

Teacher	Student Interviewee	Pre-Interview	Post-Interview
Prof. Cambria	Joe 90/95	Not Available	Not Available
	Lydia 35/45	I've taken advantage of those opportunities (tutoring).	She pushed me to the Learning Center.
Prof. Franklin	Rachel 30/30	I ask my mom for help. She took this course.	I use Prof. Franklin (the teacher) as a resource.
Prof. Montgomery	Jennifer 10/35	I haven't needed help yet.	I haven't struggled in this class, but if I do, I know where to go for help.
Prof. Sullivan	Anna 15/70	I always raise my hand.	Not Available
	Keesha 75/95	I used the Learning Center (last semester).	I've been meeting with Prof. Sullivan for office hours.
Prof. Warren	Jamie 25/10	I haven't had to use it (tutoring).	I would never go to the Center and get help.
Prof. York	Chelsea 05/05	I never need to like, set up a meeting or tutoring.	Not Available
	Danielle 95/99	I would take advantage of the learning centers or office hours if I needed to.	Not Available
	Mark 25/25	I understand the Learning Center is there, but maybe I don't need it.	Not Available

Note. The interviewees' pre/post LASSI percentile scores for the Using Academic Resources scale appear under their names.

Summary of the Analysis of Interview Data on the Components of Strategic Learning.

In this section, I discussed my analysis of the available interview data on 10 students' reflections of the effects of their developmental mathematics class on their learning and study strategies, and I began to examine descriptions of the students' learning experiences in this class. Each LASSI component, Skill, Will, and Self-Regulation, was broken down and analyzed by

scale. Here are the key findings. The analysis was grounded in the frameworks of social cognitive theory and student success/productive persistence.

For the Skill component, interviewees shared about their Information Processing, Selecting Main Ideas, and Test Strategies scales. Although Information Processing was statistically significant with the larger participant group of n=65, it was not for the interviewees. Some students discussed struggling to know what is being asked in a problem-solving situation, but most of the interviewees did not experience much fluctuation in this scale. Selecting Main Ideas, however, experienced statistically significant gains among the interviewees. Although five students raised their scores and four stayed the same, no one mentioned this scale directly. Seven out of 10 interviewees gained in Test Strategies, citing helpful review packets and learning how to study for a math test as key components. There is evidence that this developmental mathematics course had an impact on students' strategic learning skills in the Skill component.

For the Will component, interviewees shared about their Anxiety, Attitude, and Motivation scales. Anxiety, which experienced statistically significant gains among both the interviewees and the larger participant group, was an area in which many students struggled. It was also the scale with the greatest gains over the course of the semester. Students described how keeping a positive attitude was at times challenging but also very important to experience productive struggles. They spoke about students who did not push through those challenges and who lacked the motivation to persevere and succeed in the course. There is evidence that this developmental mathematics course had an impact on students' strategic learning skills in the Will component.

For the Self-Regulation component, interviewees shared about their Concentration, Self Testing, Time Management, and Using Academic Resources scales. Concentration, another area with statistically significant gains among the interviewees, was hard for some to do during class, but it was also an area that they developed strategies to improve at. Self Testing was not something that many knew about before, but they learned how to do it and find value in a new way to study. Time Management was a common struggle for the interviewees, but six experienced gains and overcame this hurdle. Using Academic Resources was an area that many students preferred to either figure things out on their own or ask a peer or their teacher. Few students utilized the tutoring services, and some even avoided it. There is evidence that this developmental mathematics course had an impact on students' strategic learning skills in the Self-Regulation component.

In the previous section, I discussed my analysis of the available interview data to gain insights to answer my first research question about the effects of a developmental mathematics class on their students' learning and study strategies. A deeper analysis of how students in a developmental mathematics course incorporating learning and study strategies described their learning experiences will address my second research question and follows in the next section.

Analysis of Data on the Student Learning Experience

After initially coding all available data according to the 10 a priori codes corresponding to LASSI scales for strategic learning, as previously explained, I recoded the data to find evidence of other emergent themes. Learning how to be a college student and overcoming barriers were themes that were often intertwined with students' responses about Anxiety, which was one of the scales that my analysis found statistically significant gains among the group of

participants. I have labeled these two themes "Doing College" and "Barriers." Although the interviewees in my study mentioned learning strategies that will help them in future classes, they more frequently spoke about the impact their teacher had on their mathematics experience, as well as the groupwork element of the Quantway curriculum. I address the emergent themes of "Teacher Impact" and "Groupwork." Many students also experienced changes throughout the semester that exhibit a "Growth Mindset." This is the fifth and final emergent theme that I address.

After establishing the five emergent codes, I performed another iteration of coding on all 20 interviews to identify sub-themes within the five main coded themes. I divided each of the five emergent themes into sub-themes. The first theme, Doing College, includes Attendance and Homework, Class Participation, Test Preparation, Academic Support, and Purpose. The second theme, Barriers, includes Classroom Barriers, Homework, Learning Disabilities, Mathematical Content, Health and Well-Being, and Balancing Acts. The third theme, Teacher Impact, includes Teaching Techniques, Student Success, and Mutual Response. The fourth theme, Groupwork, includes Buy-In, Pretenders, Sense of Community, and Synergy. The fifth theme, Growth Mindset, includes Open Mind, Confidence in Ability, and Productive Persistence. Once I determined the sub-themes, I also coded all the written responses again, seeking more evidence to support the interview findings. Although the interviews provide significantly more descriptions of the students' learning experiences, the written data also provides further support for many of the sub-themes. The table below summarizes how often these sub-themes appeared in the available data (see Table 27). The next section addresses each aspect of this table as I

discuss how students describe their learning experiences as I address each of these themes as they relate to the framework for student success.

Table 27

Frequency of Evidence for the Five Emergent Themes

Emergent Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Doing College				
Attendance & Homework	1	0	4	8
Class Participation	1	0	6	8
Test Preparation	3	0	6	7
Academic Support	12	2	9	4
Purpose	3	5	7	5
Total	20	7	32	32
Barriers				
Classroom Barriers	0	0	6	9
Homework	0	0	3	9
Learning Disabilities	2	0	2	2
Mathematical Content	0	0	7	8
Health and Well-Being	1	1	3	3
Balancing Acts	5	19	4	3
Total	8	20	25	34
Teacher Impact				
Teaching Techniques	0	0	9	5
Student Success	1	2	8	7
Mutual Response	0	0	3	3
Total	1	2	20	15
Groupwork				
Buy-In	0	0	7	6
Pretenders	0	1	1	1
Sense of Community	0	1	6	4
Synergy	0	0	4	3
Total	0	2	18	14
Growth Mindset				
Open Mind	5	1	4	5
Confidence in Ability	0	5	6	7
Productive Persistence	3	3	3	5
Total	8	9	13	17

Doing College. Many interviewees shared how returning to school and doing the work required in college were sources of anxiety. For most, as they became better at being a college student, anxiety levels dropped. Consider Keesha, Chelsea, and Danielle. Keesha, who returned to school eight years after graduating from high school shared that just being in school has helped her get better at being a college student. Chelsea, who has a diagnosed anxiety disorder, recently dropped out of 12th grade, subsequently earned a GED, and was now starting college. She said that as the semester progressed, she was learning what worked and what did not work for her. Danielle who had been out of high school for five years, believed she was incorrectly placed low in mathematics. Despite that, she acknowledged that Quantway has strengthened her mathematics skills and made her a better student. She was "hungry for success" and would do whatever it took to succeed. A subset of Table 28 below summarizes both the frequency and data sources for evidence of students learning to do college (see Table 28).

Table 28

Frequency of Evidence for Doing College

Sub-Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Attendance & Homework	1	0	4	8
Class Participation	1	0	6	8
Test Preparation	3	0	6	7
Academic Support	12	2	9	4
Purpose	3	5	7	5
Total	20	7	32	32

Additionally, Table 29 details which interviewees addressed each sub-themes and in which interview(s) (see Table 29).

Table 29

Interview Evidence for Doing College

Interviewees	Attendance & Homework		Class Participation		Test Preparation		Academic Support		Purpose	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Joe		X		X	X				X	
Lydia		X	X				X			
Rachel	X	X		X		X	X	X	X	X
Jennifer	X	X		X	X		X		X	X
Anna			X		X	X	X			
Keesha				X		X	X	X	X	X
Jamie	X	X	X	X		X	X	X		X
Chelsea		X	X	X	X	X	X		X	
Danielle	X	X	X	X	X	X	X		X	X
Mark		X	X	X	X	X	X	X	X	
Tally by interview	4	8	6	8	6	7	9	4	7	5
Total per Sub-theme	12		14		13		13		12	
Grand total for Doing College										64

Note. An X indicates in which interview(s) an interviewee addressed the given sub-themes.

A total of 27 survey comments and 64 interview segments support the findings for the Doing College theme. In this section, I provide evidence of ways that students learned to do college. The sub-themes of Doing College that I address are: Attendance and Homework, Class Participation, Test Preparation, Academic Support, and Purpose.

Attendance and Homework. Several students mentioned the importance of attending class and doing homework to prepare for and practice skills learned in class. Here are some examples from the one survey and 12 interviews that addressed this topic. Rachel told me, “You have to go to class, and you have to do your homework if you wanna pass.” She seemed more concerned about getting points for having it done than learning the material, but after missing

several classes due to an illness, she discovered how difficult it can be to catch up on missed schoolwork, which also increased her anxiety level. One day Anna's teacher showed the class's homework scores without names. "There were multiple zeros at the top, and I'm thinking, 'We've had like four assignments. You didn't do four assignments?' There are people in here that didn't do four assignments! Multiple people … That's when I knew nobody was, maybe me and two other people, were taking this course seriously. And I just felt so sad for them, that if you can't pass this course easily … You are going to have a hard time in college." Anna could not believe how many of her classmates were not completing homework, especially since most of it was multiple choice or fill-in-the-blank, and each question provided multiple attempts. Chelsea admitted to missing several classes and stated that she could have done better with attendance. Possibly due to multiple absences, Chelsea did not realize that she was required to enter her homework into the computer to receive a grade for her work. Her workbook came with a paper version of the assignments, and she had just been doing them there. Late in the semester, Mark had to miss one week of classes due to a family crisis. He said, "I wasn't focusing on studying in that week. So, when I came back, it really did feel like I just did a quantum leap backwards. I felt like I was taking from everyone by trying to engage, trying to catch up." Mark, who typically struggled with the course material, found unexpectedly missing a few classes to be a major setback. Attending class and completing homework are both essential for doing college.

Class Participation. Despite the difficulties faced by many of the students in mathematics, multiple students commented on the value of participating and being engaged in class. Here are some examples from the one survey and 14 interviews that addressed this topic. Mark always tried to participate. He shared that he liked to help his classmates, so when he knew

how to do something, he volunteered to explain it. If he wasn't answering questions, he would be trying to take notes and outline what the questions were asking. He felt like he took a lot of unnecessary notes, but he was trying his best to engage with and understand the material. Anna admitted that she usually figured out solutions before her classmates and got bored. To stay engaged in class, however, she would either help her classmates during the problem-solving time, or she would concentrate on taking notes while the professor provided explanations, even though she already knew how to do it. Anna knew that if she did not do this, her mind would drift, and she would miss something important in class.

Anna's realization about herself supports the idea that merely being in class, physically, is not enough. Students must also be mentally present and engaged. One day Mark's professor snapped at him for not paying attention. She said, "Mark, what are you doing? Are you even here today?" He replied, "Honestly, I'm not here today," followed by a joke. His professor said, "I think you need to be here." Mark reported that he was first shocked, then embarrassed, and lastly, disappointed for letting down his professor and himself that day. Reflecting on this incident made him look up to her more. He said, "There's something she's giving, and who am I to play around in her class?" Mark realized that simply attending class is not sufficient. He needed to be focused and involved, too. Body and mind are both necessary to fully engage in the learning process.

Test Preparation. One major aspect of becoming a better student is learning how to study and prepare for tests. I present below some examples from three surveys and 13 interviews that addressed this topic. Anna shared about the day she failed her first quiz of the semester in her business course. She immediately changed how she studied for that course, leading to better

future outcomes. Her study techniques, including the use of notecards, also carried over into other courses, serving her well. She also noted that every teacher has a testing style, and that after the first assessment, students can adjust how they prepare based on the style of the teacher's exam. Mark struggled with learning to take notes and how to study from his notes. As the semester went on, and with some help from his professor, Mark noticed improvements in the depth of his preparation. Joe, Jamie, and Anna mentioned using review sheets provided by their professors to practice and prepare for math tests. Jamie liked to make lists of what she needed to accomplish for school, and she found that a rigid study routine helped her focus and be productive. At our first interview, she shared this with me about Self Testing. "The self-testing-- I think with math, like he gave us these packets, and I think it's been super helpful, because I can go through and like, look at what I'm doing, and then check it against his answers online, which I really like being able to test myself before going in, so I know what areas I need to work on." Jamie's study routine points to the importance of time management, another important skill for carving out meaningful study time.

Academic Support. Another important step to becoming a better college student is to learn about available resources and take advantage of them to support learning. Below are some examples from 14 surveys and 13 interviews that addressed this topic. Keesha, who was repeating Quantway, failed her first exam. She said, "I kind of had a little grace for the beginning of this semester, because I knew some of the stuff from last semester." Keesha was over-confident and thought she did not need to prepare for it since she had taken the class before. She continued, "Here we go. I definitely need the learning center." To prepare for her retest, Keesha met with Prof. Sullivan during office hours. She confessed that the first time she took this class,

she did everything alone. This time around, she regularly attended office hours, and she formed a study group with Anna from her class. Both activities proved beneficial for Keesha's progress in class. She also knew about the college's Learning Center, but she, like many of the interviewees, never felt that she needed that extra layer of support.

Other students, like Mark and Lydia, did take advantage of the Learning Center for tutoring. Mark, who had anxiety about seeking help for math and who never wanted to burden anyone with his problems, felt that maybe he could figure out the mathematics for himself if he just focused harder. "I know that there's a learning lab… but I wanted to just see if I could do this first half of the semester, and then seek that. Because, I don't know, I just wanted (laugh) to try to figure it all out… I understand that the learning center is there for people, too, but I just figured…maybe I am someone that don't need it if I just pay more attention and try to focus harder, so-- that's where I'm at." After trying to do it alone for several weeks and having an unsuccessful study session with a classmate, he realized that he should seek out the tutoring. Like Mark, Lydia also needed a nudge to take that step, and she sought tutoring after Prof. Cambria strongly encouraged it.

Purpose. Another important component to learning how to do college and be a better student is to have goals and be focused on them. Here are some examples from eight surveys and 12 interviews that addressed this topic. Although not happy about being placed into this developmental course, Danielle adopted this mantra from Prof. York: "Know your why, and know what you're here for." Having a purpose for taking this class provided students with the motivation to continue attending and doing the work needed to succeed. Jennifer, Danielle, Anna, and Mark all commented on how many students ceased attending classes very early in the

semester. Typically, the older students in the class were still attending. These students described the younger ones who no longer attend as immature, being distracted in class, and lacking goals. Mark shared that he has learned to make acquaintances in future classes with students who do not have their phones out in class on the first day. He observed that the students who were always playing on their phones are no longer in the class. Mark said, "It's just being a young adult. You have to like, unscramble all of that other stuff that you feel is important in your life." The day that Professor Sullivan displayed the homework scores in class opened Anna's eyes to how many students did not seem to care about learning, and she thought to herself, "I'm sure they'll be in this class again next semester. Maybe it's a lesson to them." Jennifer said, "I think some of the younger students think, 'I have time. If I screw up, I can come back later.' For everyone else, this is our second go around. We gotta." She pointed out that the older students remaining in her class all realize that they need this course for their endeavors, and they are committed to completing the course. Knowing their "why" moved them forward in their academic pursuits.

Summary to Doing College. Attending class and completing homework are both essential for doing college. Students said that you cannot pass the class without doing the assignments and that missing classes is detrimental to one's progress. In addition to attending class regularly, participating and actively engaging in the learning process with both body and mind are also essential. Notetaking, working in groups, and answering questions are all ways to participate actively. Another aspect of becoming a better student is learning how to study and prepare for tests, as well as seeking help when one needs it. Many students enjoyed using review packets prepared by their professors. They also spoke about the importance of time management

in establishing a study routine. Having a purpose for being in college motivated the students to persist. Many students commented on how many of their classmates had ceased attending class, and they speculated that these students did not care about their education. All these aspects of doing college led to the interviewees becoming better students. They became students who learned how to do college.

Barriers. In addition to academic challenges, students frequently commented on external things that got in their way of doing college. Balancing family, jobs, money, and personal issues were common concerns. Some students faced learning disabilities or difficulties with mathematical content and homework. Others dealt with health issues that hindered their progress in school. A subset of Table 30 below summarizes both the frequency and data sources for this evidence of students encountering barriers in college (see Table 30).

Table 30

Frequency of Evidence for Barriers

Sub-Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Classroom Barriers	0	0	6	9
Homework	0	0	3	9
Learning Disabilities	2	0	2	2
Mathematical Content	0	0	7	8
Health and Well-Being	1	1	3	3
Balancing Acts	5	19	4	3
Total	8	20	25	34

Additionally, Table 31 details which interviewees addressed each sub-themes and in which interview(s) (see Table 31).

Table 31

Interview Evidence for Barriers

Interviewees	Classroom Barriers		Homework		Learning Disabilities		Mathe-matical Content		Health & Well-Being		Balancing Acts	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Joe		X		X			X					
Lydia			X	X								
Rachel	X	X		X	X	X	X	X		X		X
Jennifer	X	X		X	X		X	X	X			
Anna	X	X		X				X				
Keesha	X	X	X				X	X			X	
Jamie		X		X			X	X			X	
Chelsea	X	X	X	X			X	X	X	X		X
Danielle		X		X			X	X			X	
Mark	X	X		X		X		X	X	X	X	X
Tally by interview	6	9	3	9	2	2	7	8	3	3	4	3
Total per Sub-theme	15		12		4		15		6		7	
Grand total for Barriers												59

Note. An X indicates in which interview(s) an interviewee addressed the given sub-themes.

A total of 28 survey comments and 59 interview segments support the findings for the Barriers theme. In this section, I provide evidence of ways that students encountered barriers in college. The sub-themes of Barriers that I address are: Classroom Barriers, Homework, Learning Disabilities, Mathematical Content, Health and Well-Being, and Balancing Acts.

Classroom Barriers. The classroom environment shapes the student learning experience. In my interviews, two instances came up as deterrents to direct learning in the classroom: behavioral problems and lack of notetaking skills. No surveys mentioned any classroom barriers. Keesha and Anna both shared about a classmate who was disruptive and disrespectful. Anna described his negativity and said, “It affected me, and I know it affected other people learning in

that class, too." She liked when Prof. Sullivan put him in his place, but she wishes he could have been kicked out of class. Keesha joked that between this disruptive student and everyone else being so needy with math questions, Prof. Sullivan should have had a teaching assistant. "I'd tell Ms. Sullivan, 'I feel like you're jumping over me, because you know I took this last semester.' And she be like, 'No!' And I'm like, 'Wait! Come here! I need you!' Um, the class is a bunch of students who need help. We all need a little bit of help. It's a great class. Ms. Sullivan is good. I think she need help though. She need like another person, because… all of us have the darndest questions." Keesha said that she was not always able to get her questions answered, and eventually she learned to spend more time on the material and seek additional help outside of class time. For Mark, he needed an assistant for notetaking. He confessed, "I don't even know how to copy notes correctly. Um, and when I say that, it's not a putdown on myself. It's because I have to use this information later, and it's like, it's not what I need." When Mark tried to use his notes at home, they were not helpful to him. He wished that his professor had provided bullet points so that he would have known what was important to write down. He also wished she would have reviewed his notes, stating that this was selfish to want, but he believed everyone else was doing it better than him, and he was not sure how to improve. Students need both academic supports and an environment conducive to learning to achieve success in college.

Homework. Completing homework was challenging for several students. Quantway students were required to use an online homework platform. Several interviewees expressed frustration with the actual platform. While no surveys mentioned homework, the topic arose in 12 interviews. For young, tech savvy Joe, he found it to be annoying and not user friendly. Students complained about not knowing what was being asked, although this was also an issue

during the in-class lessons. Mark despised the question in each assignment that asked students to reflect on a previous lesson that connects to the newest topic being learned. He said, “They don’t want you to just have cookie cutter answers. They want organic answers.” He felt these were too time consuming. He also desired more follow-up questions to ones that he got wrong. He did not like moving on when he had not yet mastered earlier topics. Chelsea, the student who did not realize she was supposed to enter her answers online, did not see the point of using the computer platform. Although Lydia understood the importance of homework, and like Chelsea, did it on paper, the computer-based version was not accessible to Lydia from home. She did not have a computer. She said:

> I had to, um, make access. And sometimes that meant staying on campus longer than I wanted to. So, the assumption that everybody has access at home is probably not a good one… I just don’t see the need for that pitstop- to put all of that into the online… It seems like a small step, but it is a step, nonetheless. And it was extra steps for me because the computer is not set up at my house. And then my phone, “You can do it on your phone!” That’s still something to DO. And just, it’s nothing for them who stay on their phones and do that stuff all day and every day, but that was just an extra step that bothered me. So, I just skipped it. I was fine with coming in and going over homework on the overhead, and you know, looking at what I did in my folder (on paper). That was enough. That’s all we needed. What was that step (online) for?

The lack of computer access presented a major equity issue for Lydia. It was either not feasible for her to, or she chose not to prioritize coming to campus for extra hours to complete that element of the course. As a result of this barrier, her grade suffered. Keesha also struggled to

complete the homework. Not only were the questions hard for her, but she also had to juggle finding the time to use the computer outside of school. Instead of viewing their assignments as supporting learning, these students found the online homework to be a deterrent.

Learning Disabilities. Some students reported that challenges presented by learning disabilities added another barrier to their learning experiences. Two surveys and four interviews from a total of four different students addressed learning challenges. Tammy wrote about difficulty concentrating due to an ADD disorder. Rachel, an interviewee, wrote, "I can't comprehend anything I read or write. It's very hard." Rachel spoke more about this in both of her interviews. Jennifer and Mark also addressed this topic in my conversations with them. At her pre-interview, Jennifer explained, "Once I get it, I'm fine, but I have to read things a few times before it sinks in. Like even in math class when we're working together, um everyone is just like, 'oh okay, yeah I get it,' and I'm just like, 'I still need to read this and figure out what it's asking…' I'm a slow reader." Jennifer felt as if she needed more time than her fellow students to process information, but she accepted that and took her time. Like Jennifer, having a learning disability was something Rachel could not control, but she has had to learn to live with it. Rachel struggled with mathematics her whole life, due to learning disabilities in both mathematics and reading. Rachel explained that her identified weakness in Selecting Main Ideas hindered her progress in Quantway, which involves a lot of reading. "Reading comprehension is not my strong suit, so like, trying to figure out what it's asking is pretty hard." She shared that in high school she had a sixth-grade reading level, so trying to figure out what a problem was asking in Quantway was a struggle. Also, retaining information was a struggle for Rachel, which presented an additional challenge to learning something like mathematics where topics build on previous

topics. Unlike Jennifer and Rachel, Mark was at times disabled by his own anxiety, or fear. While he did endure several learning challenges as an adult student returning to college after many years, he shared at his post-interview about his frustrations with not understanding material and not knowing how to ask for help. He said:

> If I could find some type of caffeine or something to just make me speak. Just speak! Because, um, it's fear. It really is. I wish I knew; I mean, this is something I've had to deal with all my life. But as an adult, you have to learn your own ways.

Although only a small cohort of participants shared about learning disabilities, each one of these students experienced significant deterrents to learning throughout the semester.

Mathematical Content. Although Rachel attributed her difficulties in class to her disability, many students talked about how difficult this developmental mathematics course was. No surveys mentioned specific mathematical content, but 15 interviews addressed the topic. Keesha and Mark both discussed how they struggled to understand what was being asked in the lesson's problem-solving scenarios. Danielle echoed that feeling. "I don't like word problems. I have a hard time picking out what I need for an equation." Mark shared about a specific type of trick question that really irritated him:

> It had 1 million, and then it had 1,000 million, so it's like a billion, but why would you just not say that? She (the professor) said, 'Well that's the thing. You have to think that through. You have to look at that and understand what you're looking at.' I'm like, it still doesn't make sense to me. I don't have anybody I can talk to and say I have a million thousand dollars. I won't hear that anywhere.

Mark did not like feeling tricked. He wanted answers to be more straightforward.

Jamie, who had been required to take the course that was prerequisite to Quantway last fall, has always struggled in mathematics. She told me, “I think for a non-credit class, Quantway is so hard. You have to take in all this information and then figure it out… you have to focus… you have to think.” The Quantway introductory “Starting Strong” materials address this rigor. On the first day of class, students are told, “The thinking is hard, but it is thinking everyone can learn how to do.” Although the problem situations involve rigorous thinking, only basic mathematical operations are needed to reach solutions.

Health and Well-Being. In addition to academic challenges, many of the interviewees encountered physical and mental health and well-being challenges during the semester. Two surveys and six interviews addressed this topic. Illnesses caused some to miss school. Rachel told me that she was committed to not missing any Quantway classes, but then a hospitalization caused her to miss several classes. This was followed by anxiety about returning to school, which caused her to miss additional classes. She shared that her anxiety struggles got worse when things got hard. Joe was also hospitalized and struggled to catch up when he came back. Prior to this semester, Joe had also taken some time off from school. When he returned to take classes again, he was more focused on completing his degree, so he did not let this illness derail his progress.

Mark encountered a broad array of challenges, including the health issues of a family member. His young wife suffered a stroke on the day of his first math test, and he missed school to care for her. This event added to prior financial struggles his family had been facing, due to Mark being on disability for an injury that occurred on a construction job site. His family also struggled with food insecurity, causing Mark to seek help from the College’s food pantry, which

he had learned about from his professor. Not only was this humbling for him, because he did not like to ask for help, but it also caused more anxiety. “I was so embarrassed by going there, and I know it’s nothin’ but help, but it still bothers me. It ate me up.” He was embarrassed to need help, and he feared that people might find out what he was struggling with. He did not want anyone to know. Health and well-being concerns are often factors that pose barriers to college students.

Balancing Acts. Like Mark, who perhaps juggled more than the average college student, many students shared about the struggles they faced with balancing schoolwork with life and their other responsibilities. While the survey responses typically provided limited evidence to support interview data, this topic received 24 mentions in the surveys, 19 of which came in the post-survey. Difficulties balancing life were also addressed in seven interviews. Students shared that they have families, jobs, and other events, outside of school, that interfere with their ability to do schoolwork. For Rachel, who still lived at home, peer pressure to hang out with friends often pulled her away from studying. Jamie was preparing to be an early childhood educator, so she was balancing classes with an internship and her regular job. Danielle said that students need to get their questions answered in class, because they have other classes to attend and then work after school. Keesha, a single mother who was also expecting her second child at the close of the semester, juggled raising her daughter, working at night, and resolving transportations issues due to car trouble. Time management is a critical component to being a successful college student.

Summary to Barriers. The classroom environment directly affected students. Behavioral problems and lack of notetaking skills posed barriers to learning in the classroom. Difficulties with both mathematical content and technology led homework to act as more of a deterrent than

an academic support to some students. Learning disabilities and struggles with mathematics increased the level of difficulty that Quantway posed to some students. Factors outside of school that affected students' physical and mental well-being became barriers to learning, along with finding time to deal with those concerns and balance schoolwork with the other demands of life. All these factors provide evidence of the various barriers faced by the interviewees.

Teacher Impact. One of the most significant themes emerging mostly from the interview data and not the surveys, was the importance of the teacher on the student learning experience. All 10 students who were interviewed spoke positively about their teachers. In analyzing comments made about each of the six teachers in the study, students who had the same teacher seemed to convey the same types of things about their teachers. For example, both Joe and Lydia had Prof. Cambria. Both students spoke to the level of thoroughness with which Prof. Cambria taught the lessons, giving ample opportunities for students to leave class each day with a firm grasp on the material. A subset of Table 27 below summarizes both the frequency and data source for this evidence (see Table 32).

Table 32

Frequency of Evidence for Teacher Impact

Sub-Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Teaching Techniques	0	0	9	5
Student Success	1	2	8	7
Mutual Response	0	0	3	3
Total	1	2	20	15

Additionally, Table 33 details which interviewees addressed each sub-themes and in which interview(s) (see Table 33).

Table 33

Interview Evidence for Teacher Impact

Interviewees	Teaching Techniques		Student Success		Mutual Response	
	Pre	Post	Pre	Post	Pre	Post
Joe	X			X		
Lydia	X	X	X	X	X	X
Rachel		X	X			
Jennifer	X		X			
Anna	X	X				
Keesha	X		X	X		X
Jamie	X	X	X	X		
Chelsea	X	X	X	X		
Danielle	X		X	X	X	
Mark	X		X	X	X	X
Tally by interview	9	5	8	7	3	3
Total per Sub-theme	14		15		6	
Grand total for Teacher Impact						35

Note. An X indicates in which interview(s) an interviewee addressed the given sub-themes.

A total of three survey comments and 35 interview segments supported the findings for the Teacher Impact theme. In this section, I provide evidence of ways that teachers impacted how students describe their learning experiences. The sub-themes of Teacher Impact that I address are: Teaching Techniques, Student Success, and Mutual Response.

Teaching Techniques. One trait that distinguishes teachers from each other is the pedagogical techniques they implement in the classroom. No students discussed this in their surveys, but all interviewees spoke with me about how their professors teach. All three

interviewees in Prof. York's class have a deep respect for her methods and her style. Chelsea described how the class does group problem-solving in this way: "Her way of teaching this is for us to kind of teach ourselves how to do it, and for us to battle back and forth until we find a resolution for it. I guess it's a learning strategy." Danielle described it this way: "You're gonna struggle for a little bit, but you'll get it." Both students seem to have understood the productive struggle philosophy behind Quantway. Chelsea thought it was just her teacher's style, but this is the pedagogy of Quantway, implemented by all Quantway faculty, albeit in their own manner.

In Professor Sullivan's class, for instance, Anna told me that this is the best teacher she has ever had. She loves how Prof. Sullivan breaks down the solutions into step-by-step processes. Keesha, however, initially told me, "I wasn't too fond of this teacher." At the beginning of the semester, she hated that the professor would not answer direct questions. She felt like Prof. Sullivan either answered her questions too fast or skipped her questions because she had already taken the class. It was not until later in the semester, after going to office hours for help, that Keesha realized the refusal of her teacher to give answers was just part of her teaching technique. She told me, "Maybe it was me havin' to go get one-on-one with her, to see maybe how to understand her a little bit more and, you know, see where she's coming from." When I asked her what Prof. Sullivan could have done differently, Keesha confessed, "It's not what she could have done, but it's more of what I could have done, which was reach out to my resources." After seeking help from and connecting with her professor in office hours, Keesha felt it changed the dynamic of their relationship, and she also developed a new admiration for her teacher's methods.

Student Success. Many students shared that their teachers truly care about student success. Three students wrote about this in their surveys, and 15 interviews addressed the topic. Danielle liked the focus Prof. York placed on making sure every student understood what was being taught. She also appreciated this teacher's gift of making real-life analogies to drive home mathematics or learning theories, sharing one about how hard it was to learn how to swim, but after a long and hard process, you can learn how to do it. For mathematics, "it's like, you're gonna struggle for a bit, but you'll get it." All of Prof. York's student interviewees shared with me how their professor does various anti-stress activities that they also appreciated for helping them through the mathematical struggles.

Mark pointed out that if students are not doing what they should be, Prof. York called on them, thus forcing them to engage with the lesson. Chelsea enjoyed when the teacher had students serve as a teaching assistant for their classmates. Mark said that no students were ever allowed to hide in the back of the room. Everyone was expected to participate and to help each other learn. He respected how Prof. York made everyone feel included in class. He said it felt like a family and the teacher had no favorites. "All of us are her favorite. She wants all of us to pass."

Jennifer was an adult student who already had a college degree but who needed a mathematics course to enter a masters' program. She enjoyed the teaching techniques used in Quantway. She said, "I think a class like this … kind of addresses that people learn differently. You know, everyone picks things up at different rates, and then, like for me, I need to see things. I'm visual. And for some people just having something explained aloud helps. For me, I need to

see why." She said that Prof. Montgomery did a good job of making sure everyone understood the material, and he encouraged students to use tutoring if they were struggling.

Other students also talked about teacher commitment to student success. Jamie described how Prof. Warren has students feed him answers. If they get stuck, he prods them to dig deeper and further explore the problem. He makes sure that everyone understands, and then writes up step-by-step solutions, which he also posts online for them to access later. Rachel, who was the sole student attending her class for the last few weeks of the semester, acknowledged that she could not have passed the course without the intense help and investment in her success from Professor Franklin. Joe, who was retaking Quantway with Prof. Cambria, also credited her encouragement for helping him get through the semester. Lydia said, "She (Prof. Cambria) truly wants her students to succeed in her class, and I think that's just really it. If you want your students to succeed, then your delivery will mirror that." Both Joe and Lydia spoke highly of Prof. Cambria's class and her passion for both teaching and for her students' success.

Mutual Response. Several students spoke about the importance of the instructor's role in a class's learning process. Having not only the ability to teach effectively and to show that one cares about her students, but also establishing respectful relationships in the classroom, were all elements of importance to the interviewees. Six students raised this idea in their interviews. In her first interview with me, Lydia shared some profound insights from her own experiences in Quantway class with Prof. Cambria:

> And it needs to be noted that *a professor matters* (emphasis added), in the grasping of a concept, whatever it may be. But like, when you have already had an issue with a subject, you're already shut down to it. And so, when you take the content that you already have a

> block up against, and you have a professor who, you know, can move that block by their delivery of this content - that matters …. And this professor understands, you know, the day you came in, you know, afterwards, she was like, "This is what it's about. Connections."

Lydia valued Prof. Cambria's efforts. She also shared about her professor's ability to teach students of all ages and recognizing that adult learners, like herself, had something unique that could be shared and incorporated in the classroom. Jennifer expressed this same view about Prof. Montgomery.

By the end of the semester, several of Lydia's LASSI scores increased, but she attributed most of those gains to a study skills class she had taken last semester. Lydia believed that it was her mathematics professor's level of interest in her students' success that motivated her to be a better student. She shared this insight with me during our post-interview:

> You know if somebody wants you to succeed. It's not by what they say, but by what they do. And she just clearly wants you to, and that has been the case the entire semester. This lady (Prof. Cambria) texts me. "You going over there to that math lab (the school's tutoring center), right?" You know, just out the blue. I was like, "Damn." I started to not go. She is like, "Um, you're going, right?" That is like, off the books. That's out of the classroom. There was nothing requiring her to text me. And remind me that I said I was gonna go. "Oh, by the way, you're gonna go, right?" You know, that's not in her job description, to give a damn to that capacity. Or on a bad winter day, I'm late. I'm coming, but I'm late. And she recognized that I'm not there. "Are you alright?" (in a text). See, that's off the math path. So, see, that's when you—on a day you might just blow off

> math class, you get up and go anyway, because now you care about how you affect this teacher. See now it's mutual response - now you done established something here. And more stuff is at stake here. And so, if you're pulling for me, then I'm gonna pull for you, too. And that's who taught my math class. So, it mattered to me to produce... You just know that this person wants you to succeed. (pause) That's not everybody up here (on campus). Sorry. It's not. And that matters. To me.

This investment of a teacher led to investment from the student. The sense of community established early on, during the first few classes of group work, fueled by constant support and encouragement from the teacher and classmates throughout the semester, is a commonality discussed by each interviewee, although to varying degrees.

Summary of Teacher Impact. The impact of the teacher is a theme addressed by all 10 interviewees. The pedagogy and techniques used in the classroom resonated with these students. Combined with a sense that their teachers truly wanted their students to succeed, the interviewees felt equipped to persist and produce work for their teachers. They all respected their teachers and felt respected *by* their teachers, leading to a sense of community in most of the classes described. The teaching techniques, emphasis on student success, and establishment of mutual response in the classroom all helped the students to feel supported.

Groupwork. For many of the teacher stories shared by the 10 interviewees groupwork was a central component of their Quantway classes. While not every student liked it at the beginning of the course, most of the interviewees described their journey with this practice and how they came to either enjoy it or at least understand, or even respect, its intent. Aside from Chelsea who still prefers to work alone, each interviewee shared something positive or beneficial

about their experiences with groupwork. A subset of Table 27 below summarizes both the frequency and data sources for this evidence (see Table 34).

Table 34

Frequency of Evidence for Groupwork

Sub-Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Buy-In	0	0	8	6
Pretenders	0	1	1	1
Sense of Community	0	1	6	3
Synergy	0	0	3	2
Total	0	2	18	12

Additionally, Table 35 details which interviewees addressed each sub-themes and in which interview(s) (see Table 35). A total of two survey comments and 30 interview segments support the findings for the Groupwork theme.

Table 35

Interview Evidence for Groupwork

Interviewees	Buy-In		Pretenders		Sense of Community		Synergy	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Joe	X						X	
Lydia							X	X
Rachel	X	X	X		X	X		
Jennifer	X	X			X			
Anna	X							
Keesha	X	X			X			
Jamie		X			X	X	X	
Chelsea	X	X			X			
Danielle	X	X						
Mark	X			X	X	X		X

Tally by interview	8	6	1	1	6	3	3	2
Total per Sub-theme	14		2		9		5	
Grand total for Groupwork								30

Note. An X indicates in which interview(s) an interviewee addressed the given sub-themes.

In this section, I provide evidence of how Groupwork impacted the interviewees. The sub-themes of Groupwork that I address are: Buy-In, Pretenders, Sense of Community, and Synergy.

Buy-In. Students who are new to Quantway typically need convincing of the group work model. While no surveys mentioned groupwork, the topic arose in 13 interviews. For Keesha and Anna, some of the behavior issues in their class made establishing group problem-solving norms a challenge. Keesha also felt that she needed to be taught how to do group work. Her early descriptions of class involved students sitting in a circle, and each person was working alone on a worksheet. Keesha saw no need to discuss the problems with classmates. She felt that she needed to think about these on her own to fully understand them, pointing out that she would not have a group during the tests. She asked, “Prof. Sullivan is there to teach. So why are we trying to make sure we know it ourselves?” Then she added, “Unless we got cubes in front of us and we’re breaking pieces off, what groupwork is there to do?” Keesha mistakenly viewed groupwork as using manipulatives and doing hands-on activities. She needed to be taught how to conduct problem solving tasks with other students. Once the teacher reigned in the problematic behaviors and earned student buy-in to the learning process, both Anna and Keesha came to value the group process and enjoy this class.

Joe, as a student repeating Quantway, felt that learning to communicate in groups was the most challenging, and yet most crucial, part of the course. He said everyone just wanted to work alone, but there are many ways to solve problems and it was necessary to share ideas. He said, "You have to be open to take that class. You can't be closeminded to any one way. You have to learn different ways of doing it." Joe was highly motivated by being close to graduation, and he knew he had to pass Quantway this time.

Jennifer shared that her own struggle with anxiety interfered with her ability to concentrate in groups. She preferred working alone, but she also enjoyed problem solving with classmates, working through the "not yet" moments in the journey to understanding new concepts. She felt the real-world focus of the course helped students invest in their learning, but she did point out that only the older adult students continued attending class for the entire semester. As discussed earlier, most of her younger classmates had ceased attending the class. She expressed gratitude for a course that provided meaningful experiences with mathematics, and she shared that this made mathematics more accessible, especially for women, and she felt that was important. Jennifer watched both age differences and gender dynamics unfold in her class. She added, "Like the other day, I was the only girl in that class. It was like a ball of testosterone! I was like, 'I'm just here to learn math, you guys.' It's important." The groupwork presented valuable opportunities for collaboration, but at times it was difficult to concentrate and keep everyone engaged in the task at hand.

Pretenders. Some students resorted to pretending to understand, even when they did not, during groupwork. Although only one survey and two interviews mentioned pretending, it is likely that more students engaged in this practice that only Rachel and Mark openly admitted to

doing. Like Jennifer, students sometimes experienced anxiety in the group setting. Rachel shared that typically, if she did not know how to do something in a larger group, she would pretend to work on something else and ignore her group, so that nobody would see her struggling. Mark was embarrassed that he did not understand something a classmate was explaining to him in a study session outside of class. He was afraid to admit it, because this fellow student had taken time out of his schedule to help Mark one evening, so he just pretended to grasp it. Mark also tried this in his class. If his classmates sighed under their breath or rolled their eyes when Mark asked a question, Mark would act like it suddenly made sense. Prof. York would usually recognize this, however, and she would call on him. He said, "It made me like, do my part, and know that I had a part to play, and look forward to what we all had to contribute to one another to get our answers together. So, it felt like a good group thing." He still experienced frustrations, usually stemming from him working slower than others, but this motivated him to persist until he did understand the material. He also acknowledged that he needs to get out of his own way and ask for help.

Sense of Community. Mark's experiences with his group allude to a sense of camaraderie that many students referenced. One survey and 10 interviews addressed the sense of community experienced in their classes. Mark said, "It's like, I felt like I was breathing and living with everyone else. Like we were a community." When another student dropped the class, Mark felt like he had let this fellow classmate down somehow.

What Rachel most liked about Quantway was that sense of community, which quickly developed early in the course. She liked having a small class. Although she sometimes pretended to understand, in small groups she felt comfortable working with peers. It forced her to work at

the mathematics and try to understand it, without hiding. Jamie also struggles with math, but she loves being in a small class and problem-solving with a group. In the past, she would just try to figure things out on her own versus asking for help. She loves Prof. Warren's style of instruction that requires the students to talk it out until they find a solution, and she feels comfortable asking questions within her group. At first, like Keesha, Rachel was annoyed that the teacher would not answer individual questions during groupwork and instead forced the groups to discuss amongst themselves, before intervening with help. Rachel, however, came to appreciate this method by the end of the semester.

By the end of the semester, Chelsea believed that she had grown as a college student, but she maintained that she would prefer to work and learn alone versus being in a group. She found groups to be intimidating and anxiety-provoking. Perhaps it was because she missed several classes, but she did not feel the same sense of community in the class that Mark had expressed.

Synergy. While not every student loved it, most students found great value in groupwork. No one alluded to synergy in the surveys, but the concept surfaced in 7 interviews. Here is Lydia's reflection on the groupwork dynamic in Quantway:

> She'll give us an opportunity to break up into groups, and um, work the problems individually or with your group. Because we're put into groups, because you know, it's … synergy, I guess. And it works! I believe in synergy. You know, instead of laboring alone. So, when we pull it all back together, you take that energy and, you know, most of the times we are able to, as a class, work it out, much more than if everybody sat in their desk individually and tried to go through. It's just an interactive class. Nobody is really left sitting by themselves, wondering what to do. You know. She just acts as a guide.

"Come on. You guys know this." It is a very interactive environment, conducive for learning.

Not only did Lydia find appreciation in the groupwork pedagogy practiced in Quantway, but she also valued her teacher who guided her students through the process. Joe, who was in Lydia's class, shared, "Of course everyone wakes up with a different attitude, but when it comes down to crunching it, yeah, everybody does pull in. When it's time to solve it, everybody's energy meets at one place." Throughout the semester, the Quantway students learned how to work effectively together.

Summary of Groupwork. All but one interviewee acknowledged the benefits associated with groupwork in their mathematics class. Not every student understood the value of groupwork initially. Teachers typically had to establish buy-in from their class and teach students how to problem solve collaboratively. The process created anxiety and even embarrassment for some, causing them to pretend that they understood material when they did not. As the semester progressed and students learned how to work together more effectively, many students described the resulting sense of community and atmosphere of synergy that evolved within their groups and classrooms. Groupwork was a central, important component of the students' learning experiences.

Growth Mindset. Students with a growth mindset possess an openness to learning that enables them to gain confidence in their abilities to learn and hence achieve success in their academic pursuits. Students' reflections about their learning experiences in Quantway indicate evidence of growth mindset development throughout the semester. The importance of an open mind, increased confidence in one's abilities to learn, and demonstration of productive

persistence are all markers for growth mindset. A subset of Table 27 below summarizes both the frequency and data sources for this evidence (see Table 36). The themes addressed are: Open Mind, Confidence in Ability, and Productive Persistence.

Table 36

Frequency of Evidence for Growth Mindset

Sub-Themes	Survey Respondents (n=65)		Interviewees (n=10)	
	Pre-Survey	Post-Survey	Pre-Interview	Post-Interview
Open Mind	5	1	5	5
Confidence in Ability	0	5	6	7
Productive Persistence	3	3	3	5
Total	8	9	14	17

Additionally, Table 37 details which interviewees addressed each sub-themes and in which interview(s) (see Table 37).

Table 37

Interview Evidence for Growth Mindset

Interviewees	Open Mind		Confidence in Ability		Productive Persistence	
	Pre	Post	Pre	Post	Pre	Post
Joe	X	X		X		X
Lydia	X		X	X		
Rachel			X	X		
Jennifer		X	X	X		
Anna		X	X		X	X
Keesha	X		X	X	X	X
Jamie	X	X	X		X	X
Chelsea						
Danielle				X		
Mark	X	X		X		X

Tally by interview	5	5		6	7		3	5
Total per Sub-theme	10			13			8	
Grand total for Growth Mindset								31

Note. An X indicates in which interview(s) an interviewee addressed the given sub-themes.

A total of 17 survey comments and 31 interview segments support the findings for the Growth Mindset theme. In this section, I provide evidence of ways that students exhibited a growth mindset. The sub-themes of Growth Mindset that I address are: Open Mind, Confidence in Ability, and Productive Persistence.

Open Mind. Students told me that Quantway requires an open mind. Six surveys and nine interviews addressed this topic. Lydia, who was initially unsuccessful in her beginning algebra course in college, felt that a course in quantitative literacy was great for students who have been out o math for several years. She said, "This is good, applicable math. Life applicable math class- to get your mind going. It's not intimidating." For Joe, who was repeating Quantway, he learned through maturity and returning to college with a new outlook that succeeding in this course requires an open mind as multiple methods of solving problems are emphasized. Jennifer, who described herself to me as "not a math person" at the beginning of her first interview, believed that "math opens your mind in certain ways." She sees math as a valuable subject for everyone to learn, but she has never enjoyed it. Quantway "brings a practical aspect to math that a lot of people don't see… I think to make it more accessible to people is a really good idea, especially for women." Although pursuing an English Language Arts degree, Jennifer found value in this required course and persisted to reach her ultimate goals. Lydia, Joe, and Jennifer

liked how problems can be solved in various ways, and that this is encouraged and expected in Quantway.

Confidence in Ability. Some of the interviewees came to Quantway lacking confidence in themselves, due to negative past experiences with mathematics. Five surveys and 13 interviews addressed this topic. After her failures with algebra, Lydia found renewed confidence in her own ability to learn with the accessibility offered by Quantway. When she opened her first test, she thought to herself, "Well, I know this!" She explained to me how good that felt. "We're talking years of not knowing- not feeling- never having that feeling. This is math that I've lived, so it makes it that much more comfortable." The content related to her life experiences and she was able to make sense in problem-solving scenarios. "You know, it makes you feel like- it'll get you the confidence. Like this is math you can actually do. I never felt confident in a math class. And I do (now). That's a big deal. (pause) Because math has bested me for most of my life."

Jamie described her experiences with mathematics in high school as awful. She lacked the confidence to ask for help in mathematics, and she suffered repeated failures. She admitted that she could have tried harder and confessed that she convinced her parents to get her out of taking Trigonometry in high school. As a college student, she had to start at the lowest level of developmental mathematics, taking a course before her developmental-level Quantway course. "I think it's just like a totally different transition from high school to college, where now it's like, okay, I understand it. I see where I am. I know I have to get through this class, so it's more of a push." She knew that it was time to get serious, and she worked hard to succeed in her first mathematics course. The confidence she found in that first mathematics course, however, was tested by the different nature of the Quantway course. Jamie described it as much harder,

because “you have to think about what you’re applying and what you need to do.” She enjoyed the small class setting of her Quantway class. Unlike high school, she felt comfortable asking questions and enjoyed the group problem-solving approach used in class. Although she was not happy about being required to take two developmental-level mathematics courses before her college-level mathematics course, Jamie was driven by a desire to reach her goals, and she persisted.

Anna explained that she had always struggled with mathematics and needed things to be broken down into steps and explained slowly. She failed twelfth grade mathematics, and she came into Quantway thinking, “I’m gonna be really bad at this! I’ll just get by.” To her surprise, she did much better than expected in Quantway, boosting her confidence for the college-level mathematics course which followed.

Productive Persistence. In addition to having an open mind, students need productive persistence, or the ability to struggle through a problem-solving experience until achieving an understanding of the solution. Six surveys and eight interviews discussed productive persistence. Here are some examples of how students encountered this struggle throughout the semester.

After three failed attempts at algebra and two semesters of Quantway, Joe finally fulfilled his developmental mathematics requirement and moved on to credit bearing mathematics after this semester. He said that quantitative reasoning was less frustrating than algebra because algebra lacked connection to real-life. In Quantway, he explained, “I know the answer, but I don’t know how to get it yet.” The power of the word “yet,” underlies the growth mindset, or productive persistence. Joe learned from his first attempt at Quantway to be open to the process of productive struggle and to never give up. With effort, strategy, and help, most students can

come to understand the concepts in the course. Accepting that one does not yet understand is part of that process.

Chelsea did not buy into the Quantway approach. She resisted the group oriented, productive struggle methods of the course, but by the end of the semester, Chelsea conceded that teaching the ideas to oneself helps the material stick better. While she seemed to hold a fixed mindset all semester, this late-semester acknowledgement indicated a potentially budding growth mindset.

Danielle provided a glimpse of growth mindset while discussing her post-LASSI results with me. She was impressed with how many of her scores increased throughout the semester. She shared that while meeting with her first-year advisor, he told her that she will become a better college student with time. After seeing her scores, she said, “Now I realize what he meant, because it’s like I did build studying strategies for tests and I didn’t even realize it. I guess I basically (laughs) grew my brain!”

Keesha, who saw no value in groupwork early in the semester, learned to appreciate it. She admitted, “In the beginning I felt it was dumb, like I just needed my own individual help. But now I’ve learned from it. We actually work through the answers.” Late in the semester, she felt like she and the remaining students were committed to succeeding. They were productively struggling through the learning together.

Mark exhibited tremendous growth throughout the semester. His ability to concentrate and make sense of class material improved. At the end of the semester he had a new-found confidence in his mathematical abilities. He shared that he used to quit doing homework when the assignment became too difficult. At the end of the semester, he said, “I’m better off. Better

than where I was." He developed strategies to work through tough problems, and although he still struggled on assignments late in the semester, he no longer quit mid-assignment. One of his favorite aspects of Quantway was learning multiple strategies to solve a problem. "They're giving it to you four or five different ways. It helps all the different types of learners." He admitted that he did not always understand all the strategies, but that motivated him to learn more. "I don't get it yet. Not yet. But I want to, and it frustrates me. Because now that I've been introduced to something that can give the same answer as my way, I want to know it! I really like this part of Quantway. I love the math. I really do!" He added, "There's so many different ways to learn math, and I can finally say that. I'm at the age where my mind is open. And somebody's actually teaching it!" Although he was initially intimidated by Quantway, he was not anymore. The class was not easy, but Mark knew he could get it with persistence.

Summary of Growth Mindset. The interviewees frequently spoke about having an open mind: toward an unfamiliar pedagogy, toward groupwork, toward multiple methods, and toward productive persistence. Even students who had always struggled with mathematics experienced successes in this developmental mathematics course, attributing this to what they would come to know as the growth mindset. These successes boosted student confidence and provided motivation for continued persistence. Joe and Mark both described the "not yet" in their learning processes. The students learned that effort, strategy, and help were key elements of the productive struggle, and that the students who persisted gained confidence in their mathematical abilities and moved beyond a state of "not yet" to a deeper level of understanding.

Summary of the Analysis of Data on the Student Learning Experience. The interview data provide descriptions of the students' learning experiences in a developmental mathematics

class that incorporates learning and study strategies. I identified five emergent themes: Doing College, Barriers, Teacher Impact, Groupwork, and Growth Mindset. Within each of the five themes were sub-themes that came out of my analysis of students' descriptions.

I provided evidence of ways that students learned to do college. The sub-themes addressed were: Attendance and Homework, Class Participation, Test Preparation, Academic Support, and Purpose. I provided evidence of ways that students encountered barriers in college. The sub-themes addressed were: Classroom Barriers, Homework, Learning Disabilities, Mathematical Content, Health and Well-Being, and Balancing Acts. I provided evidence of ways that teachers impacted how students describe their learning experiences. The sub-themes addressed were: Teaching Techniques, Student Success, and Mutual Response. I provided evidence of how Groupwork impacted the interviewees. The sub-themes addressed were: Buy-In, Pretenders, Sense of Community, and Synergy. Lastly, I provided evidence of ways that students exhibited a growth mindset. The sub-themes addressed were: Open Mind, Confidence in Ability, and Productive Persistence.

Summary of Qualitative Analysis

Throughout this analysis, I have shared vignettes of students' experiences around mathematics. For many, their journeys were less about mathematics and more about learning to navigate life. Each came with his or her own unique challenges, all very different from their peers. Some overcame the odds and succeeded in the course. Others did not (see Table 38).

Some of those outcomes were surprising, based on their stories and the resilience they demonstrated. Like the literature demonstrates, students of developmental mathematics often

Table 38

Interviewees' Final Course Grades

Teacher	Student Interviewee	Course Grade
Prof. Cambria	Joe	SC
	Lydia	U
Prof. Franklin	Rachel	SC
Prof. Montgomery	Jennifer	SA
Prof. Sullivan	Anna	SA
	Keesha	SC
Prof. Warren	Jamie	SA
Prof. York	Chelsea	S
	Danielle	S
	Mark	S

Note: A grade of "U" is unsatisfactory. A grade of "S" is satisfactory. Some professors further delineate a satisfactory grade with an A, B, or C. (SA for 90-100. SB for 80-89. SC for 70-79.) A minimum overall average of a 70%, as well as a 70% minimum on the final exam, is required to pass Quantway.

come with more than just academic hurdles to overcome. They deal with non-academic life challenges and may not be as equipped as others to handle them, or they may not have an existing support system. The next chapter addresses these issues and the struggles faced by the students in my study in light of recent research in the field of developmental education.

Summary of Research Findings

For my first research question, I investigated the effects of incorporating learning and study strategies in a developmental mathematics course. I utilized LASSI, or Learning and Study Strategies Inventory, as a tool for measuring changes in students' strategic learning skills. LASSI measures strategic learning in three components: skill, will, and self-regulation. Each of the three main components of strategic learning is broken down into three or four related sub-categories called scales. For my second research question, I investigated what insights can be gained from

students' descriptions of their learning experiences in a developmental mathematics course that incorporates learning and study strategies. In this chapter, I provided a quantitative analysis of the participants' LASSI scores, followed by a qualitative analysis of the students' written reflections. In addition to these written reflections, I also presented interview data.

The sense of community that many of the interviewees either directly discussed or alluded to in their descriptions of class underlies two key themes that emerged in the interview data but were virtually non-existent in the survey responses: Teacher Impact and Groupwork. The role of the teacher is important to examine in how successful the students are. In this study, overall student success, defined here as passing the course (with a grade of S, SA, SB, or SC), appears to be related to number of years of teaching experience (see Table 39).

Table 39

Professors' Passing Rates and Experience

Teacher	Number of Quantway Enrollees	Official Withdraw Rate	Passing Rate among Completers	Years of Teaching Experience	Number of Semesters Teaching Quantway
Prof. Bradford	18	0%	53%	6	1
Prof. Cambria	34	24%	58%	20	10
Prof. Franklin	14	57%	33%	8	1
Prof. Montgomery	13	15%	82%	42	0
Prof. Sullivan	31	19%	56%	14	2
Prof. Warren	18	28%	46%	8	1
Prof. York	27	7%	48%	15	4

Note. Completers refers to all students who finished the course and took the final exam.

In a linear regression analysis of years of teaching experience and passing rates, there was a strong, positive correlation with r=0.86 and R^2=0.73. Teaching experience explained 73% of the variance in passing rates. Removing the professor with the most teaching experience, who was in his first semester of teaching Quantway, the correlation was still positive, although slightly weaker, with r=0.5. This finding is consistent with the quantitative findings earlier that indicated a weak, yet statistically significant, relationship between a student's teacher and the midterm/final grade.

My analysis in this study indicates that the participants placed a high level of significance on the teachers. My data tell a different story than I had anticipated. I was examining whether a developmental mathematics course incorporating learning and study strategies had helped the students improve their study skills. I found less evidence of change and growth in that area, but instead found more evidence of change in other areas. The relevance of the mathematics in this course to real life was immensely important to many, especially the older students. Chelsea, however, a younger student, did not feel that way, and even felt the topics were not relevant to her life. Jamie also pointed out a disdain for certain topics, like taxes. She said that she planned to pay people to do those for her, so there was no need for her to learn about that.

The stories told by students indicate more about the importance and impact of a teacher on students' perceptions and on students' sense of belonging. Lydia summed that up when she told me that her teacher's level of interest in her students' success motivated Lydia to be a better student. The investment of the teacher, to create this sense of belonging in the classroom community, led to investment from the students. That is what it is all about. Beyond the content, however, students largely bought into the Quantway model and left the course better prepared for

college, and possibly life, as a result of the experience. In the following chapter, I share how the findings of this study both align with, and deviate from, the existing literature about students of developmental mathematics.

Chapter 5 - Discussion

Reform efforts are underway nationwide in the United States to address the lack of college readiness of first-year college students, particularly in mathematics. About two-thirds of first-year students at community colleges (Bailey, 2009; Clyburn, 2013; Zachry, 2008) require remediation. Among these underprepared students who take the recommended developmental mathematics courses to become college-ready, less than one-third successfully complete these courses, posing a barrier to their access to a college education. The purpose of this study was to investigate the impact of incorporating learning strategies into a quantitative literacy course that was designed for non-STEM students of developmental mathematics.

To conduct this investigation, I gathered both quantitative and qualitative data from participants enrolled in developmental mathematics courses using a reform-oriented curriculum, *Quantway*. Participants took the 60-item *Learning and Study Strategies Inventory (LASSI)* early in the course and again near the end of the course. Upon completing each *LASSI* questionnaire, the 65 participants received immediate results at the computer and were asked to provide written responses to reflection questions about their LASSI results. The reflections on the post-LASSI also asked participants to compare their pre-test and post-test scores. A sub-group of 10 students continued participation in the study by allowing me to interview them at both the start and end of the semester. The two research questions guiding this study were:

- Research Question #1: What effects does taking a developmental mathematics course that incorporates learning and study strategies have on students' strategic learning skills?
- Research Question #2: How do students in a developmental mathematics course incorporating learning and study strategies describe their learning experiences?

In this chapter, I discuss the main findings of this study in relationship to supporting students of developmental mathematics while considering the limited research available in this area. I also discuss the limitations of the study, implications of this investigation for educators, and recommendations for further research.

Discussion of Course Impact on Strategic Learning Skills

The first research question sought to investigate the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills. The LASSI survey was a means to quantify the students' strategic learning and study skills at both the beginning and end of the semester to determine if there were any measurable outcomes. I analyzed the three main components of strategic learning, as measured by LASSI: Skill, Will, and Self-Regulation. In this section, I discuss the findings from the numerical results gathered during the investigation, as well as students' reflections on these results.

I developed this investigation to closely model the research done by Mireles, Offer, Ward, and Dochen (2011). They investigated the impact of incorporating study skills instruction in an intensive summer course that paired developmental mathematics with college algebra in one semester at a four-year college. In their study, the participants' scores pointed to statistically significant, positive changes (on average) in all 10 scales. In contrast to my study, Mireles et al. created their paired course with learning modules and activities that purposefully centered around the skills addressed by LASSI. My study took a pre-existing course, Quantway, developed through research based on the learning needs of non-STEM students of developmental mathematics, but not directly connected to the specific elements assessed with the *LASSI* questionnaire. Although my study did not reveal gains in all scales, like that of Mireles et al., my

findings add support to a growing body of research on the value of incorporating learning and study strategies in courses for students of developmental mathematics.

Although examining the data as three main components of strategic learning did not indicate any statistically significant findings, in my further analysis I found statistically significant changes in mean differences of pre-test and post-test scores for some of the scales assessed by LASSI. When analyzing the 10 individual scales measured by LASSI, the mean differences of significance were not the same for the sample of 65 participants as for the sub-group of 10 interviewees. I found statistically significant changes in the mean differences of pre-test and post-test scores for the 65 participants' Anxiety scale and Information Processing scale over the course of the semester. When limiting the analysis to just the 10 interviewees, I found statistically significant changes in the mean differences of pre-test and post-test scores with respect to the Concentration scale and the Using Academic Resources scale. I discuss these four main findings within the context of the related research on learning and study strategies.

Skill

In the Skill component, consisting of the Information Processing, Selecting Main Ideas, and Test Strategies scales, Mireles et al. (2011) found statistically significant changes in each of these scales. In their study, the mean differences of pre-test and post-test scores with respect to the Information Processing scale displayed the smallest improvement of all ten scales. In their regression analysis, the results of Wadsworth et al. (2007) indicated that improvements in Information Processing were highly predictive of course success but Selecting Main Ideas and Testing Strategies did not contribute to the model. Consistent with the findings of Wadsworth et al. (2007) and Mireles et al. (2011), in my study, the mean differences of pre-test and post-test

scores with respect to the Information Processing scale among the n=65 displayed statistically significant gains, increasing 9% over the semester. The mean differences of pre-test and post-test scores with respect to the Information Processing scale among the 10 interviewees did not change significantly. In contrast to Mireles et al. (2001) but in line with Wadsworth et al. (2007), neither cohort displayed statistically significant changes in mean differences with respect to Selecting Main Ideas or Testing Strategies.

The Information Processing scale assesses a student's ability to take in and make sense of new information by connecting it to what they already know. The participants in my study displayed the second largest gains in this scale, compared to the other scales. In contrast, Mireles et al. (2011) found the smallest gains in this scale, which they attributed to students' "lack of previous content knowledge and thus inability to make the necessary connections." An explanation from a few students in my study might also explain the difference between my findings and those of Mireles et al. Some students in my study noted that what they do already worked for them, so they did not change their methods. While most students with gains did not attribute their gain to anything course-specific, one student gave credit to "doing the work" and to "the instructor." Often, even though students were unable to say what caused changes, they noticed areas of improvement in their learning strategies.

Will

In the Will component, consisting of the Anxiety, Attitude, and Motivation scales, Mireles et al. (2011) found statistically significant changes in each of these scales. In their regression analysis, the results of Wadsworth et al. (2007) indicated that improvements in Motivation were highly predictive of course success, but Anxiety and Attitude did not contribute

to the model. In contrast to both research studies, my study only found statistically significant change in the Anxiety scale. The statistically significant mean differences of pre-test and post-test scores with respect to the Anxiety scale among the n=65 indicate lower levels of anxiety near the end of the course. In my analysis of the Anxiety scale I found an 11.5% reduction in students' levels of anxiety over the course of the semester. The mean differences of pre-test and post-test scores with respect to the Anxiety scale among the ten interviewees did not change significantly. Neither cohort displayed statistically significant changes in mean differences with respect to Attitude or Motivation.

The Anxiety scale measures the degree to which students worry about school and their performance on academic tasks. The participants in my study displayed the largest change in this scale, compared to the other scales. In contrast, the students in the Mireles et al. study demonstrated a significant overall reduction in Anxiety, but it was not the scale with the largest change. No students in my study wrote about the lack of change in their Anxiety scale score, but one student attributed her reduction in anxiety to her teacher and a class activity. She described an article that she had to read for class about managing stress. The Quantway curriculum directs instructors to administer this activity immediately preceding the first major exam in the semester, as it reveals the potential benefits of stress in test-taking situations (Silva & White, 2013). This student reported remembering the article upon entering each exam throughout the semester. She also noted her teacher's role in lowering her anxiety, due to his "no person left behind" attitude.

I did not find any significant gains in the Attitude or Motivation scales. Wadsworth et al. (2007) noted that a possible detriment to motivation was that the developmental course was required and not elected by the students. Several of my participants noted a drop in their

motivation levels upon completing the post-LASSI survey and interview near the end of the semester. My findings lend further support to Mireles' et al. (2011) claim that motivation was lower near semester's end. One student in the Mireles et al. study called it "burnout" with math (p. 18). My participants spoke about feeling overwhelmed and discouraged by the volume of work that needed to be done at that point in the semester, and they felt discouraged.

Self-Regulation

In the Self-Regulation component, consisting of the Concentration, Self Testing, Time Management, and Using Academic Resources scales, Mireles et al. (2011) found statistically significant changes in each of these scales. The regression analysis of Wadsworth et al. (2007) indicated that improvements in both Concentration and Self Testing were highly predictive of course success, but Time Management and Using Academic Resources did not contribute to the model. In my study, however, I found no statistically significant changes in mean differences displayed among the n=65 with respect to these four scales associated with Self-Regulation. Among the 10 interviewees in my study, however, the mean differences of pre-test and post-test scores with respect to both the Concentration scale and the Using Academic Resources scale displayed statistically significant gains in mean differences.

The Concentration scale assesses a student's ability to focus on academic tasks without being distracted. Seven out of 10 interviewees displayed gains in Concentration. Students with weaknesses in Concentration early in the semester did not attribute any elements of improvement to the course, but they did use the survey results to consciously make decisions about productive changes to their study habits. Mark, who gained 35 points from his pre-test to his post-test in Concentration, spoke about how he had "concentrated the wrong way" at the beginning of the

semester. Consistent with student comments in the Mireles et al. study (2011), as the semester progressed, Mark learned new strategies and learned to focus on his academics more effectively. Mireles et al. found the highest percentage of gains for Concentration compared to all scales.

The Using Academic Resources scale measures a student's willingness to seek help and use support services when needed. Six out of 10 interviewees displayed gains in Using Academic Resources. The scores of the other four students remained stagnant, and they said they did not feel they needed additional resources to be successful. In line with the findings of Mireles et al. (2011), my interviewees acknowledged that throughout the semester they became aware of available resources and would use them if necessary.

Summary of Course Impact on Strategic Learning Skills

In contrast to Mireles et al. (2011), while not every area assessed by LASSI showed significant results in my study, four areas did reveal changes in scores. In my analysis of data from all 65 survey participants, I found statistically significant results in both the Anxiety and Information Processing scales. In my analysis of data from the 10 interviewees, I found statistically significant changes in Concentration and Using Academic Resources.

Students' written reflections pointed to some important observations about what students think about the incorporation of learning and study strategies into their developmental mathematics course. The participants identified their strengths and shared how they can use these throughout the semester. They identified their weaknesses and shared how they might overcome them during the semester. Many students shared about gains that could be attributed to the course or to becoming better at being a college student. Consistent with the findings of Mireles et al. (2011, pg. 40), Anna, from my study, reflected on how a combination of strategies (motivation,

time management, and test strategies) helped her to be successful, pointing to the importance that the 10 scales cannot necessarily be disentangled. Some students pointed out a lack of change in various scales because they did not specifically work at improving an area of weakness or because they viewed some traits as innate and unchangeable. Many shared about personal issues that prevented them from improving in various areas during the semester.

In the next section of this chapter, I discuss the qualitative data gathered from both written student surveys and student interviews and address how they provide insights to the four statistically significant changes found.

Discussion of Course Impact on the Student Learning Experience

The second research question investigated the perspectives of students of developmental mathematics to gain insight into how they describe their learning experiences. This is an area lacking in empirical research. Stigler, Givvin, and Thompson (2010) argued that to make meaningful pedagogical changes to developmental mathematics courses, researchers must consider the needs of this population of students. From a social constructivist lens, Mesa (2010) promoted the creation of a curriculum that is relevant to students' needs and life goals. Perin (2011) went further to argue that basic skills instruction must also accompany this instructional shift. Yeager and Dweck (2012) cautioned against implementing curricular reform without implementing support for students' non-academic needs. Bandura (1993) and Pajares (2002) emphasized the importance of the teacher's ability to impact students' habits of thinking and enable students to overcome non-academic factors that pose barriers to academic success. During my study, the importance of both the teacher and a non-traditional, more relevant curriculum

were common themes that emerged as students shared their reflections with me in writing and in interviews.

Since little is known about what students in developmental mathematics think, I used the LASSI to provide these students with an opportunity to reflect on their learning and share their insights. Since its inception, the Pathways have been collecting data on student thinking and continually revise the course to better suit the needs of the non-STEM student requiring a developmental education course. My study provided these students with an opportunity to reflect on and then share their own experiences as they connected to the 10 LASSI scales. While discussing their results with me, students identified aspects of their mathematics course that related to scales being assessed, and they began to share about their experiences in the classroom. These interview data gave me evidence of five additional emergent themes: Doing College, Barriers, Teacher Impact, Groupwork, and Growth Mindset. I discuss the main findings of this analysis while considering the related literature in the next section.

Doing College

Many interviewees shared how returning to school and doing the work required in college were sources of anxiety. Targeted interventions in the Pathways curriculum were developed to help students cope with stress and lower their anxiety while also building a sense of belonging and atmosphere where students were comfortable learning (Clyburn, 2013; Merseth, 2011; Carnegie Foundation for the Advancement of Teaching and Learning, 2017; Yamada et al., 2018). For most dealing with anxiety, as they became better at being a college student, anxiety levels dropped. Some attributed this positive change to specific course activities that

helped them, while others felt that learning how to do college, in general, eased their anxiety over time.

Interviewees shared behaviors that they believed to be important when learning how to do college and become a better college student: Attend class and actively engage in the lesson; do homework; learn how to prepare for tests; seek help when needed; establish study routines; manage your time; have a purpose for being in college. These practices were consistent with the literature review findings of Nagaoka et al. (2013), and they motivated the students.

In addition to having, or developing, a purpose for learning, knowing when to ask for help is an important factor associated with academic performance (Nagaoka et al., 2013). When reflecting on the Using Academic Resources scale from LASSI, several students shared that they preferred to go to their teachers instead of tutoring services. One student explained her growth in this area by saying, "You learn different things over the semester, so you change your way of thinking." While not pointing to anything course-specific, her increase in the Using Academic Resources scale indicates a changed perception in the value of seeking help. The value a student places on learning serves as a motivator to engage and persist in learning (Bandura, 1993; Bonham & Boylan, 2012; Yeager & Dweck, 2012; Silva & White, 2013; Dweck et al., 2014).

Barriers

According to Dweck et al. (2014), academic success is more significantly associated with non-cognitive factors than it is to cognitive ability. Nolting and Boylan (2011) claimed that 25% of student achievement is attributed to a student's ability to manage these non-cognitive factors that impact learning. Many students shared conflicts with their academics and their life responsibilities. More than one-fifth of the students started their semester in Quantway with a

weakness in Time Management, attributing this also to the balance of work, school, and other responsibilities outside of school.

The students in my study described many different barriers that they encountered in college. In the classroom, behavioral problems and lack of notetaking skills deterred learning. Some students faced learning disabilities or difficulties with mathematical content. Others struggled with online homework, finding the content and/or technology to be frustrating. In addition to academic challenges, students frequently commented on external things that got in their way of doing college. Some students lacked access to internet, adding another barrier to completion of course requirements. Balancing family, jobs, money, health concerns, and personal issues were common factors that hindered students' progress in school. Factors both in and out of the classroom impacted students' abilities to learn.

Teacher Impact

The teacher's role is central in social cognitive theory, which underlies productive persistence and combines it with key non-academic factors that impact student learning (Pajares, 2002; Bonham & Boylan, 2012; Yeager & Dweck, 2012) and promote engagement and enjoyment in the learning process. A teacher with high instructional efficacy will motivate and instill academic persistence (Bandura, 1993). Each interviewee spoke about how their teacher impacted their learning experiences. The pedagogy and techniques used in the classroom resonated with these students. Combined with a sense that their teachers truly wanted their students to succeed, the interviewees felt equipped to persist and produce work for their teachers. They all respected their teachers and felt respected *by* their teachers, leading to a sense of community in most of the classes described. The teaching techniques, emphasis on student

success, and establishment of mutual response in the classroom all helped the students to feel supported.

Although each interviewee recognized their teacher as central to their success, Lydia's story stands out here. Lydia believed that her teacher's level of interest in all her students' success motivated Lydia to be a better student. This is consistent with the findings of Engstrom and Tinto (2008) in learning communities. A student in their study reflected that "it is amazing the impact these teachers in the learning community have on students because you have teachers that want to learn from you and they want to talk to you about how you're learning and how you are developing. They just want to show that they really care, like it's sincere and it's not just something to do for a paycheck. It means a lot more and makes you want to view life differently. It makes you want to view life positively because teachers actually care about you (p. 17)." The investment of the teacher, to create a strong sense of belonging and a strong support system in the classroom community, leads to investment from students (Engstrom & Tinto, 2008; Clyburn, 2012; Clyburn, 2013; Silva & White, 2013).

Groupwork

All but one interviewee in my study acknowledged the benefits associated with groupwork in their mathematics class. Not every student understood the value of groupwork at the beginning of the semester. Teachers typically had to establish buy-in from their class and teach students how to engage in problem solving collaboratively. The process created anxiety and even embarrassment for some, causing them to pretend that they understood material when they did not. As the semester progressed and students learned how to work together more effectively, many students described the resulting sense of community and atmosphere of

synergy that evolved within their groups and classrooms. Groupwork was a central, important component of the students' learning experiences.

Some students faced struggles associated with being part of a group. Jennifer shared that she liked groupwork, but she found it hard to concentrate in a group. She also shared how her anxiety affected her ability to interact in a group, undermining her ability to concentrate. Similarly, Jamie shared that she must "be in the mood" to concentrate, potentially posing a barrier to her ability to interact effectively in a group. This points to the complexities of understanding students' lived experiences with developmental mathematics courses.

Despite challenges associated with groupwork, the interviewees all found value in the learning opportunities provided by the collaborative approach to problem solving in their non-STEM developmental mathematics class. Lydia described it as "synergy." Several enjoyed working with classmates. Some spoke to a camaraderie they developed with classmates, and when someone ceased attending class, the other students noticed and felt that loss. This is consistent with the findings of Bandura (2000), Clyburn (2013), Silva and White (2013), and Dweck et al. (2014) which suggested that collaboration in the classroom not only motivates students but also instills a sense of responsibility to the group. Even those students who were not fans of groupwork acknowledged that they could see the benefits to learning in that way and were open to collaboration.

Growth Mindset

An openness to learning is crucial for academic success. Students with a growth mindset possess an openness to learning that enables them to gain confidence in their abilities to learn and hence achieve success in their academic pursuits. Students' reflections about their learning

experiences in Quantway indicate evidence of growth mindset development throughout the semester. The importance of an open mind, increased confidence in one's abilities to learn, and demonstration of productive persistence are all markers for growth mindset. The interviewees frequently spoke about having an open mind: toward an unfamiliar pedagogy, toward groupwork, toward multiple methods, and toward productive persistence. Even students who had always struggled with mathematics experienced successes in this developmental mathematics course, attributing this to what they would come to know as the growth mindset. These successes boosted student confidence and provided motivation for continued persistence. The students learned that effort, strategy, and help were key elements of the productive struggle.

The Pathways were designed around three elements: effort, strategy, and asking for help (Yeager & Dweck, 2012). In particular, the nature of the Quantway lessons involve persisting even when one is not sure what to do until progress is achieved (Merseth, 2011; Clyburn, 2013). Quantway was built upon the theory of productive persistence and a growth mindset philosophy. These theories also underlie a pedagogy aimed at helping students understand that it is okay if they do not yet understand a topic, as long as they continue to try, exercising grit, even in the face of struggles (Duckworth & Seligman, 2005; Dweck et al., 2014). Quantway lessons purposefully give students rigorous tasks that require deep thought but only need basic mathematics to solve. They are intended to be solved in collaboration with classmates, so that students learn to work together and productively persist when tasks are challenging.

Summary of Course Impact on the Student Learning Experience

Students' written reflections and interview comments provided insights into how students in a non-STEM developmental mathematics course describe their learning experiences.

Reflections about their LASSI scores opened up conversations with the interviewees. As students shared their thoughts, they identified elements of their course that may have influenced their outcomes, as well as shared about their classroom experiences. In addition to the 10 scales examined by LASSI, five additional themes emerged: Doing College, Barriers, Teacher Impact, Groupwork, and Growth Mindset.

Doing College involved learning the appropriate behaviors of being a college student. As students became acclimated to college, they felt more comfortable in both social and academic settings. Many students learned to deal with anxiety, a common barrier, as they became more comfortable at college. Barriers, both academic and non-academic, affected most students. Many faced a tension between both learning barriers and issues in their personal lives. Teacher Impact, a central element of social cognitive theory, was mentioned by all interviewees. The students recognized that their teachers cared about their success, and that the teachers of their non-STEM developmental mathematics course created a comfortable atmosphere to engage in problem-solving. All interviewees appreciated the benefits of Groupwork, a central component of the Pathways learning experience. Although some felt nervous or struggled to concentrate while in groups, collaboration often established a camaraderie, even "synergy," among classmates. Those with an openness to learning exhibited development of a Growth Mindset. Students shared that being openminded was essential for success in this class.

Discussion of the Theoretical Frameworks Influencing the Study

The relationship between cognitive and non-cognitive factors must be examined when considering students' success in developmental mathematics. For this reason, I situated this

dissertation study at the intersection of social cognitive theory and a framework for student success, also known as productive persistence.

Social Cognitivism

Pajares (2002) promoted the use of social cognitive theory, on the basis that teachers can improve students' mindsets and correct misguided beliefs about themselves. Teachers and parents must prepare students to face challenges in their learning experiences (Yeager & Dweck, 2012). Careful attention toward the affective factors impacting students must be given to prevent them from becoming barriers to student learning, particularly among students of developmental mathematics (Bonham & Boylan, 2012).

Framework for Student Success (or Productive Persistence)

In addition to psychological factors and non-cognitive factors, institutional, curricular, and pedagogical initiatives also provide a framework for student success. A focus on initiatives that foster non-cognitive skills is necessary for achieving academic success. A pedagogical shift away from "drill and skill" teaching methods towards sense-making learning opportunities that problematize mathematics, allowing students to engage in productive struggles, are crucial for improving success in students of developmental mathematics (Stigler et al., 2010; Merseth, 2011). While educational research suggests both pedagogical and psychological reforms to improve achievement, institutions must also reform and improve how they guide and support students on that journey (Nagaoka et al., 2013). This combination establishes a strong framework for student success in developmental mathematics.

Summary of the Theoretical Frameworks

The findings of my study support the two theoretical frameworks. Both cognitive abilities and non-cognitive factors affect the learning process. This study focused on the non-cognitive factors. The influence of non-cognitive factors and the level of productive persistence that students bring with them to the classroom underlie both their sense of belonging and their ability to learn. The findings of this study will add to the growing body of research on the needs of students of developmental mathematics and what factors influence their learning experiences.

Study Limitations

This study has several limitations. One limitation of the study is sample size. Due to high attrition and potential lack of interest from an initial population of 195 students required to enroll in this developmental mathematics class, a final sample of only 65 students was available at the end of the semester. This also points to the limitation of potential self-selection bias. Although all 195 enrolled students were invited to participate, students had to be motivated to volunteer and then stay motivated to continue with all phases of the study.

Results could also potentially be skewed since the students who volunteered to participate and completed the full semester in the course may be more motivated than those who either chose not to participate or discontinued participation along the way. Generalizations about persistence may therefore be limited, given that the population that completed both the pre-LASSI and post-LASSI as well as completed the course is likely more persistent than the overall population of students enrolled in this course. A longitudinal study over multiple semesters at one institution would yield a larger sample size from which to support the claims of this study.

Another limitation is that the LASSI is a self-reporting measure. Although vetted and well-respected, my findings and recommendations still come at the mercy of students' responses to the survey questions. It is also impossible to untangle changes that resulted from participating in the LASSI from changes that may have occurred due to taking this developmental mathematics course. The written reflections and interview components, however, were intended to gain a deeper assessment that would validate or raise questions about LASSI results and students' learning experience. These supporting instruments could be refined for future studies. Despite the existing limitations, the study still provides insights about the perceptions of students of developmental mathematics on their learning experiences.

Suggestions Arising from the Study

Teachers can improve student mindsets, promoting improvements to academic skills and learning behaviors (Pajares, 2002; Yeager & Dweck, 2012). This can ultimately equip students with the skills needed for success in their lifelong learning endeavors beyond their current classes. My study adds to the larger body of literature in support of the recent quantitative literacy initiative to help underprepared students succeed in college. The results of this LASSI analysis lend support to Carnegie Foundation's claims that reform-oriented curricula in both quantitative literacy and statistics is helping students succeed in mathematics and in coursework beyond this developmental-level course. Since my findings align with those of Carnegie Foundation, this both adds validity to my study and provides more evidence of how to help students of developmental mathematics in a field with limited research in this area. Furthermore, the instructional strategies and emerging best practices that have been effective with students of developmental education may also benefit a broader population of students.

Learning and Study Strategies for All

The research studies of Mireles et al. (2011) and Wadsworth et al. (2007) involving the LASSI both involved algebra curriculum. My study extends their findings that incorporating learning strategies into algebra curriculum impacts students by showing that reform-oriented quantitative literacy courses can also have a similar impact. Improved learning and study strategies will help the students of developmental mathematics to successfully complete future coursework, ultimately raising the number of students who continue their college education and graduate from college. As suggested by the Guided Pathways movement for systemic changes in education (Bailey et al., 2021), all professors should share the work of preparing first-year students to do college-level work. Incorporating the learning and study strategies that have been effective with students of developmental education into other first-year courses may also extend the resultant benefits to a broader population of students.

Effective Learning Experiences for All

I offer the same suggestion regarding the learning environment that my study found to be effective. Consider the five emergent themes that I discussed. Although some students may already know how to "do college" from an academic standpoint, coming to college with strong learning strategies, students like those in my study can still benefit from support systems that help acclimate them to campus resources. All students face barriers on their journey to graduation and can benefit from both academic and non-academic support as they learn the resiliency needed to work to overcome those barriers (Yeager & Dweck, 2013). The teacher's impact on the learning experience is not only important for struggling learners. All learners can benefit from quality instruction (Bloom, 1976), including the increased practice of collaboration

in classes. The lessons learned from the learning communities research (Engstrom & Tinto, 2008; Mesa, 2010) and the initial Pathways research, for instance, reveal the power of groupwork and active learning to build community and create a sense of belonging as post-secondary learners share in the responsibility of learning. All students with an open mind and a willingness to engage can benefit from this practice. Students at all levels can also benefit from instruction on productive persistence and academic tenacity. First-year students with higher-level abilities may come to college with a fixed mindset and could have their learning experiences, and lives, transformed by exposure to the concept that mindsets are malleable. Once again, instructional strategies and emerging best practices that have been effective with students of developmental education may also benefit a broader population of students.

Recommendations for Future Research

As I suggested in the previous section, all students benefit from meaningful learning experiences; therefore, faculty need ongoing professional development. Teachers need professional development to learn effective ways of fostering this type of learning environment among students of developmental education. My investigation did not observe types of pedagogies as I did not collect classroom data. Although my participants shared elements of effective pedagogical moves from their professors, more studies are needed to explore effective strategies that will positively impact learning as well as enhance the classroom experience for this student population. Future studies should consider the inclusion of a control group to help identify the effectiveness of various pedagogical moves among students of developmental education.

My study points to growing evidence that teachers need support in the task of reforming developmental education. My research results illuminate the importance of the effect a teacher can have on student outcomes. Not only did my quantitative data showed the highest course success rates among the most experienced teachers (see Table 48), but my qualitative results also provided numerous reflections from students on the importance of the teacher to their successes, even from students who did not pass the course. Bailey et al. (2021) advocated for investment in community college professors to equip them with ways to provide rich, meaningful mathematical experiences in the classroom. Furthermore, active learning experiences, like those implemented in Quantway, have been shown to be positively associated with undergraduate motivation, successful completion of developmental and college-level coursework, and persistence to graduation (Bailey et al., 2021; Engstrom & Tinto, 2008; Theobald et al., 2018).

Both new and seasoned teachers need ongoing training and opportunities to discuss pedagogical methods for building community and creating a sense of belonging in the classroom. In my study, Lydia emphatically told me that "A professor matters." She discussed how a teacher's investment in her students can lead to a student's investment in both the teacher and the course. For this reason, the educational system must invest in professional development for teachers. All participating Pathways colleges are involved in continuous collective educational reform efforts, nationally, through participation in Carnegie Foundation's Network Improvement Community (Clyburn, 2013). Similarly, community college educators could benefit from forming such networks, even at the local level, creating teams who can share teaching ideas on a regular basis. Implementation can begin on a small scale, at the department level, and the

collaborative work among colleagues can expand in time. These interactions have the potential to advance ongoing reform endeavors, benefitting both teachers and students at all levels.

My research should also be expanded to college-level courses, too. Quality instruction benefits students of all levels. Studies should compare and contrast the pedagogical techniques that are effective for each population: developmental and college-level. As I have discussed, students of developmental mathematics have unique learning needs, but good teaching is something that can appeal to a variety of learners. What other characteristics of a teacher might be important? How do we teach educators to adapt their practice to better meet students' needs?

Additionally, another study could investigate specific elements of a mathematical literacy course. What elements in the curriculum are leading to the gains experienced by students? The pedagogical methods of the *Pathways* model are not new concepts. Active learning and productive struggle have been documented for decades, under different names. The blending of these pedagogical techniques with the instruction of learning strategies, support for non-cognitive needs, and general knowledge about how to thrive in a college environment, merge together individual initiatives that have already demonstrated effectiveness and been documented in the literature. Not only does the combination of each of these elements strengthens developmental education (Bailey et al., 2009), but the same combination could also provide insights to improving the quality of education in college-level courses.

Imagine a culture, in education, where time for this kind of work was valued. Imagine how much change educators could bring about if time was built into teaching schedules to allow for collaboration with members of various network improvement communities, instead of just at monthly department meetings or one-day summer in-services. Educational reforms, like the

Pathways initiative, for instance, did not scale up to the level of success they have reached by meeting once a month.

Summary

The twofold purpose of this study was to investigate the effects of a developmental mathematics course that incorporates learning and study strategies on students' strategic learning skills and to gain insights about the learning experiences of these students of developmental mathematics. A learning strategies inventory called the *LASSI* questionnaire was used as a tool to explore this impact on students of developmental mathematics who were enrolled in a non-STEM class called *Quantway*. Students' changes to pre-LASSI and post-LASSI scores showed that students' levels of anxiety significantly decreased over the course of the semester. Survey participants showed gains in Information Processing, and the 10 interviewees experienced gains in both Concentration and Selecting Main Ideas. In addition to improvements noted in the learning strategies assessed by the LASSI, students' reflections, both written and spoken, pointed to the significant impact of the teacher on the learning experience, as well as an appreciation for both a curriculum that was relevant to their lives and also the opportunity to have experienced meaningful collaborations over mathematics with their classmates.

More research is needed on what students think about and experience in their developmental mathematics education. Leading researchers call for an examination of both the academic and non-academic needs of community college students of developmental mathematics. Carnegie Foundation created the *Pathways* curricula, which includes the reform-oriented, non-STEM quantitative literacy course, *Quantway*, that was central to my study. My findings provide insights that point to opportunities for both teachers and educational

researchers. While evidence emerged for the incorporation of learning strategies in mathematics curriculum, the importance of a teacher's ability to foster a sense of community and sense of belonging among students is also significant. It may even be possible that the teacher is the ultimate intervention impacting student success.

The work of Stigler et al. (2010), Mesa (2010), Perin (2011), and Carnegie Foundation are situated at the intersection of two theoretical perspectives on learning: social cognitive theory and the framework for student success/productive persistence. These perspectives provided the underlying framework for this investigation. As educators and institutions work together to help students succeed, new innovations are always on the horizon. It is important to approach new initiatives with a historical lens through the research literature, noting both the successes and shortcomings of past initiatives as we try new approaches.

Appendix A: Sample *LASSI* report comparing pre & post results of Danielle

LASSI

Advising/Counseling Report

"Danielle"	
Pre-Test Date: *Week 2 Spring 2017*	Post-Test Date: *Week 14 Spring 2017*

This report provides pre- and post-test LASSI scores as well as the percentage of change in raw scores for Danielle. The second half of this report shows individual item responses on both the pre- and post-tests.

Compare Pre/Post Test Scores

Scale	Pre-Test Percentile	Post-Test Percentile	Pre-Test Raw Score	Post-Test Raw Score	% Change Raw Score
ANX	20	20	13	13	0%
ATT	65	99	26	30	15%
CON	90	99	26	30	15%
INP	50	95	22	29	32%
MOT	99	99	30	30	0%
SMI	70	85	24	26	8%
SFT	50	95	18	29	61%
TST	50	95	21	28	33%
TMT	85	99	24	30	25%
UAR	95	99	29	30	3%

Compare Pre/Post Item Scores

Pre-Test Item Score	Post-Test Item Score	Anxiety Scale (ANX)
2	1	28. I feel very panicky when I take an important test.
1	1	34. When I am taking a test, worrying about doing poorly interferes with my concentration.
5	5	37. I worry that I will flunk out of school.
1	2	50. Even when I am well prepared for a test, I feel very anxious.
1	3	53. Courses in certain subjects, such as math, science, or a foreign language, make me anxious.
3	1	56. When I am studying, worrying about doing poorly in a course interferes with my concentration.
(1 lowest - 5 highest)		

Pre-Test Item Score	Post-Test Item Score	Attitude Scale (ATT)

4	5	14. I only study the subjects I like.
5	5	29. I have a positive attitude about attending my classes.
5	5	32. I would rather not be in school.
5	5	39. I do not care about getting a general education, I just want to get a good job.
4	5	42. I dislike most of the work in my classes.
3	5	59. In my opinion, what is taught in my courses is not worth learning.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Concentration Scale (CON)**
4	5	6. I concentrate fully when studying.
4	5	13. I find it difficult to maintain my concentration while doing my coursework.
4	5	25. My mind wanders a lot when I study.
5	5	40. I find it hard to pay attention during lectures.
5	5	47. I am very easily distracted from my studies.
4	5	58. If I get distracted during class, I am able to refocus my attention.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Information Processing Scale (INP)**
5	5	3. I try to find relationships between what I am learning and what I already know.
5	5	10. To help me remember new principles we are learning in class, I practice applying them.
2	5	18. To help me learn the material presented in my classes, I relate it to my own general knowledge.
4	5	22. I translate what I am studying into my own words.
1	4	35. I try to see how what I am studying would apply to my everyday life.
5	5	41. I try to relate what I am studying to my own experiences.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Motivation Scale (MOT)**
5	5	1. Even when study materials are dull and uninteresting, I manage to keep working until I finish.
5	5	17. When work is difficult, I either give up or study only the easy parts.
5	5	24. Even if I am having difficulty in a course, I can motivate myself to complete the work.
5	5	31. Even if I do not like an assignment, I am able to get myself to work on it.
5	5	33. I set goals for the grades I want to get in my classes.
5	5	45. I do not put a lot of effort into doing well in my courses.
(1 lowest - 5 highest)		

Pre-Test Item Score	Post-Test Item Score	Selecting Main Ideas Scale (SMI)
5	1	9. During class discussion, I have trouble figuring out what is important enough to put in my notes.
4	5	16. I have difficulty identifying the important points in my reading.
4	5	19. There are so many details in my textbooks that it is difficult for me to find the main ideas.
3	5	44. When studying, I seem to get lost in the details and miss the important information.
4	5	48. It is hard for me to decide what is important to underline in a text.
4	5	55. When I listen to class lectures, I am able to pick out the important information.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Self Testing Scale (SFT)**
2	5	15. When preparing for an exam, I create questions that I think might be included.
3	5	20. I review my notes before the next class.
4	5	26. I stop periodically while reading and mentally go over or review what was said.
2	5	38. To help make sure I understand the material, I review my notes before the next class.
3	4	49. To check my understanding of the material in a course, I make up possible test questions and try to answer them.
4	5	52. I test myself to see if I understand what I am studying.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Test Strategies Scale (TST)**
3	4	5. In taking tests, writing papers, etc., I find I have misunderstood what is wanted and lose points because of it.
4	5	21. I have difficulty adapting my studying to different types of courses.
3	5	30. When I study for a test, I have trouble figuring out just what to do to learn the material.
2	4	36. I have trouble understanding exactly what a test question is asking.
5	5	43. I review my answers during essay tests to make sure I have made and supported my main points.
4	5	57. I do poorly on tests because I find it hard to plan my work within a short period of time.
(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Time Management Scale (TMT)**
4	5	4. I find it hard to stick to a study schedule.
4	5	8. When I decide to study, I set aside a specific length of time and stick to it.
4	5	11. When it comes to studying, procrastination is a problem for me.
5	5	23. I put off studying more than I should.
4	5	51. I set aside more time to study the subjects that are difficult for me.
3	5	54. I end up "cramming" for every test.

(1 lowest - 5 highest)		
Pre-Test Item Score	**Post-Test Item Score**	**Using Academic Resources Scale (UAR)**
5	5	2. When it is difficult for me to complete a course assignment, I do not ask for help.
5	5	7. When I am struggling in one or more courses, I am too embarrassed to admit it to anyone.
5	5	12. If I am having trouble with a writing assignment, I seek help from resources available at my college such as the writing center, learning center, or tutoring center.
5	5	27. I am not comfortable asking for help from instructors in my courses.
5	5	46. If I find that a course is too difficult for me, I will get help from a tutor.
4	5	60. When I do not understand how to use a method or procedure presented in one of my courses, I ask another student to teach me so that I can do it on my own.
(1 lowest - 5 highest)		

Appendix B: LASSI Pre-Post Achievement Measure

LASSI Pre-Post Achievement Measure

- *Write your name on the BACK of this paper.*
- *Please record your percentile scores for each scale in the appropriate column.*

10 LASSI Scales for Strategic Learning	LASSI One	LASSI Two
The Skill Component		
Information Processing	_____	_____
Selecting Main Ideas	_____	_____
Test Strategies	_____	_____
The Will Component		
Attitude	_____	_____
Motivation	_____	_____
Anxiety	_____	_____
The Self-Regulation Component		
Concentration	_____	_____
Time Management	_____	_____
Self-Testing	_____	_____
Using Academic Resources	_____	_____

Appendix C: Mathematics Information Pre-Survey

Mathematics Information Survey:

Reflections on Your Pre-LASSI Achievement Measure

1. Which of the 10 scales would you consider to be your strengths?

2. How will you use your strengths to help you succeed this semester?

3. Which of the 10 scales would you consider to be your weaknesses?

4. What can you do to overcome these areas of weakness this semester?

5. How can you use the information from your pre-LASSI scores for your benefit during the upcoming semester?

Appendix D: Mathematics Information Post-Survey

Mathematics Information Survey:

Reflections on Your Post-LASSI Achievement Measure

1. What areas do you feel you made the most progress in?

2. What areas do you feel you made the least progress in?

3. What are reasons for why some of your scores changed over the semester?

4. What are reasons for why some of your scores did NOT change over the semester?

5. How can you use the information from your post-LASSI scores for your benefit as you move beyond this semester?

Appendix E: Faculty Information Sheet

Faculty Information Sheet

Neatly PRINT
your name: _____

Please complete all questions, as you feel comfortable.
***(All information provided on this sheet will remain confidential.*)**

1. How many years of teaching experience do you have? _____

2. How many full semesters of Quantway have you taught (*not* including the current semester)? _____

3. What form of training did you participate in prior to ever teaching Quantway?

   Check all that apply:

   _____ conference in San Francisco

   _____ conference in Saratoga Springs

   _____ online training on the hub

   _____ training at OCC when Quantway was first piloted

4. What form of training have you participated in since you started to teach Quantway?

   Check all that apply:

   _____ conference in San Francisco

   _____ conference in Saratoga Springs

   _____ online training on the hub

Appendix F: Student Information Sheet

Student Information Sheet

Student ID#: _____ **Office Use Only:**

Prof:_____

Neatly PRINT
your name: _____

Room:_____

Mtg.Time: _____

Please complete all questions, as you feel comfortable.

***(All information provided on this sheet will remain confidential.*)**

1. Gender _____

2. Age _____

3. Ethnicity _____

4. Year enrolled at the college _____

5. How many semesters have you attended OCC *before* this semester? _____

6. What is the highest level of math you took *before* college? _____

7. How long has it been since you were in a math class? _____

8. Is this your first time taking this math course? _____ yes _____ no

   If **NO**, how many times did you attempt it *before* this semester? _____

9. I am enrolled in school: _____ full-time _____ part-time

10. I receive financial aid. _____ yes _____ no

11. I graduated from high school. _____ yes _____ no

If **YES,** what year? _____

If **NO**, please answer the following:

I have a GED. _____ yes _____ no

I am currently working on my GED. _____ yes _____ no

12. Have you ever used the Learning Center at OCC for tutoring? ____ yes ____ no

13. Are you employed? _____ yes _____ no

If **YES,** how many hours do you work each week? _____

14. Do you have children? _____ yes _____ no

If **YES,** how many? _____

What are the ages of your children? _____

15. Do you grant your teacher permission to share your midterm and final grade with the SU researcher? _____ yes _____ no

16. Are you interested in being interviewed by the SU researcher about this study? _____ yes _____ no

Appendix G: LASSI Codebook

Main Components of Strategic Learning	Related LASSI Scales	Description of what is assessed *(from LASSI manual)*	Sample questions being assessed by test items
Skill	Information Processing **(INP)**	how well students' can use imagery, verbal elaboration, organization strategies, and reasoning skills as learning strategies to help learn new information and skills. These strategies are also used to build bridges between what students already know or believe and what they are trying to learn and remember.	Do students try to summarize or paraphrase their class reading assignments? Do they try to relate what is being presented in class to their prior knowledge?
	Selecting Main Ideas **(SMI)**	students' thinking skills for identifying important information for further study from less important information and supporting details.	Can students identify the key points in a lecture? Can they decide what is important to underline in a textbook?
	Test Strategies **(TST)**	students' use of both test preparation and test taking strategies.	Do students know how to study for tests in different types of courses? Do they review their answers to essay questions?
Will	Anxiety **(ANX)**	the degree to which students worry about school and their academic performance.	Do students worry so much that it is hard for them to concentrate? Are they anxious even when they are well-prepared?

	Attitude **(ATT)**	students' attitudes and interests in college and achieving academic success.	Do students only study for the courses they like? Is college really important or worthwhile to them?
	Motivation **(MOT)**	students' diligence, self-discipline, and willingness to exert the effort necessary to successfully complete academic requirements.	Are students willing to put in the effort necessary to succeed on academic assignments? Do they easily "give up" in difficult classes?
Self-Regulation	Concentration **(CON)**	students' ability to direct and maintain their attention on academic tasks.	Are students easily distracted? Can they direct their attention to academic tasks?
	Self Testing **(SFT)**	students' use of comprehension monitoring techniques, such as reviewing or paraphrasing, to determine their level of understanding of the information or skill to be learned.	Do students create and respond to questions that might be asked on a test? Do they stop periodically while reading to review the content?
	Time Management **(TMT)**	students' use of time management principles and practices for academic tasks.	Do students procrastinate about completing academic tasks? Do they strategically manage their time for studying?
	Using Academic Resources **(UAR)**	students' willingness to use different academic resources such as writing centers, tutoring centers and learning or academic support centers, when they encounter problems with their coursework or performance.	Do students go to a resource center for guidance? Do they avoid going for help?

OTHER (non-specific to LASSI items)	Teacher Impact **(TCH)**	students' acknowledgement that teacher has an effect (either positive or negative) on the learning process	N/A
	Groupwork **(GRP)**	students' acknowledgement of the group work aspect of the course having an impact (either positive or negative) on the learning process	N/A
	Evidence of Change **(CHG)**	the emergence of new and/or altered perceptions about some aspect of the course or the learning experience	N/A

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