

## AN ABSTRACT OF THE DISSERTATION OF

Brandon I. Muranaka for the degree of Doctor of Philosophy in Education presented on June 10, 2019.

Title: Positive Emotions and Community College Developmental Mathematics Achievement.

Abstract approved:

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Darlene F. Russ-Eft

Developmental mathematics and the completion of degrees have been at the forefront of community colleges in recent years. Positive psychology has given rise to the Broaden-and-Build Theory of Positive Emotions. The purpose of this study is to study the relationship between positive emotions and developmental mathematics achievement at the community college through the lens of the Broaden-and-Build Theory of Positive Emotions.

Students enrolled in developmental mathematics courses were surveyed using the modified Differential Emotion Scale at a large suburban community college as part of a correlational study. Survey results were collected and a positivity ratio (ratio of positive emotions to negative emotions) was calculated. The college site provided student end of semester grades and student demographic information.

The data were analyzed using correlation and linear regression. This study found that there was not a significant correlation between the positivity ratio and the student final grades for students that completed all survey administrations (N=82).

However, male students (N=30) showed a correlation between positivity ratio and final course grade. Students with a positivity ratio above 3:1 (N=7) showed a significant negative correlation with final grades. Linear regression for the male and high positivity ratio group showed statistically significant predictability between positivity ratio and final grades.

Overall, this study concluded that there is a need for research relating positive emotions and community college developmental mathematics achievement, especially studies that have larger sample sizes. Practical implications of this study include consideration to emotional well-being of students at the community college, professional development for faculty and staff on the benefits of positive emotions, and the creation of a positive classroom environment for students at the community college. Additionally, interventions may consider targeting specific populations such as male students, students with high positivity ratio, and potentially Asian students.

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Positive Emotions and Community College Developmental Mathematics  
Achievement

by  
Brandon I. Muranaka

A DISSERTATION

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Dean of the College of Education

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Dean of the Graduate School

I understand that my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Brandon I. Muranaka, Author

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## DEDICATION

To my grandparents, Sam and Sally Muranaka, Shig and Lillian Kuroda.

## **Chapter 1**

### General Introduction

This chapter presents a general introduction to the dissertation. The focus and significance of the dissertation are presented, followed by the purpose of the study, the research question, and the significance of the study, specifically the practical, scholarly and social significance of this study.

#### **Focus and Significance**

Data indicate that completion rates of developmental mathematics education in community colleges could be improved. An investigation using data from the National Education Longitudinal Study (NELS:88 study) where in a representative sample of eighth-grade students were tracked through college, it was found that 30% of students passed all of the developmental mathematics courses in which they enrolled at community college (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009). Additionally, a study of remedial mathematics in the California Community College System found that about 75% of students do not successfully remediate, and of those, about 82% do not complete a credential or transfer (Bahr, 2008). The results are even worse for students assessing far below college level; only 16% of students assessing three levels below college level complete their mathematics sequence within three years (Bailey, 2009). In California about 33.7% of students assessing three levels below college level mathematics eventually completed a college level mathematics course within an eight year period (California Community College Chancellor's Office [CCCCO], 2012).

Not only is it difficult to successfully remediate, certain demographic groups also appear to be disproportionately impacted with respect to remediation. Bahr (2010) used the California Community College system data to identify the most numerous student groups racial/ethnic group (White, Black, Hispanic, and Asian), along with data on age, sex, and tracking information. The desired outcome of achievement was the completion of a college-level mathematics course (defined to be at or above the level of college algebra). The author found that over a six year period 11.75% of Black students and 20.28% of Hispanic students successfully remediated in mathematics (completed a college-level mathematics course) in the California Community College System, compared to 28.99% for White students and 33.69% for Asian students. Also, for those students starting at the lowest levels of developmental mathematics basic arithmetic and pre-algebra, the author found that 6.88% and 13.44%, respectively, of students successfully remediated over a six year period. Additionally, Bahr showed that Black students were overrepresented in the lowest level of mathematics with 40.75% of the Black students in the study starting at the lowest level. The results showed disparities in the California system, while accounting for student preparedness, between racial groups. Further study is needed to address these achievement differences in these groups and perhaps using the philosophical foundation of positive psychology can help.

Bahr (2008) studied the California Community College System's remedial mathematics success and effectiveness in preparing students for college level work. He found that students that complete remedial level mathematics sequences were just as successful at completing the college goals of transfer, degree, or certificate, as



students that did not need remediation. These data of nearly 86,000 California community college freshmen were significant in showing that completing remedial mathematics education does lead to success, provided the student completes the remedial mathematics sequence. Thus, finding ways to improve student remediation rates, and reduce disproportionate impact, could potentially improve student completion. Given these data and with a call from the past President for completion and increasing the number of degrees earned by 2020 (Obama, 2009), getting students through their remedial sequences in mathematics is a higher priority for higher education than ever. Rather than focusing on the characteristics of students that are not completing, perhaps it is time to focus on the characteristics of those students that are successful and have characteristics that can be fostered for greater success.

One way to improve remediation rates can be found within the area of positive psychology which has placed emphasis on “nurturing what is best” (Seligman & Csikszentmihalyi, 2000, p. 7) rather than focusing on treating pathologies. Following this thinking, Fredrickson (1998, 2004) developed the Broaden-and-Build Theory of Positive Emotions which states that positive emotions can, among other things; broaden attention and thinking, undo negative emotions, fuel resiliency, and build personal resources. The goal of this study is therefore to begin the investigation of positive emotions and achievement in developmental mathematics, rather than focus on the challenges and road blocks to achievement. As Fredrickson's theory points out, positive emotions contribute to cognitive development and resiliency, two key components of achievement in developmental mathematics.

### **Purpose of the Study**

The treatment goal of positive psychology is “not just fixing what is broken; it is nurturing what is best” (Seligman & Csikszentmihalyi, 2000, p. 7). With this in mind, the purpose of this study is to investigate the relationship between positive emotions and student achievement in community college developmental mathematics. Through the lens of Fredrickson’s (1998, 2004) Broaden-and-Build Theory and a post-positivist philosophical approach (Borg & Gall, 1989; Schutt, 2004) this study hopes to identify a relationship between positive emotions experienced by an individual and course success community college developmental mathematics. The results of this study will provide a baseline from which to pursue further study towards “nurturing what is best” for developmental mathematics at the community college.

### **Research Question**

According to Fredrickson and Losada (2005) the *positivity ratio* for an individual is the number of positive or pleasant feelings compared to the number of negative or unpleasant feelings experienced over time. This ratio is tied to research in a theory of positive psychology known as the Broaden-and-Build Theory of Positive Emotions (Fredrickson, 1998, 2004). The present study seeks to examine the relationship between the positivity ratio and student achievement in community college developmental mathematics course work.

**Question.** What is the relationship between Fredrickson and Losada's (2005) positivity ratio and student achievement in community college developmental mathematics course work?

***Rationale.*** According to the Broaden and Build Theory of Positive Emotions, positive emotions lead to human flourishing (Fredrickson, 1998, 2004). Human flourishing includes a broadened mindset and actions which build over time. In the context of remedial mathematics, human flourishing can refer to successful remediation, because with a broadened mindset students can build upon previous mathematical knowledge over time. With this in mind, the goal of this study is to seek evidence of a relationship between the positivity ratio and successful completion of community college developmental mathematics courses. Specifically, Fredrickson and Losada (2005) defined the positivity ratio as the ratio of positive emotions to negative emotions and found that a positivity ratio of approximately 3 to 1 is sufficient to seed human flourishing. Utilizing this positivity ratio as a measurement of positive emotion, a correlation between a student's positivity ratio and achievement in a mathematics course can be explored.

***Null Hypothesis.*** The null hypothesis is that there will be no significant correlation between the positivity ratio and student final grades in developmental mathematics courses.

***Alternative Hypothesis.*** The alternative hypothesis is that there will be a significant correlation between a measured positivity ratio and student final grades in developmental community college mathematics courses.

### **Significance of the Study**

The current study is significant for both practical and scholarly reasons. These reasons are outlined in the following subsections.

**Practical significance.** Bonham and Boylan (2011) acknowledged that there are challenges in developmental mathematics education; however, there are also many promising practices. When discussing the value of the affective factors related to developmental mathematics education, Bonham and Boylan stated that students, faculty, and support staff “should be familiar with and employ strategies to help alleviate mathematics anxiety, build self-confidence, and maximize student learning in mathematics” (p. 4). The results of this study could provide evidence for the development of positive emotion interventions for students in developmental mathematics courses.

Meyer and Turner (2002) reviewed the findings from their previous qualitative work and found that emotions played an integral part in the classroom setting. In particular, the authors reviewed previous work (Turner, Meyer, Cox, Logan, DiCintio, & Thomas, 1998) and found that results “highlighted the importance of emotions for understanding student involvement in learning from the instructional perspective” (Meyer & Turner, 2002, p. 110). The authors also concluded that “teachers' explicit responses and demonstrations of their personal positive emotions and motivation as learners are evident both as features of instructional context and as correlates of student reports of positive affect and motivation to learn” (p. 112). These conclusions further emphasize the importance of positive emotion research in the pedagogical context. The results of the present study could be used as evidence for the infusion of new classroom practices in the community college setting, namely practices that promote positive emotions.

**Scholarly significance.** Current work has shown the value of positive emotions and positive mood. Bryan and Bryan (1991) have shown how induced positive mood created higher test results on a short mathematics test for junior high and high school students. However, the students in the study were students with learning disabilities. Expanding upon their work and the work of many others, Fredrickson (1998, 2004) proposed the Broaden-and-Build Theory of Positive Emotions, which posits that positive emotions can broaden an individual's attention and thinking, undo negative emotions, fuel resiliency, build personal resources, trigger well-being, and seed flourishing. The results from this study could expand the work of Bryan and Bryan (1991) to a new population (community college developmental mathematics students) and add to the large body of work supporting Fredrickson's (1998, 2004) Broaden-and-Build Theory.

Meyer and Turner (2002) concluded that emotions played an integral piece in student motivation in the classroom setting. As a result of their review of previous qualitative studies, Meyer and Turner (2002) stated “we seek theories that will help us research and better understand how emotion is intertwined with motivation and cognition within the context of classroom learning.” (p. 112). O'Regan (2003) also called for theory to address the critical role of emotions in the learning process. By seeking a relationship between positive emotion and success in a developmental mathematics classroom in a community college setting, the results of the present study could add to this theory within educational psychology.

Furthermore, while many positive emotion studies have been conducted with college age university students (Fredrickson & Branigan, 2005; Fredrickson & Joiner,

2002; Fredrickson & Losada, 2005; Fredrickson, Tugade, Waugh, & Larkin, 2003; Rowe, Hirsh, & Anderson, 2007; Staus, 2012) and K-12 students (Austin, 2005; Ahmed, van der Werf, Kuyper, & Minnaert, 2013; Bryan & Bryan, 1991; Bryan, Mather, & Sullivan, 1996; Grootenboer & Hemmings, 2007; Hannula, 2002; Hemmings, Grootenboer, & Kay, 2011; Yasutake & Bryan, 1995), very few have been conducted with community college students (Watts, 2011). Considering that approximately 12 million students enrolled in credit and non-credit courses in community colleges in the United States in Fall 2017 (American Association of Community Colleges [AACCC], 2019), this is a large population that is currently understudied. Even with a focus on developmental mathematics students, there is a sizable population of students that has been overlooked in positive emotion research. This gap in the research provides a final scholarly significance to studying the relationship between positive emotions and developmental mathematics community college student achievement.

**Social significance.** As Bahr (2010) found in the California Community College System over a six year period 11.75% of Black students and 20.28% of Hispanic students successfully remediated in mathematics (completed a college-level mathematics course), compared to 28.99% for White students and 33.69% for Asian students. There is also an over representation of Black students at the lowest level of mathematics (40.75% of the Black students in the study starting at the lowest level). Being over represented in the lowest level and the lowest level students having the lowest completion rates is unacceptable. These disparities in the California Community College system have led to a clear disproportionate impact on

students of color. Keeping these data in mind, this study will track differences in student demographic groups with the hope of finding new motivation for different and innovative approaches to developmental mathematics in the community college system.

The current disproportionate impact is a national concern as well, Bailey, Jeong, and Cho (2010), in a study of students enrolled at Achieving the Dream Colleges over a three year period, noted that African American students were less likely to pass on to a higher level developmental mathematics course than their White counterparts (0.67-0.91 times likely). The authors also noted that in addition to African American students, male students, part-time students, or students with vocational areas of study were all less likely to complete the developmental mathematics sequence. Seeking new and different ways to analyze student achievement will be key in motivating changes to pedagogy in developmental mathematics.

### **Organization of the Dissertation**

The first manuscript discusses the literature review and provides the background of the study. The second manuscript discusses the methods used in the study and present the results of the study. The third manuscript provides an overview of the results, a discussion on the limitations of the study, directions for future research, and concludes with implications for practice. A final manuscript of personal self-reflection concludes the dissertation.

### **Summary**

The purpose of this study is to investigate the relationship between positive emotions and developmental mathematics student achievement in the community college. The hypothesis to be tested is whether there exists a positive correlation between the positivity measure of positive emotions and student achievement in developmental mathematics. The results of this study address the practical significance of adding to the need to improve student success in developmental mathematics at community college across the nation and addressing the best practice of being aware of affective factors in the classroom, thus impacting classroom practices. The scholarly significance of this study would add to the Broaden-and-Build Theory of Positive Emotions, by providing an analysis of a population not explored in current research.



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## Chapter 2

### First Manuscript: Literature Review

Students enrolled in community college face many challenges to their completion of degrees, certificates, and transfer. Among those obstacles to completion is developmental mathematics coursework. Approximately, 30% of students who require remediation in mathematics do not complete their remedial course sequence within three years (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009; Bailey, Jeong, & Cho, 2010). The current environment in community colleges and the desire of the past President to have greater completion by 2020 (Obama, 2009) make students' successful completion of developmental mathematics a high priority. Rather than focusing on the characteristics of students that are not completing, perhaps it is time to focus on the characteristics of those students that are successful and have behaviors that can be fostered for greater success.

The field of positive psychology may provide some answers towards improving student persistence and completion. An emphasis on "nurturing what is best" (Seligman & Csikszentmihalyi, 2000, p. 7) rather than on treating pathologies is the focus on positive psychology. Following this thinking, Fredrickson (1998, 2004) developed the Broaden-and-Build Theory of Positive Emotions which states that positive emotions can, among other things; broaden attention and thinking, undo negative emotions, fuel resiliency, and build personal resources. As Fredrickson's theory claimed, positive emotions contribute to cognitive development and resiliency, two key components of achievement in developmental mathematics.

This manuscript represents the review of the literature related to positive

psychology, positive emotions, and mathematics education. The themes analyzed in this review were the history and terminology of positive psychology, the positivity ratio, emotions and mathematics education, and interventions of positive psychology. Particular critiques of the literature addressed were; the populations typically studied within positive psychology and mathematics education, the measurements used, and the lack of educational applications in positivity ratio research.

### **Purpose**

The purpose of this literature review was to examine the research related to positive psychology, specifically the Broaden-and-Build Theory of Positive Emotions, and the relationship between psychology and student achievement in mathematics. By examining the literature, this manuscript hopes to offer some ideas for future research.

### **Coverage**

The overall approach to this literature search was to find studies and theories relating theories of positive psychology to mathematics education. Specifically, links to community colleges' developmental mathematics education were sought. In the spirit of this overall approach, broad search terms were used at first followed by more specific connectors of the terms. The main set of key words used in the search process were: positive emotions, positive affect, mathematics education, mathematics anxiety, community colleges, positivity ratio, positive psychology, success in mathematics. To narrow the search, terms were combined: for example, “mathematics anxiety” and “community college” or “positive psychology,” “community college,” and “mathematics education.”

Once it was found that very few connections existed between positive psychology and community college mathematics education, a search of specific authors was conducted to better understand the theories presented by the authors and the ways in which the theories could apply in the context of community college developmental mathematics. Given the relative recency of the field of positive psychology and the difficulty of finding relationships to community college mathematics education, the level of students studied was kept broad (elementary, junior high, high school, and university levels) and the country of origin of the studies was kept open (Germany, India, Australia, and the United States all emerged in the literature).

A majority of the search was conducted using the Oregon State Library 1Search. At times the search required the utilization of the Oregon State Library Scholars Archive and various databases specific to psychology and dissertations. Those databases were Psychinfo, ERIC, ProQuest, and Education Research Complete. In addition to the resources provided by the Oregon State University Library, Google Scholar was used in follow-up searches to find additional articles in which particular articles or authors were cited. Finally, further research was conducted utilizing the references found in various key articles.

### **Synthesis**

This literature review was organized into three sections. The first section provided a background in the history and terminology related to positive psychology and the Broaden-and-Build Theory of Positive Emotions (Fredrickson, 1998, 2001, 2004). The second section addressed what is currently known about the benefits of

positive emotions and specifically addressed the use of the positivity ratio as a measure of positive emotions in a variety of studies. The third section highlighted areas of psychology as they related to mathematics education. The final section outlined a variety of positive psychology interventions used to increase psychological health and well-being, including positive emotions. Appendix A provides a highlight of the recent work related to the growth mindset as a tangentially related field.

**The broaden-and-build theory.** Positive psychology was the product of the realization that traditional psychology was more interested in curing psychological maladies than focusing on the positive aspects of an individual's personality (Seligman & Csikszentmihalyi, 2000). The focus of positive psychology on an individual level is concerned with positive traits such as courage, interpersonal skill, perseverance, future mindedness, spirituality, and wisdom. In groups, positive psychology is concerned with civic virtues, responsibility, moderation, tolerance, and work ethic (Seligman & Csikszentmihalyi, 2000). Positive psychology seeks to discover what is right, what works, and how to improve and grow (Hoy & Tarter, 2011).

Fredrickson (1998, 2001, 2004) theorized that positive emotions are essential for optimal functioning. Fredrickson's Broaden-and-Build Theory of Positive Emotions stated that positive emotions (a) broaden an individual's attention and thinking, (b) undo negative emotions, (c) fuel resiliency, (d) build personal resources, (e) trigger future well-being, and (f) seed flourishing. Fredrickson and Losada (2005) defined the positivity ratio as “the ratio of pleasant feelings and sentiments to unpleasant ones over time” (p. 678) and used the positivity ratio to characterize

flourishing mental health. According to Fredrickson and Losada (2005) “to flourish means to live within an optimal range of human functioning, one that connotes goodness, generativity, growth, and resilience” (p. 678). The authors found that a positivity ratio of 2.9:1 was enough to seed human flourishing. Furthermore, a positivity ratio of approximately 11.6:1 was estimated mathematically to be the beginning of the disintegration of flourishing. It should be pointed out that the mathematics of Fredrickson and Losada (2005) was called into question and therefore the particular the estimated 11.6:1 ratio where the disintegration of flourishing occurs may be invalid (Brown, Sokal, & Friedman, 2013). Fredrickson’s (2013b) response to the Brown, et al (2013) critique did not respond to the mathematics of the original 2005 article, but reinforced the theory that a critical positivity ratio for flourishing exists and is approximately 3:1 (positive to negative emotions). Even without the mathematical model, the theory still holds. In Fredrickson’s (2013b) response, she emphasized that “the data say that when considering positive emotions, more is better up to a point” (p. 820) and “the data also say that when considering negative emotions, less is better, down to a point” (p. 820). While Fredrickson and Losada’s (2005) mathematical model is in question, the reality is that empirical evidence does exist that the Broaden-and-Build Theory still holds as a psychological theory supported by quantitative evidence (Fredrickson, 2013b).

***The broaden hypothesis.*** The first component of the Broaden-and-Build Theory of positive emotions is the broaden hypothesis. According to Fredrickson (2013a) this hypothesis “states that positive emotions, relative to negative emotions and neutral states, widen the array of thoughts, action urges, and percepts that



spontaneously come to mind.” (p. 17). Several studies have verified this component of the theory in a variety of ways (Fredrickson & Branigan, 2005; Johnson, Waugh, & Fredrickson, 2010; Rowe, Hirsh, & Anderson, 2007).

Fredrickson and Branigan (2005) sought to test the Broaden and Build Theory of positive emotions via two experiments. The two experiments induced positive, neutral, and negative emotions in 104 college students. Experiment one used a global-local visual processing test and showed that positive emotions, when compared to neutral emotions, broadened attention. Experiment two used an open-ended Twenty Statement Test, which showed that positive emotions, when compared to neutral emotions, expanded thought-action repertoires (that is, the subjects had more numerous thought-action urges). The number of thought-action urges was measured by the number of responses given by participants to the statement “I would like to \_\_\_\_.” Thoughts and actions were coded by the researcher into categories such as eat/drink, read, sleep/rest, schoolwork/work, outdoors/nature, play, etc. This particular study verified the broadening component of the Broaden-and-Build theory as it showed that the positive emotions of contentment and amusement induced a broadened the scope of attention and thought-action repertoires. While this qualitative study verified the broaden component of the Broaden-and-Build Theory, the study was limited to showing the results for two emotions and the emotions were self-reported by the participants.

Johnson, Waugh, and Fredrickson (2010) conducted experiments which induced positive emotions and measured the facial smiles of participants using electromyography. The experimenters were able to classify the smiles as genuine and

non-genuine. They found that genuine facially expressed positive emotion correlated with broadened attention, as shown by lower participant response time when performing a global-local recognition task in recognizing global targets. In a second experiment Johnson et al. (2010) found that self-reported positive emotions and facial expressions of positive emotions predicted increased attention flexibility, as shown by lower participant reaction time in a variation of the Posner test (which measures the flexibility in shifting attention). Johnson et al. (2010) concluded that “Taken together, the results of Experiments 1 and 2 provide evidence that positive emotions forecast broadened cognition, namely, holistic processing and attentional flexibility.” (p. 316).

Rowe, Hirsh, and Anderson (2007) examined the thesis that positive affect may broaden the scope of attention (reducing selectivity). A sample of 24 university students were induced with positive and negative mood via music (happy and sad), and neutral mood induced via reading of facts. Subjects were given a test of creative problem solving and a visual test of attention. Relative to sad and neutral, the positive mood induction associated with increased scores on the remote associates task (a test of creative problem solving). Positive affect also showed greater influence of distractors in the attention task, thus showing an expanded scope of the participants.

In summary, the broaden hypothesis stated that positive emotions more so than negative or neutral emotions will broaden attention scope, and widen thoughts. Furthermore, this theory has been tested in several studies of students in a university setting (such as Fredrickson & Branigan, 2005; Johnson, Waugh, & Fredrickson, 2010; Rowe, Hirsh, & Anderson, 2007).

*The build hypothesis.* The build hypothesis “posits that the function of the expansive form of positive emotions is to spur the development of resources, placing people on positive trajectories of growth” (Fredrickson, 2013a, p. 24). Such resources include upward spirals of well-being (Fredrickson & Joiner, 2002), resiliency (Cohn, Fredrickson, Brown, Mikels, & Conway, 2009; Fredrickson, Tugade, Waugh, & Larkin, 2003), social connections (Waugh & Fredrickson, 2006), and overall psychological flourishing (Fredrickson & Losada, 2005).

Fredrickson and Joiner (2002) assessed the Broaden and Build Theory's claim that positive emotions initiate upward spirals of emotional well-being. The experiment involved 138 college students completing self-reports that measured affect and coping five weeks apart. A regression analysis on the variables of positive affect and broad minded coping, as well as a mediational analysis revealed that positive emotions have an effect on broadened thinking which, in turn, produce, increases in positive emotions. Thus, the authors concluded that upward spirals of emotional well-being occurred.

Fredrickson, Tugade, Waugh, and Larkin (2003) tested if positive emotions were an active ingredient in resilience; that is, they examined to what extent positive emotions created a buffer after a crisis against depression and fueled thriving. University students from a larger parent study were called back after the 9/11 attacks for follow-up work, data from the parent study was compared with the follow-up study. The data collected were pre-crisis measures of resiliency and psychological resources compared to post-crisis measures of mood, stresses, or positive or negative emotions. The statistical analysis found that positive emotions were a valid mediator

pathway from high resilience to low depressive symptoms, and positive emotions were a valid mediator pathway from resilience to posttraumatic growth.

Cohn, Fredrickson, Brown, Mikels, and Conway (2009) measured the daily emotions of 109 university students (86 completed the study adequately) for the period of one month and tested the students ego resilience and life satisfaction before and after the month. The authors found that daily positive emotions predicted growth in ego resilience (a person's ability to adapt to changing and challenging situations). As the authors stated, more importantly it was the positive emotions more than general life satisfaction that predicted growth in ego resilience. In fact, the authors conclude that this study suggested “an upward spiral in which ego resilience and positive emotions maintain and build on one another” (Cohn, et al, 2009, p. 367). The authors also concluded that “when momentary positive emotions were disentangled from general life satisfaction, it was the momentary emotions that remained predictive” (Cohn, et al, 2009, p. 366). In other words, it was the positive emotions that an individual experienced over time that predicted growth.

Fredrickson and Losada (2005) used two samples from independent tests to verify Fredrickson’s Broaden and Build Theory of positive emotions and Losada’s mathematically predicted critical positivity ratio of 2.9:1. Two samples of university students were tested for flourishing mental health and screened for depression and separated into a flourishing group and a non-flourishing group. The groups then recorded positive and negative emotions for a period of 28 days, in order to determine a positivity ratio. A statistical analysis of the results revealed that the flourishing group were above the predicted (via other studies and mathematically modeled)

positivity ratio of 2.9:1 (the two flourishing groups had average positivity ratios of 3.2:1 and 3.4:1), the non-flourishing group were below the predicted positivity ratio of 2.9:1 (the two non-flourishing groups had average positivity ratios of 2.3:1 and 2.1:1). Thus, flourishing mental health was found to be associated with positivity ratios above 2.9:1.

***Summary of the broaden-and-build theory.*** This section reviewed the philosophical notions of positive psychology and the terminology related to the Broaden-and-Build Theory of Positive Emotions. This section also highlighted several studies that supported the broaden theory as well as the build theory separately.

**The positivity ratio.** Fredrickson and Losada (2005) used a nonlinear systems model to determine that a positivity ratio of approximately 2.9:1 was sufficient to seed human flourishing. Several studies in a variety of context have shown that this approximate positivity ratio of 2.9:1 is related to optimal functioning under stress (Shrira, Palgi, Wolf, Haber, Goldray, Shacham-Shmueli, & Ben-Ezra, 2010), creativity (Rego, Sousa, Marques, & Pina e Cunha, 2012), and social resources via self-other overlap (a measure of perceived closeness in a relationship) (Waugh & Fredrickson, 2006).

Shrira et al. (2010) compared positivity ratio with functioning under stress in two studies. One study was with cancer patients, and a second study was with hospital personnel that had experienced missile attacks. They found that the relationship between positivity ratio and functioning under stress were curvilinear (in the form of a U-shaped or reverse U-shaped curve relationship between measures of

stress and positivity). For the first study involving cancer patients, the authors used the Affective Balance Scale (a four point scale which uses five items to assess positive affect and five items to assess negative affect) they measured positive and negative affect of cancer patients and compared those values with scores of psychological distress (measured with the General Health Questionnaire) and illness cognitions (measured with the Illness Cognition Questionnaire - a measurement of three items: helplessness, acceptance of disease, and disease benefits). They found optimal functioning occurred at an approximately 3:1 positivity ratio. Thus, for those with a lower positivity ratio patients had higher levels of psychological distress, lower levels of disease acceptance, and lower levels of perceived disease benefits; and for those with a higher positivity ratio (up to 3:1) lower psychological distress, higher acceptance, and higher perceived disease benefits. Since cancer is considered a long-term stressor, the authors investigated a short term stressor as well, missile attacks during war (the participants were recruited approximately four weeks after the Second Lebanon War began). Affect was measured using subscales from the Center for Epidemiological Studies-Depression questionnaire. Traumatic distress was measured using the Impact of Event Scale-Revised. Traumatic distress decreased with an increase in positivity ratio, but at 3:1, traumatic distress leveled, indicating optimal functioning at a positivity ratio of approximately 3:1. These two studies independently showed a tipping point positivity ratio of approximately 3:1.

Rego et al., (2012) investigated how optimism predicted creativity through the mediating factors of positive affect and positivity ratio. With respect to the positivity ratio the researchers found that optimism predicted creativity through the mediating

role of positivity ratio. Moreover, the relationship with positivity ratio was curvilinear; that is, too high of a positivity ratio showed lowered creativity. The authors found that positivity ratios that are comprised of high levels of positive affect and extreme low levels of negative affect caused lowered creativity. They found that positivity ratio correlated positively with creativity until the maximum positivity of approximately 3.6:1.

Waugh and Fredrickson (2006) investigated how positive emotions related with self-other overlap (a measure of perceived closeness in a relationship) in relationships with first year freshmen university students. The participants measured their positivity ratios at three time intervals: (a) three weeks before the term, (b) one week into the term, and (c) approximately five weeks into the term; then, between the latter two tests, the participants conducted daily emotion tests. Using the modified differential emotion scale and accounting for negativity bias, the investigators calculated positivity ratios for the participants. Self-other overlap was measured using the Inclusion of Other in Self Scale which measures the perceived relationship closeness (in this case between participants and their roommates). An opposite-pair attribution procedure was used to measure a complex understanding of others. Extraversion was measured using the Ten-Item Personality Measure. The authors found that positive emotions will predict self-other overlap even after accounting for extraversion. Using the predicted flourishing positivity ratio of 2.9:1 (Fredrickson & Losada, 2005), the authors grouped the participants into two groups, those with high positivity ratios (above or equal to 2.9:1) and those with low positivity ratios (below 2.9:1). The results revealed that those with high positivity ratios experienced more

change in their self-other overlap scale over the course of a month than those with low positivity ratios. The authors also created a relationship building index from the self-other overlap and complex understanding scores. Those with high relationship building had a mean positivity ratio of 2.91:1 and those with low relationship building had a mean positivity ratio of 2.13:1. These data supported the theory that a positivity ratio of approximately 2.9:1 showed the benefits of positive emotions in building relationships.

***Summary of positivity ratio.*** These studies supported Fredrickson's theory that optimal functioning occurs at a positivity ratio of approximately 3:1. These studies highlighted the connections between a positivity ratio of approximately 3:1 and creativity, functioning under stress, and building social resources. These studies also showed that positivity has its limitations, positivity ratios that scored too high also lowered the output of creativity and functioning under stress.

**Emotions and mathematics education.** Studies have shown the benefits of positive-mood, self-efficacy, attitudes toward mathematics, and these studies have indicated a variety of emotions that predict performance and achievement in mathematics (Ahmed, van der Werf, Kuyper, & Minnaert, 2013; Bryan & Bryan, 1991; Bryan, Mathur, Sullivan, 1996; Fredrickson & Branigan, 2005; Grootenboer & Hemmings, 2007; Hannula, 2002; Hemmings, Grootenboer, & Kay, 2011; Rowe, Hirsh, & Anderson, 2007; Staus, 2012; Watts, 2011; Yasutake & Bryan, 1995). Historically, other studies have highlighted the converse as well, that there is a negative correlation between anxiety and student achievement in mathematics (Ma, 1999 and Hyde, Fennema, Ryan, Frost, & Hopp, 1990). Several of these studies will



be highlighted in this section and specific gaps and concerns in the literature are addressed.

Bryan and Bryan (1991) conducted two studies to assess the impact of positive moods on students' feelings of self-efficacy and mathematics performance. The first study consisted of 32 elementary school students (third through fifth grades) identified as high risk for failure by their teachers. The second study consisted of 18 junior high and high school students with learning disabilities attending a private school. Both groups of students were assigned either the experimental positive-mood induction or the control no-treatment. Using an analysis of covariance the researchers found that students with the positive-mood induction completed significantly more problems correctly than the control group. Also, the junior high and high school experimental group indicated higher levels of self-efficacy in mathematics than the control group. The Bryan and Bryan (1991) study supported the hypothesis that positive emotions can contribute to success in learning mathematics. Since this was a study conducted with elementary and high school students, it remains unknown whether these results would generalize to a population of students in higher education.

Ahmed, van der Werf, Kuyper, and Minnaert (2013) studied the relationship between the emotions of anxiety, boredom, enjoyment, and pride over a year with 495 middle school aged (mean age of 12.8 years) students in the Netherlands. The students were surveyed over the course of a year during the fall, winter, and spring (approximately 3.5 months apart). The students were surveyed to assess their levels of academic emotions (anxiety, boredom, enjoyment, and pride). The students' grades

were used to determine their level of mathematics achievement (the Dutch grading scale is from 1 to 10, with 1 being poor and 10 being outstanding). Ahmed et al. (2013) used a growth curve analysis which showed that as boredom increased, enjoyment and pride declined while anxiety stayed the same. The authors also showed that changes in anxiety and boredom predicted changes in mathematics achievement negatively while enjoyment and pride predicted achievements positively. Multilevel modeling (Singer & Willett, 2003) was used to conduct this analysis to show the development of students' emotions and the impact of these emotions on the students' achievement. The study by Ahmed et al. (2013) supported the claim that positive emotions can contribute to students' success in mathematics. However, the population studied was middle school aged students, and it is yet unknown whether this relationship between emotions and student achievement would exist in the higher education context.

Grootenboer and Hemmings (2007) designed a study to examine the potency of mathematics affective factors and background factors (gender, ethnicity, SES) on 8-13 year old New Zealand students' mathematics performance. The study used a large data set of 1888 students and 78 teachers with the data collected via surveys of children and performance ratings of teachers. Through a statistical analysis (which included correlation and logistic regression), four factors (positive view, utilitarian belief, traditional belief, math confidence) were predictive of mathematics performance. However, since teacher ratings of student mathematics performance were used, these results were limited by the teachers' potential biases. Even with this particular critique of the study, the overall results contributed to the support of the

hypothesis that positive emotions should positively impact mathematics performance. While the sample of this study was large, the targeted population was young (8-13 years old). It remains to be shown whether these same results would apply to a higher education population.

Hemmings, Grootenboer, and Kay (2011) focused on attitudes toward math, ability, and achievement in mathematics. A sample of 100 (53 males and 47 females) Australian secondary students, age range 12-13 years old, were selected, and test scores in math from year 7 were compared to a math attitude score (taken during year 7) and a standardized math test in year 10. It was found that: (a) female students were more likely to have positive attitudes toward math; (b) reading, numeracy, and attitude scores were predictive of standardized math scores in year 10; and (c) it was possible to develop a model of performance on the year 10 standardized mathematics test based on numeracy, reading, and attitude scores from year 7. This study referred to dispositions rather than emotions, and the dispositions were geared toward mathematics rather than the individual's overall emotional health. While not particularly focused on emotions, the relationship between positive attitudes toward mathematics warrants further investigation. Again, the population studied was secondary age students (12-13 years old), leaving the question of whether these results would hold for students in higher education.

Meyer and Turner (2002) reviewed their own qualitative research and concluded that teachers' positive emotional responses have a positive impact on student motivation. The conclusion that teachers and others have an impact on students' self-efficacy was further supported by one of the conclusions of Usher's

(2009) qualitative investigation of middle school students' self-efficacy in mathematics. Usher's (2009) qualitative study found that students' self-efficacy in mathematics can be influenced by others (adults or peers). In one instance, even a student with family members that failed mathematics commented that he wanted to be different and used being different from others as a motivation. O'Regan (2003) interviewed 11 students studying online in Australia in order to identify which emotions were experienced while learning online and concluded that "learning will be enhanced when negative emotions are minimized and positive emotions are maximized" (p. 89). Hannula (2002) used an ethnographic case study of a secondary school student and determined that her initially negative attitude toward mathematics changed towards the positive. Hannula's (2002) interpretation of how this occurred was that mathematics became "more fun" for the student and that the student had "been understanding more" (p. 41). These qualitative studies indicate that positive emotions are beneficial, but also that there is the potential for interventions to have an impact on students.

Ahmed, et al. (2013), Grootenboer and Hemmings (2007), Hemmings, Grootenboer, and Kay (2011), and O'Regan (2003) all studied populations of students from countries outside of the United States. The present study will study students attending community college in the United States and there may be cultural differences between countries that influence a student's perceptions of mathematics. While interesting, this is beyond the scope of the present investigation and may warrant further research in the future.

Ma (1999) examined 26 studies that addressed the relationship between anxiety toward mathematics and achievement in mathematics with elementary and secondary students. The overall correlation was significant and negative (a combined correlation of -0.27), and this result was consistent across gender, grade-level, ethnicity, and instruments used to measure anxiety. Although, the author was unable to determine the correlation into traditional ethnic groups and investigated those studies that reported different ethnic groups (as mixed) with those that did not (as unmixed). The author concluded that the results of this study were particularly important in terms of advocating for different treatment programs that support self-management of emotions and cognitive based treatments that help students reduce their difficulties in learning mathematics (thus reducing their anxiety).

Hyde, Fennema, Ryan, Frost, and Hopp (1990) conducted a meta-analysis of students from 1967-1988 searching for the gender differences in attitudes and affect toward mathematics. The authors reported that there were small gender differences in most aspects of attitude and affect toward mathematics. However, the authors found that the largest gender difference in mathematics anxiety was in remedial samples (female students experienced more anxiety than male students). The authors also indicated a lack of research related to the variable of ethnicity. This opens the door for the possibilities of further research related to ethnicity and remedial (or developmental) mathematics populations.

***Summary of psychology and math.*** As can be seen from the literature certain positive emotions, mood, affect, and attitudes have an impact on student learning in mathematics. A variety of methods and measurement tools were utilized;

experimental, correlational, surveys, and interviews. It remains to be explored if these concepts can be generalized to other populations of students, specifically students in higher education. Furthermore, a few of these studies related attitudes toward mathematics related to mathematics achievement but not how overall emotional health related to mathematics achievement.

**Positive psychology interventions.** This section will outline a variety of research related to positive psychology interventions. Studies have verified that positive psychology theories can be used as interventions to achieve positive results. Austin (2005) showed that positive academic behaviors, efficacy, expectancy, and extrinsic motivation could be developed using the foundations of positive psychology. Kim and Hodges (2012) were able to show that an emotion control treatment positively impacted motivation. Seligman, Ernst, Gillham, Reivich, and Linkins (2009) suggested several methods for teaching well-being in schools and that such interventions yield positive results.

Austin (2005) investigated the effects of a strengths-development intervention in high school students. With a large sample size of 527 students the author was able to create an experimental and control group of students. The experimental group was given a 6 week intervention, and results showed that there were statistically significant benefits to positive academic behaviors, efficacy, expectancy, and extrinsic motivation.

Kim and Hodges (2012) experimentally investigated an emotion control treatment and determined that there were benefits to positive academic emotions and motivation. In this study, 95 participants were enrolled in an algebra and

trigonometry online course at a large public university. The treatment was administered online in the first two weeks of the term, and follow-up surveys were conducted. Statistically significant effects on the positive emotions of enjoyment and pride occurred between the experimental group and the control group, with the experimental group showing higher levels of positive emotions of enjoyment and pride than the control group. No significant effects were found on the negative emotions. The authors also found that there was a higher level of motivation between the treatment group and the control group, but no difference between the groups with respect to their achievement in the course. The authors also concluded that, given the impact on motivation, these results suggested that it is possible to improve motivation through emotion control.

Seligman, Ernst, Gillham, Reivich, and Linkins (2009) defined positive education as a means for teaching traditional skills as well as happiness in schools. They summarized two programs the Penn Resiliency Program (PRP) and the Strath Haven Positive Psychology Curriculum. The PRP was found to reduce depression and negative emotions such as anxiety and hopelessness, as well as increase overall well-being. While the data on the Positive Psychology Curriculum was not conclusive, the authors speculated that positive education interventions will become invaluable in the future.

Furthermore, research in positive emotions have shown how interventions can increase positive emotions experienced and lead to increases in well-being (Cohn & Fredrickson, 2010; Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Specifically, Fredrickson, Cohn, Coffey, Pek and Finkel (2008) studied the effects of inducing

positive emotions through loving kindness meditation. Loving kindness meditation is a mind training meditative exercise designed to focusing on warm feelings toward oneself and others. In short, loving kindness meditation is designed to evoke positive emotions, which then lead to broadened attention (per the Broaden-and-Build Theory). The participants in the study were employees at a company who volunteered for the study. Of the 139 participants 67 received the loving kindness mediation training and 72 did not. The authors found that the loving kindness mediation did increase the number of positive emotions experienced by the participants both during and two weeks after the intervention ended.

***Summary of positive psychology interventions.*** These studies have shown that positive psychology provides a variety of interventions that could be used to impact an individual's life. Whether it be through awareness of strengths, reduction of negative emotions, or an increase in positive emotions, we know that there exist viable interventions to affect the emotional and psychological state of an individual.

### **Critique**

This literature review has revealed several critical limitations of current research. While the populations studied thus far were extensive and included several education levels of students, a substantial population of students in higher education is missing. Furthermore, as with any aspect of emotion research, there is an over-reliance on self-report measures. Finally, the obstacle of trait versus state emotions and mood need to be addressed in greater detail with respect to educational research.

**Populations studied.** The studies found in this literature review have been conducted with respect to positive emotions, self-efficacy, and mathematics anxiety



on college age students, but not community college students (Austin, 2005; Fredrickson & Branigan, 2005; Fredrickson & Joiner, 2002; Fredrickson & Losada, 2005; Fredrickson et al., 2003; Hall & Ponton, 2005; Kim & Hodges, 2012; Luttrell, Callen, Allen, Wood, Deeds, & Richard, 2010; Rowe et al., 2007; Staus, 2012). Also, many of the studies found in this literature review focused on younger students, elementary school, junior high, or high school age students (Ahmed et al., 2013; Bryan & Bryan, 1991; Bryan et al., 1996; Grootenboer & Hemmings, 2007; Hannula, 2002; Hemmings et al., 2011; Jain & Dowson, 2009; Yasutake & Bryan, 1995). Very few studies were found that involved community college developmental students (Watts, 2011), or community college students in general (Bai, Wang, Pan, & Frey, 2009), or working adult populations.

The two-year or community college student seems to be missing from this body of work. This could be for two main reasons: (a) the access to elementary, junior high, or high school students may be more consistent as those students tend to be less transient and longitudinal studies can be conducted with minimal sample reduction for unforeseen reasons and (b) the university students are in closer proximity to the campuses with psychology departments conducting research in positive psychology. This gap in the research with respect to the populations studied needs to be addressed, especially considering there were approximately 12 million students enrolled in credit and non-credit course work in community colleges in the United States in 2009 (AACC, 2019). Given that approximately 58% of the students in the NELS:88 study took a remedial course (with mathematics being the most common remedial subject) (Attewell et al., 2006) in community college, it is safe to

say that there is a large population of students that are not represented in the literature.

Although Fredrickson, Cohn, Coffey, Pek, and Finkel (2008) did examine effects of positive emotions in the workplace, more research is needed. Might positive emotions help workers thrive in stressful environments, such as emergency medicine? With continued changes in management and operations, might positive emotion aid workers in dealing with these changes?

**Measurements.** Another of the limitations discovered in the literature was the usage of self-report surveys to gauge the subjects' emotion, attitude, or self-efficacy (Fredrickson & Branigan, 2005; Fredrickson & Joiner, 2002; Fredrickson & Losada, 2005; Fredrickson et al., 2003; Hall & Ponton, 2005; Staus, 2012; Watts, 2011; Yasutake & Bryan, 1995). This particular limitation introduces a potential bias in the data collected. Even if scales are created to produce numeric values, those values are still subject to the potential bias of the participant. However, despite this critique the use of the appropriate statistical methodologies was present to determine statistically significant relationships between the various positive factors and academic or intellectual performance.

**Summary of critique.** Current literature is limited in populations studied and measurements utilized to measure emotions. Two-year college or community college students represent a significant portion of students and are missing from current literature. Current measures rely heavily on self-reports of emotions, while attempts can be made to eliminate bias, within this particular research area self-reports are almost unavoidable.

## **Implications**

Several implications exist for practice and research with respect to positive emotion research and mathematics education.

**Practice.** The development of programs within higher education that emphasize positive psychology practices could have an impact on student completion and success. In particular, elements of the Broaden-and-Build Theory of Positive Emotions point directly at desirable characteristics of students (open and broadened mindsets, resilience, functioning under stress, etc). Applying this theory of positive emotions may be of particular use in the area of community college developmental mathematics, where a large percentage of students do not complete their remedial sequence (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009; Bailey, Jeong, Cho, 2010). When highlighting the value of the affective factors related to developmental mathematics education, Bonham and Boylan (2011) stated that students, faculty, and support staff “should be familiar with and employ strategies to help alleviate mathematics anxiety, build self-confidence, and maximize student learning in mathematics” (p. 4). While increasing overall positive emotions of students may not directly relate to alleviating mathematics anxiety, the possibility of increasing resilience, and broadening the student's mind set, creativity, and functioning under stress may be very useful.

Implication exist for potential interventions within the workplace. Practitioners can implement some strategies to build self-confidence and positive emotions particularly during times of stressful assignments or organizational change. Use of the lovingkindness meditations as in Fredrickson, Cohn, Coffey, Pek, and

Finkel (2008), may lead workers to exhibit more positive behaviors toward each other during these times.

**Research.** Additional research with community college students would fill a need in the literature. In addition, studies undertaken in workplace settings would add to the knowledgebase. For example, developmental education community college students represent a large population of students in higher education and a traditionally low achieving group. Replication of studies such as Bryan and Bryan's (1991) or Rowe et al. (2007) studies with students in higher education could be extremely useful in extending research further with respect to positive mood induction.

To add to the proposed ideal positivity ratio of 3:1, replication of studies such as Shrira et al. (2010), Rego et al. (2012), and Waugh and Fredrickson (2006) with community college students or with organizational employees would present an interesting extension of the theory to a different population. In particular, using the positivity ratio as a measure of positive emotions, while a self-report, presents an easy measurement and calculation for the purposes of correlational and possibly experimental studies. Targeting a subject area such as mathematics, especially at the community college level, would provide an adequate base of students to study.

Lyubomirsky, King, and Diener (2005) conducted a meta-analysis to determine how happiness related to success. Happiness for these authors was defined as frequent experience of positive emotions. The investigation considered not only how happiness correlated with success, but how happiness preceded successful outcomes. Both correlational studies and longitudinal studies confirmed that

happiness and pleasant moods preceded successful characteristics. However, the volume of longitudinal studies was small and is a source of future research.

Lyubomirsky, et al (2005) found evidence that happy people and those in pleasant moods could be more creative and better problem solvers. Only one longitudinal study was found relating to creativity and problem solving to positive affect, most of those studies were found to be experimental. This leaves a gap in the theory calling for more longitudinal studies involving positive emotions or happiness and success. Again, this leaves a door wide open for future studies in a variety of settings such as the community college and in the workplace.

**Summary of implications.** The implications of this literature review are both in practice and in research. The overall practical benefits of positive emotions could be used as interventions in a variety of places in higher education, but especially in developmental mathematics. The research in higher education is also wide open with respect to community college students. In addition, examination of the effects of interventions in the workplace would contribute to a new understanding. Replication of studies at the community college or in the workplace, application of emotion measurements, and longitudinal studies are all possible examples of future research.

## **Conclusion**

The literature review presented has shown that the history of positive psychology and its motivation to focus on the “what works” rather than “what needs to be fixed” is a key component to this study. The current literature has shown there is strong theoretical foundation from which to begin exploring the relationship between positive emotions and community college developmental mathematics. A

focus on positive emotions in future studies will hopefully validate current findings and add to the literature by exploring a population of students underrepresented thus far.

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### Chapter 3

#### Second Manuscript

Students enrolled in developmental mathematics education in community college do not show much success on average. Based on data from the National Education Longitudinal Study (NELS:88 study) of a representative sample of the United States' eighth-grade students in 1988 that were tracked through college, it was found that only 30% of students passed all of the developmental mathematics courses in which they enrolled at community college (Attewell, Lavin, Domina, & Levey, 2006; Bailey, 2009). These data indicated that there is room to improve the current completion rates of developmental mathematics education in community colleges.

The current environment in the community colleges and a call from the previous President for increasing completion and the number of degrees earned by 2020 (Obama, 2009) suggests that getting students through developmental mathematics is a higher priority for higher education than ever. Rather than focusing on the characteristics of students that are not completing, perhaps it is time to focus on the characteristics of those students that are successful and have characteristics that can be fostered for greater success.

The field of positive psychology places emphasis on “nurturing what is best” (Seligman & Csikszentmihalyi, 2000, p. 7) rather than focusing on treating pathologies. Following this thinking, Fredrickson developed the Broaden-and-Build Theory of Positive Emotions that states that positive emotions can, among other things; broaden attention and thinking, undo negative emotions, fuel resiliency, and build personal resources (Fredrickson, 1998, 2004).

Rather than focusing on the challenges and roadblocks to achievement, the goal of this study is to begin the investigation of positive emotions and achievement in developmental mathematics. As Fredrickson's (1998, 2004) theory pointed out, positive emotions contribute to cognitive development and resiliency, two key components of achievement in developmental mathematics.

This study will investigate the relationship between positivity ratio, as defined by Fredrickson and Losada (2005), and the achievement of community college developmental mathematics students. Positivity ratio is defined to be the number of positive emotions to negative emotions an individual experiences in a given time period (Fredrickson & Losada, 2005). For the purposes of this study, achievement in mathematics was determined by a final grade in a community college developmental mathematics course. Positivity may be mediated by other factors related to student achievement in mathematics, including gender, socioeconomic status, race/ethnicity, age, and prior experience in mathematics.

### **Guiding Theoretical Perspective**

The theoretical perspective of this study is an amalgamation of the Broaden-and-Build Theory of Positive Emotions (Fredrickson, 1998, 2004, 2009) and a variety of theoretical studies relating achievement in mathematics to several factors (Ma, 1999; Reyes & Stanic, 1988). The additional factors of interest are socioeconomic status, gender, and race/ethnicity. Community college students often vary in age and previous experience in mathematics, therefore data related to age and previous experience in mathematics were also collected.

**The broaden-and-build theory.** The primary guiding theory for this study will be Fredrickson's (1998, 2004, 2009) Broaden and Build Theory of Positive Emotions. This theory posits that experiencing positive emotions leads to psychological flourishing and broadened and more open mindsets. Theoretically, this should mean improved cognition and academic performance. As Fredrickson and Losada (2005) stated “to flourish means to live within an optimal range of human functioning, one that connotes goodness, generativity, growth, and resilience” (p. 678).

To develop a quantitative measure of positive emotions, Fredrickson and Losada (2005) created a positivity ratio. The positivity ratio is the number of positive affects (or emotions) a person experiences over time to the number of negative affects (or emotions). This ratio has been shown to correlate with the notion of human flourishing. Fredrickson and Losada (2005) found that optimum human flourishing happens at a positivity ratio of approximately 3:1. Other studies have shown that a relationship exists between the positivity ratio and creativity (Rego, Sousa, Marques, & Pina e Cunha, 2012) and functioning under stress (Shrira, Palgi, Wolf, Haber, Goldray, Shacham-Shmueli, & Ben-Ezra, 2010), and this relationship is curvilinear with an optimal positivity ratio of approximately 3:1. These results could imply that a curvilinear correlation may be found in the current study. But more importantly, these results show a relationship exists between positivity ratio and creativity or functioning under stress, and this relationship is centered around a ratio of 3:1. While this does not guarantee an ideal positivity ratio of 3:1, it is hopeful that such a ratio will appear in the present study.

**Factors influencing achievement in mathematics.** Reyes and Stanic (1988) presented a model for addressing student achievement in mathematics based on race, sex, and socioeconomic status. At the time of writing, the authors stated that this model was designed to guide future research and that considering any single group alone did not reveal significant differences. Thus, the need to consider all factors in future research was suggested.

Ma's (1999) examination of 26 studies concluded that there is a significant negative relationship between anxiety toward mathematics and mathematics achievement in elementary and secondary student populations. While the author showed this result across different demographic groups, a lack of data with respect to the variable of race/ethnicity calls for more specific investigation on the relationship between emotions and mathematics achievement. Hyde, Fennema, Ryan, Frost, and Hopp's (1990) meta-analysis searched for gender differences in attitudes and affect toward mathematics. The authors found the largest difference was in remedial populations, and female students experienced more anxiety than male students. Also, the authors noted a lack of research relating to race/ethnicity.

Given that these studies have identified some relationships between gender and race/ethnicity with attitudes and anxiety, further study is warranted. For these reasons, the variables of race/ethnicity and gender will be included in the present study, if not to find similar differences, to find additional relationships that may or may not exist before investigating the relationship between positivity ratio and course success. The theoretical framework of Reyes and Stanic (1988), the lack of studies involving race/ethnicity found by Ma (1999), and the difference in mathematics

anxiety by gender in the remedial samples of Hyde, et al. (1990) all pointed to a need to investigate how the factors of race/ethnicity, socioeconomic status, and gender relate to mathematics achievement. Thus, the factors of race/ethnicity, income level, and gender were included in the present study as demographic categories to investigate.

**Blending perspectives.** Studying emotions in mathematics education research is not new, as McLeod (1992) pointed out,

research on emotional responses to mathematics have been conducted, but it has never played a prominent part in research on the affective domain of mathematics. A major problem has been the lack of a theoretical framework within which to interpret the role of emotions in the learning of mathematics. (p. 583)

More recent authors have noted that emotions have not been used in mathematics education research as much as the variables of beliefs and attitudes (Zan, Brown, Evans, & Hannula, 2006). But there is at least some theoretical belief that “Emotions also affect cognitive processing in several ways: they bias attention and memory and activate action tendencies” (p. 116).

Given the need for a theoretical framework for emotions and the previous theoretical framework of Reyes and Stanic (1988), this study will attempt to investigate the relationship between emotions and mathematics achievement, as well as the relationship between the factors of income level, race/ethnicity, and gender through the positivity ratio. Rego, et al (2012) investigated the relationship between optimism and creativity through the mediating effects of positivity ratio. The present study adapted this model by investigating the relationship between demographic variables and course success through the mediating effects of the positivity ratio.



Figure 3.1 shows how the variables will be investigated through the positivity ratio. The course grades and positivity ratios for each demographic group were investigated separately to determine if there is any relationship within a demographic subgroup between the positivity ratio and student course success. While it is important to investigate the relationship between the positivity ratio and student course success directly, without passing the relationship through the demographic variables, we may lose an opportunity to see if different demographic groups show differences in positivity ratio as it relates to course success.

### **Research Question**

The primary research question of this study was: To what extent is there a relationship between Fredrickson and Losada's (2005) positivity ratio and the final course grades of community college developmental mathematics students?

**Null hypothesis.** The null hypothesis is that there will be no significant correlation between the positivity ratio and student final grades in developmental mathematics courses.

**Alternative hypothesis.** The alternative hypothesis is that there will be a significant correlation between a measured positivity ratio and student final grades in developmental community college mathematics courses.

**Rationale.** According to the Broaden and Build Theory of Positive Emotions, positive emotions lead to human flourishing (Fredrickson, 1998, 2004). Human flourishing includes a broadened mindset and actions, which build over time. The goal of this study is to seek evidence of this relationship with respect to students taking community college developmental mathematics courses. Fredrickson and

Losada (2005) defined the positivity ratio as the ratio of positive emotions to negative emotions and found that a positivity ratio of approximately 3 to 1 is sufficient to seed human flourishing. Utilizing this positivity ratio as a measurement of positive emotion, a correlation between a student's positivity ratio and achievement in a mathematics course can be explored.

According to Fredrickson (2013) the broaden hypothesis “states that positive emotions, relative to negative emotions and neutral states, widen the array of thoughts, action urges, and percepts that spontaneously come to mind.” (p. 17). The build hypothesis “posits that the function of the expansive form of positive emotions is to spur the development of resources, placing people on positive trajectories of growth” (p. 24).

Fredrickson and Losada (2005) used a statistical analysis that revealed that flourishing occurs above the ratio of approximately 3:1. They also showed that, at a ratio of approximately 11:1, there is a drop off in function. Furthermore, in a variety of studies it has been shown that a positivity ratio of approximately 3:1 is related to optimal functioning under stress (Shrira, Palgi, Wolf, Haber, Goldray, Shacham-Shmueli, & Ben-Ezra, 2010), creativity (Rego, Sousa, Marques, & Pina e Cunha, 2012), and social resources via self-other overlap (Waugh & Fredrickson, 2006).

### **Methods**

The following section describes the data sources, the survey instrument, the sample, and the recruitment strategy. It concludes with a discussion of the procedures. A discussion of the researcher's philosophical approach can be found in Appendix B.

### **Site and Data Source**

Data were collected from students enrolled in a community college developmental mathematics courses. The data collection site was a community college in Sacramento, CA. The college has approximately 9,657 full-time equivalent students (FTES) and 19,650 headcount students annually (CCCCO, 2017). There are approximately 15 course sections offered in a variety of formats at the developmental level. For the purposes of this study the developmental level of mathematics was considered to be coursework designed to bring students to college level (Attewell et al., 2006; Kozeracki, 2002). This yielded a population of approximately 600 students (California Community College, 2013) from arithmetic and pre-algebra courses.

### **Survey Instrument**

To measure positivity ratio the modified Differential Emotions Scale (mDES) was used. This scale was developed by Fredrickson, Tugade, Waugh, and Larkin (2003) and is a modified version of the Differential Emotions Scale created by Izard (1977). The mDES according to Cohn and Fredrickson (2009) “is useful both for finely categorizing a person's emotion experience and for measuring his or her overall level of positive and negative emotion” (p. 19). In fact, changing response options to refer to “how often you have experienced” and “how often you have felt” and the instructions to “over the past two weeks” will address a person's experience of positive emotions of a longer duration of time, rather than in response to a particular incidence or induction of emotion (Fredrickson, 2013).

The mDES is a 20 item Likert Scale survey that measures 10 positive and 10 negative emotions. Computing the mean of the positive and negative emotion scores

was used to create a positivity ratio (Fredrickson, 2013). A variety of research studies have demonstrated that the internal reliability of the positive and negative emotion subscales of the mDES show acceptable internal reliabilities with alphas ranging from 0.79 to 0.86 (Fredrickson, et al, 2003; Waugh & Fredrickson, 2006). The version of the mDES used in this study can be found in Appendix C.

In addition to the positivity ratio, with permission from the college site IRB, student identification numbers were collected at the time of the first survey. The college student identification numbers allowed access to the college's record of the other variables (age, race/ethnicity, gender, and income level). Low income was defined by the college site as the student receiving aid in the form of CalWORKS/TANF/AFDC, Supplemental Security Income program, General Assistance, or eligibility for a Board of Governor's fee waiver. To gather data on previous mathematics experience a survey question asking for previous course work and experience was at the time of the first survey.

The survey questions on the mDES were Likert scale questions ranging from 1 (rarely) to 5 (most of the time). Age and recency of mathematics coursework were considered continuous variables. Gender and level of income are dichotomous variables. Race/ethnicity were collected through the college research office as a nominal-level variable. Final grades in the students' current course work were accessed via the student identification number, provided the students consented to participation in the study.

## **Sample**

An attempt was made to survey all students (approximately 600) in the developmental level courses at the college site. The population being studied included 15 class sections and approximately 600 total students. Efforts were made to survey all sections during a single semester. Due to the availability of the student researcher, nine sections of courses were surveyed (two arithmetic sections and seven pre-algebra sections) yielding approximately 300 potential participants.

### **Recruitment Strategies**

The student researcher worked with college administration and faculty (vice president of instruction, dean of science mathematics and engineering, mathematics department chair, and the dean of research and planning) to gain access to the mathematics department. Then the student researcher contacted the mathematics department and the faculty to request permission to administer the survey in each of the arithmetic and pre-algebra sections.

### **Procedure**

Partially replicating the Waugh and Fredrickson (2006) procedure, this study surveyed students at three instances in person during the semester term and during class time. The survey took approximately 10-15 minutes of class time to administer each time the survey was given. The surveys were done on paper and presented by the student researcher. The survey was introduced to the class with a printed consent form. The participants signed and returned the consent document before each administration of the survey. The surveys were given within the first month of instruction; each arithmetic, pre-algebra instructor was asked for permission to administer the initial survey instrument to their students in class. The initial survey

collected student identification numbers, and the students completed the mDES. Students were also asked for consent to participate in the study, and they were given the opportunity to opt out of participation. Halfway through the semester (approximately 8 weeks later) the mDES was given again in person in classes. Finally, during the last week of instruction students were given the mDES for the final time. Working with the college site research office, final grades for the participants were collected approximately one month after the semester had concluded. All data were secured and stored in a locked location. Data that were processed through a digital format were encrypted and stored on secure drives and servers.

### **Analyses**

The primary independent variable in this study was positivity ratio, calculated as the average of the positivity ratio from each survey response. The positivity ratio of each survey response was calculated as the ratio of the average of positive responses to the average of negative responses on the mDES. The dependent variable in this study was the final grade the student received in their developmental course at the end of the semester. The descriptive variables as determined by the theoretical framework were socioeconomic status, race/ethnicity, gender, previous experience in mathematics, and age.

To ensure the reliability of the mDES instrument, Cronbach alphas were computed for the positive and negative emotion subscales. It was assumed that the instruments are valid, given that they have been previously validated. Nevertheless, a factor analysis was undertaken to examine the factor structure of the instrument. If

needed, items would be eliminated if they did not fit the factor structure and/or if they reduced the size of the Cronbach alpha.

This study utilized a correlation and regression analysis to examine the relationship between positivity ratio (independent variable) and student achievement in the form of the student final grades (dependent variable). The regression analysis was used to determine if the positivity ratio can serve as a variable that predicts student achievement. The descriptive variables of income level, race/ethnicity, gender, previous experience, and age were used to determine if any of the descriptive variables moderate the correlations between positivity ratio and achievement. It should be noted that, if the numbers of students in a particular demographic group were too small, then that variable would not be used in these analyses in order to protect the identity of the students. Additionally, a check for the correlation differences between students with high positivity ratio and low positivity ratio was done to determine if there is a relationship centered around the theoretical 3:1 positivity ratio.

### **Limitations**

Several limitations exist in this study with respect to the participants and to the methods. The first limitation with the participants is the survey itself. Given the large number of English as a Second Language students in the community college system, participants may have had difficulty with the language of the survey instrument. Consideration was given to translating the survey instrument to various languages, but logistically this was not possible. During the administration of the survey the student researcher was asked some questions regarding the emotions listed

in the survey and provided some clarification about the meaning of the emotions when possible to the student participants. Second, the use of a survey to determine emotions has the potential limitation of only capturing a participants' emotional state at the current time, even with the request of asking individuals to reflect up on the previous two weeks. This temporal limitation in the study of emotions could pose a question of the validity in comparing student emotions during the first month of the semester and the student final grades. For this reason, surveys were given at the beginning, middle and end of the semester. Additionally, an overall positivity ratio was calculated for each student using an average of all three survey results. The overall positivity ratio was calculated by creating a ratio of the average of positive responses to the average of negative responses.

In addition to the limitations previously mentioned, there are limitations in the variance regarding how each class was run by individual instructors (grading schemes, testing methods, teaching methods, etc.). By including a large number of students in a variety of classes the researchers hoped that these differences would be minimized through a large sample selection.

### **Protection of Human Participants**

Both the Principal Investigator and the Student Researcher completed CITI training and certification. All data were stored and encrypted on secure drives and servers that meet FERPA compliance. Working with the research office of the college site, any use of student identification numbers were kept secure as well. There was an institutional IRB process at the college site, and the campus research office and dean of research and planning were consulted throughout the research



process. This study collected data from students via a survey, and by connecting with the campus student identification numbers, additional data were able to be analyzed (age, race/ethnicity, gender, income level, and final course grades). The raw data were sent to the research office of the college site; the data were downloaded as an encrypted Excel file and sent securely to the research office. Once at the research office, the data were stripped of ID numbers, and college collected demographic data were added to the spreadsheet for analysis.

## **Results**

The following provides the results of the study. It begins with a description of the participants. It then turns to a description of the variables and the analyses. It provides details on the reliability and validity results, the correlation results, and the linear regression results.

### **Participants (Data Set)**

Prior to data collection permission was sought from the college site, and participants were asked for informed consent. After getting consent from the participants, the mDES was given to the students who signed the consent documents. To be sure that participants consented with each survey administration, consent forms were signed prior to each survey administration. Surveys were given during the first two weeks of the semester, during between week 8 and week 10, and finally during the final two weeks of the semester (weeks 15 and 16).

A total of 151 students completed the first administration; 138 completed the second administration; and 126 completed the third administration. For the analysis

of the data, the respondents who completed all three surveys and earned a letter grade in the course were analyzed. This group was comprised of 82 participants.

The sample group was comprised of 50 female students, 30 male students, and 2 unknown gender students. (See Table 3.1 for a comparison between the college developmental mathematics courses and the study sample.) Low income students were defined by the college site as having received a variety of aid or qualifying for a tuition fee waiver (receiving CalWORKS/TANF/AFDC, part of the Supplemental Security Income program, receiving General Assistance, eligible for Board of Governors fee waiver income standards). There were 59 students defined as low income and 23 as not low income. (See Table 3.2 for the comparison between the sample and the college). The race/ethnicity breakdown for the sample and the college developmental mathematics courses are described in Table 3.3.

The age groups as typically defined by the college site are as Table 3.4 shows. The majority of the students served in the developmental courses were within the traditional college age range of 18-24 years of age.

### **Variables and Analysis**

Prior to analysis data needed to be coded and sorted in the sample data set. Grade points were used to calculate final grade; previous experience in mathematics was coded; the definition of low income was determined by the college site; and a modification was made to calculate positivity ratio and account for missing or double responses (incidents where two or more answers were marked for one question on the survey) in the survey results.

**Course grade.** Final course grades were assigned point values for analysis (A = 4, B = 3, C = 2, D = 1, and F = 0). A W grade is a withdrawal from a course prior to the end of the semester and does not have a point value. In the case of a W the student did not earn a grade, and the W did not impact their grade point average. However, a W grade could be considered a non-success in the course and counted as a zero grade point. These results reflect not including the W grades in the grade point calculations as there was only one W grade in the set of students that took all three surveys. This is likely due to a late W being issued administratively to the student. A separate calculation could be done with the W grade as a 0 grade point, however with one data point this data point was considered an outlier and not included.

**Previous experience in mathematics.** Respondents were classified as underplaced if the name of the previous course given described a course that was above the current course enrolled. (For example, Algebra 2 is a higher level course than Pre-Algebra so this respondent was coded as underplaced.) The code Not Underplaced was used for respondents that indicated a previous course that was at the appropriate prerequisite level or the same course they are currently enrolled. (For example, a respondent currently enrolled in Pre-Algebra was considered appropriately placed with previous course listed as Arithmetic or previous course listed as Pre-Algebra – presumably a student that fails a Pre-Algebra course and retakes the course is appropriately placed.) The remainder of respondents were coded as having no data. (For example, blank responses or inappropriate responses where non-math courses were stated.)

A large number of respondents indicated their previous math course occurred in 2017, followed by the 2016 response, and 2015 and before. Some indicated no response. In coding these, the latest year indicated was chosen if a response contained multiple years. (For example, if a response was 2015-2016, it was coded as 2016.)

**Income level.** The “low income” status was defined by the college site research office as the student qualifying and receiving financial aid in the form of CalWORKS/TANF/AFDC grants, participation in a Supplemental Security Income program, receipt of General Assistance, and eligibility for a Board of Governors fee waiver.

**Positivity ratio.** Initially, the overall positivity ratio was to be calculated using the total of all positive responses divided by the total of all negative responses. However, many respondents left questions blank or responded twice to a question. To account for this, two options were considered. Option one was to replace the missing or double answered responses with an average of negative or positive responses based on the category of question. (In this case, the average would be either the average of the individual or the average of the data set for the question.) The second option was to calculate the positivity ratio for each survey as an average of positive responses divided by the average of negative responses, then calculate the overall positivity ratio as the average of the positivity ratios from each survey. Mathematically, the second option when compared to the first option had minimal changes to the resulting overall positivity ratios. Given the ease of calculation the second option was chosen to calculate the overall positivity ratio when more than one

survey response was used in the analysis. See Appendix D for the imputed results from the first option.

### **Reliability and Validity Results for the mDES**

An Exploratory Factor Analysis was conducted on the results of each survey administration with two factors. Those results showed that the positive emotions questions correlated with the first factor, and the negative emotions correlated with the second factor. These results were as expected given that the intent of the survey is to measure two categories of emotions (positive and negative). The results of the analysis can be found in the Appendix E.

Cronbach Alphas were calculated for each survey administration. The Cronbach Alpha for the first survey administration positive subscale was 0.88 and the negative subscale 0.84. The second survey administration had Cronbach Alpha values 0.89 and 0.89 for the positive and negative subscales, respectively. The third survey administration had Cronbach Alpha values 0.90, and 0.87 for the positive and negative subscales, respectively. Since all the Cronbach alpha values were above the acceptable 0.70 value, the mDES showed a high level of internal reliability, as expected.

Previous studies (Fredrickson, et al, 2003; Waugh & Fredrickson, 2006) have found acceptable internal reliability of the mDES positive and negative subscales to range from 0.79 to 0.86. The Cronbach alpha values found in the present study are well above the previous results and above the 0.70 standard acceptable value.

### **Correlation Results**

A summary of the course grade and positivity ratio of the participant subgroups that were analyzed in this study are presented in Table 3.5. The overall course grade for the entire sample was 2.305, and the average positivity ratio for the entire sample was 1.901. The course grade for the different race/ethnicities ranged from 1.333 to 2.875, and the average positivity ratios ranged from 1.643 to 2.229. Female participants showed a slightly higher course grade (2.400) than males participants (2.133), and female participants had a slightly lower positivity ratio (1.856) than male participants (2.010). Both of these differences were not statistically significant ( $t=-1.056$ ,  $p>0.05$  and  $t=-.917$ ,  $p>0.05$ , respectively). A similar result was seen with students classified as low income (average course grade 2.339 and average positivity ratio 1.859) versus not low income (average course grade 2.217 and average positivity ratio 2.009). These results were also not statistically significant ( $t=0.503$ ,  $p>0.05$  and  $t=-0.782$ ,  $p>0.05$ , respectively). By age group average course grade ranged from 2.000 to 3.083, and average positivity ratio ranged from 1.734 to 2.125.

Over the entire sample of participants that took all three surveys and received a final letter grade for the course, there was no correlation or acceptable p-value between students' positivity ratio and their final course grade ( $r=0.145$ ,  $df=80$ ,  $p>0.05$ ). Ultimately, this means the null hypothesis must be accepted, and there is not significant correlation between a student's overall positivity ratio and final course grade. However, there is room for additional analysis by demographic subgroups to investigate the possibility of other significant correlations (for additional detail see Table 3.6 for correlations of sample subgroups and p-values).

When reviewing the results from the correlation analysis between the students' course grade to their total positivity ratio one subgroup, males, had a significant but moderately positive correlation ( $r=0.38$ ,  $df=28$ ,  $p<0.05$ ).

Additionally, students with a low income showed almost no correlation between positivity ratio and course grade ( $r=0.119$ ,  $df=57$ ,  $p>0.05$ ), and students not classified as low income also showed minimal correlation between positivity ratio and course grade ( $r=0.253$ ,  $df=21$ ,  $p>0.05$ ).

The race/ethnicity subgroups showed no significant correlations or acceptable p-values. The Asian subgroup showed moderately positive but insignificant correlation ( $r=0.46$ ,  $df=14$ ,  $p>0.05$ ). This Asian subgroup had a small sample size of  $n = 16$ , potentially leading to the lack of significant results. Further study in the area of the relationship between positivity ratio and course grades with various race/ethnicities may be warranted given the differences seen in this study.

Age did not yield any correlations values or p-values of significance. The less than 20 years of age subgroup had almost no correlation ( $r=0.04$ ,  $df=33$ ,  $p>0.05$ ), the subgroup between 20 and 24 years of age showed a weak positive but insignificant correlation ( $r=0.216$ ,  $df=25$ ,  $p>0.05$ ), and the subgroup 25 years and older a weak positive but insignificant correlation ( $r=0.193$ ,  $df=18$ ,  $p>0.05$ ). Grouping the age ranges above 20 yielded no significant correlation between final course grade and positivity ratio ( $r=0.195$ ,  $df=45$ ,  $p>0.05$ ).

Previous experience in mathematics by student placement level did not yield a significance in correlation value or p-value. Students that were considered underplaced showed a weak positive but insignificant correlation ( $r=0.304$ ,  $df=15$ ,

$p > 0.05$ ). Students that were not underplaced showed almost no correlation ( $r = 0.067$ ,  $df = 52$ ,  $p > 0.05$ ).

Students with previous experience in mathematics in 2015 and before showed a weak negative but insignificant correlation ( $r = -0.301$ ,  $df = 9$ ,  $p > 0.05$ ). It should be noted that this particular subset was created out of convenience as there were many different years provided by respondents before 2015. A majority of the respondents had listed their previous math course taken as 2017, which had a weak positive but insignificant correlation ( $r = 0.184$ ,  $df = 50$ ,  $p > 0.05$ ). Students with previous course work in 2016 also showed a weak positive but insignificant correlation ( $r = 0.232$ ,  $df = 9$ ,  $p > 0.05$ ).

The theoretical critical positivity ratio of 3:1 represents an ideal ratio of positive to negative emotions experienced that leads to human thriving (Fredrickson & Losada, 2005). Analyzing the group of participants with a ratio below 3:1 showed no significant results; however, above or equal to 3:1 the group showed a significant negative correlation ( $r = -0.81$ ,  $df = 5$ ,  $p = 0.027$ ). This result is somewhat in alignment with the potential curvilinear or quadratic (inverted u-shape relationship) between positivity ratio and thriving. The number of participants with a total positivity ratio above or equal to 3:1 was extremely small. The significant result with such a small number provides some important evidence for the finding.

### **Linear Regression Results**

A linear regression analysis was conducted between the variables of course grade and positivity ratio of the entire sample data. In addition, a linear regression



analysis was conducted with each of the demographic subgroups that showed some level of correlation (male, Asian, and positivity ratio above or equal to 3:1).

The linear regression between the outcome variable of course grade and the independent variable positivity ratio showed that the positivity ratio is a poor predictor of course grade (See Table 3.7). This was somewhat expected as the correlation between positivity ratio and grades for this data set was 0.1453 with a p-value 0.1927.

The linear models for the subsets of data that had the highest correlations yielded linear models that were a poor to modest fit and of a range of significance levels. The male subgroup as seen in Table 3.8 showed a modest fit model, ( $R^2 = 0.1128$ ,  $F(1, 28) = 4.688$ ,  $p = 0.03905$ ). The result indicated that for the male subgroup positivity ratio is a modest predictor of final grades. The Asian subgroup seen in Table 3.9 showed a poor fit with an insignificant p-value above 0.05.

Of note, the subgroup with a positivity ratio above or equal to the theoretical idea of 3:1 had a strong fit linear model showing that positivity ratio could be a strong predictor of the student grade ( $R^2 = 0.5889$ ,  $F(1, 5) = 9.595$ ,  $p = 0.02693^*$ ). See Table 3.10 for the results. This result along with the significant negative correlation found for this subgroup shows that higher ratios above 3:1 can result in lower rather than higher grades. This finding is a point worthy of future investigation, given the significant result with such a small sample. However, this result is supposing that the theoretical 3:1 positivity ratio is the ideal ratio.

## **Discussion**

The present study explored the relationship between positive emotions and community college developmental mathematics achievement. It confirmed the null hypothesis: There will be no significant correlation between the positivity ratio and student final grades in developmental mathematics courses. This result is in contrast to what was expected by the Broaden-and-Build Theory of Positive Emotions (Fredrickson, 2004, 2009, 2013).

While this study did not confirm the relationship predicted by the Broaden-and-Build Theory of Positive Emotions, the study did raise questions not yet addressed by the theory related to the demographics of the population studied. In particular, differences in the regression analysis showing a relationship of positivity ratio on final grade, as well as correlations between positivity ratio and final course grade appeared to exist for certain subgroups based on gender, race/ethnicity, and age.

The regression analysis showed two groups with statistically significant results, male students and students with a high positivity ratio (3:1 and above). While statistically significant the male group produced a model with a modest positive fit, with a sample size of 30. The high positivity ratio group model showed a strong negative fit, however with a small sample size of seven. Given the small sample sizes, such results indicate a strong relationship. Presumably using larger samples would lead to even stronger relationships.

While the correlation between positivity ratio and course grade for male students and students with a high positivity ratio (3:1 or above) were statistically significant, with a sample sizes of 30 and 7, respectively, attempting to repeat this

study with larger sample sizes is recommended. Similarly, the Asian subgroup showed a stronger positive correlation but with a p-value too large to be considered statistically significant ( $p=0.07$ ) and sample size of 16, again warranting the recommendation to replicate this study with a larger sample size. Larger sample sizes will allow for further investigation of demographic groups that had sample sizes too small to report or be statistically significant.

### **Conclusion**

The present study found that positivity ratio was moderately predictive of final course grades for male participants and strongly predictive for participants with a high positivity ratio (3:1 or above). Specifically, the regression results showed that for male participants the positivity ratio was a modest predictor of final course grade, such that those males who had a higher positivity ratio also received higher final course grades. The regression results also showed that, for participants with a positivity ratio above 3:1, the positivity ratio was a strong predictor of final course grade. Additionally, the correlation for the group above the 3:1 positivity ratio, the correlation with final course grade was strong and negative; thus, those with higher positivity ratios received lower final course grades. These latter results align with the work of Fredrickson and Losada (2005) and Rego, et al (2012) as both found a decrease in thriving and creativity after the 3:1 positivity ratio.

Two positive moderate correlations were found, one with male participants which was statistically significant and one with Asian participants which was slightly outside of the 0.05 acceptable p-value. These findings are similar to those found in Rego, et al (2012) and Waugh and Fredrickson (2006) in that they found a predictive

relationship between positive emotions and positive outcomes of creativity and self-other overlap; however, these previous authors did not examine gender or racial/ethnic differences. The correlations in the current work indicate that more work could be done to add to the theoretical framework of the Broaden-and-Build Theory of Positive Emotions as related to different groups and the positive outcomes in an educational setting.

The correlations, obtained in the present study, provide the foundation for future work in the fields of education and positive psychology. In particular, research should focus the relationship between positive emotions and student success for the gender and race/ethnicity. Research focused on the students who already have a high positivity ratio will be of interest, as this group showed a strong negative correlation between positivity ratio and course grades. Additionally, the linear regression for the subgroups of students with high positivity ratio students and male students showed statistically significant results with linear models that were a modest fit (male students) and a strong fit (high positivity ratio students). Both represent areas for future research and investigation.

Practitioners, specifically community college faculty, administrators, and staff, should take note of these findings. The possibility of using these results to help guide students towards services for emotional health and academic support might be of worthy consideration. For example, the mDES could be administered during an orientation to determine if a student should seek out an emotions intervention to help raise their positivity ratio, although care must be taken not to raise the student's positivity ratio above the 3:1 level.

There are, however, some limitations of this work. As has previously been mentioned, the study took place with a small group of students at one community college. Future research should focus on a larger sample size and more frequent administration of the surveys. Emotions may change over time; therefore future research may consider administering the mDES at more frequent time intervals throughout a term or school year.

Many of the subgroups investigated in this study contained small sample sizes. These small sample sizes could mean that relationships were not revealed or results may not be repeated. Large scale investigations should be conducted to increase the sample sizes of each subgroup and reveal new results or replicate current results.

The results of this study provided a direction to the future research related to emotions and community college developmental mathematics. It is possible that positive emotions can be merged with other theories from positive psychology such as the growth mindset or grit. A future study relating measurement instruments from a variety of fields may yield interesting results. The results of this study showed there is a potential relationship between overall emotional state and student achievement outcomes. Revision of this study or related future studies are recommended and should be considered a worthy pursuit in education and positive psychology research.

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Table 3.1

*Gender Demographics – College Developmental Math versus Study Participants*

<u>Gender</u>	<u>College</u>	<u>Sample</u>
Female	328/537 = 61.1%	50/82 = 61%
Male	203/537 = 37.8%	30/82 = 36.6%
Unknown	6/537 = 1.1%	2/82 = 2.4%

Table 3.2

*Low Income Status – College Developmental Math versus Study Participants*

<u>Low Income Status</u>	<u>College</u>	<u>Sample</u>
Yes	350/537 = 65.2%	59/82 = 72%
No	187/537 = 34.8%	23/82 = 28%

Table 3.3

*Race/Ethnicity – College Developmental Math versus Study Participants*

<u>Race/Ethnicity</u>	<u>College</u>	<u>Sample</u>
African American	100/537 = 18.6%	14/82 = 17.1%
American Indian/Alaskan Native	1/537 = 0.2%	0%
Asian	104/537 = 19.4%	16/82 = 19.5%
Filipino	22/537 = 4.1%	5/82 = 6.1%
Hispanic/Latino	188/537 = 35.0%	32/82 = 39.0%
Pacific Islander	5/537 = 0.9%	3/82 = 3.7%
White	84/537 = 15.6%	7/82 = 8.5%
Multi-Race	31/537 = 5.8%	5/82 = 6.1%
Unknown	2/537 = 0.4%	0%

Table 3.4

*Age – College Developmental Math versus Study Sample*

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<u>Age</u>	<u>College</u>	<u>Sample</u>
Younger than 20	219/537 = 40.8%	35/82 = 42.7%
20 to 24	149/537 = 27.7%	27/82 = 32.9%
25 to 39	121/537 = 22.5%	12/82 = 14.6%
40 or older	48/537 = 8.9%	8/82 = 9.8%
Unknown	0%	0%

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Table 3.5

*Average Course Grade and Positivity Ratio for Various Demographic Groups*

<u>Group</u>	<u>Mean Course Grade</u>	<u>Mean Positivity Ratio</u>	<u>Count</u>
All	2.305	1.901	82
African American	2.357	1.643	14
Asian	2.875	1.894	16
Filipino	2.400	2.080	5
Hispanic/Latino	2.000	1.950	32
Pacific Islander	1.333	1.800	3
White	2.857	2.229	7
Multi-Race	2.000	1.760	5
Male	2.133	2.010	30
Female	2.400	1.856	50
Unknown Gender	2.500	1.400	2
Yes Low Income	2.339	1.859	59
No – Low Income	2.217	2.009	23
Younger than 20	2.200	1.734	35
20 to 24	2.185	2.044	27
25 to 39	3.083	1.917	12
40 or older	2.000	2.125	8
Positivity ratio 3 or higher	2.714	3.514	7
Positivity ratio less than 3	2.267	1.751	75
Underplaced Students	2.353	2.188	17
Experience 2015 and before	2.909	2.018	11

Table 3.6

*Correlations of Course Grade and Positivity Ratio for Various Demographic Groups*

<u>Group</u>	<u>R</u>	<u>df</u>	<u>p</u>
All	0.145	80	0.1927
African American	-0.1808	12	0.536
Asian	0.4605	14	0.07265
Hispanic/Latino	0.2259	30	0.2137
Male	0.38	28	0.03905*
Female	0.0541	48	0.7088
Yes – Low Income	0.119	57	0.3684
No – Low Income	0.253	21	0.2439
Younger than 20	0.04	33	0.8181
20 to 24	0.216	25	0.2793
25 to 39	0.3941	10	0.2048
Positivity Ratio 3 or higher	-0.811	5	0.02693*
Positivity Ratio less than 3	0.114	73	0.3312
Underplaced Students	0.304	15	0.2363
No Placement Response	0.264	9	0.4331
Appropriate Placement	0.067	52	0.6297
Previous Experience 2015 and before	-0.301	9	0.3679
Previous Experience in 2017	0.184	50	0.1923
Previous Experience in 2016	0.232	9	0.4919

Table 3.7

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
Entire Sample (N=82, df = 80)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.8876	0.3397	5.556	
Positivity ratio	0.2195	0.1671	1.314	0.193

---

Note:  $R^2 = 0.008882$ ,  $F(1, 80) = 1.726$ ,  $p = 0.1927$

---

Table 3.8

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
Male Subgroup (N=30, df = 28)*

---

	<u>B</u>	<u>SE B</u>	<u>T</u>	<u>p</u>
Constant	1.0064	0.5523	1.822	0.0791
Positivity ratio	0.5607	0.2590	2.165	0.0391*

---

Note:  $R^2 = 0.1128$ ,  $F(1, 28) = 4.688$ ,  $p = 0.03905^*$

---

Table 3.9

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio Asian Subgroup (N=16, df = 14)*

---

	<u>B</u>	<u>SE B</u>	<u>T</u>	<u>p</u>
Constant	1.4655	0.7633	1.920	0.0755
Positivity ratio	0.7443	0.3834	1.941	0.0727

---

Note:  $R^2 = 0.1558$ ,  $F(1, 14) = 3.768$ ,  $p = 0.7265$

---

Table 3.10

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio, Positivity Ratio  $\geq 3$  (N=7, df = 5)*

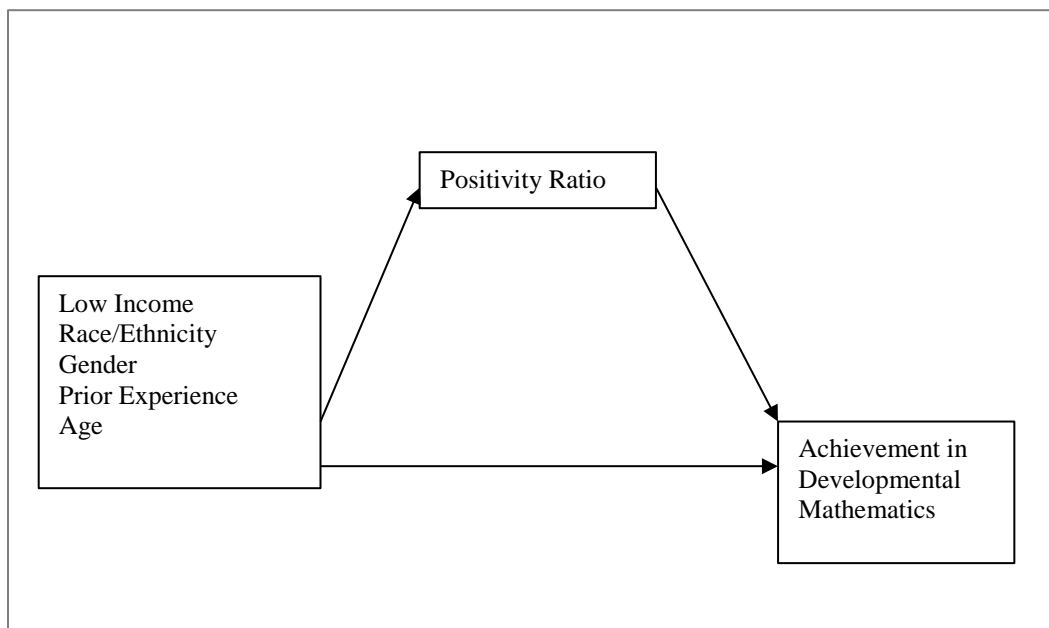
---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	6.5018	1.2284	5.293	0.00321
Positivity ratio	-1.0777	0.3479	-3.098	0.02693*

---

Note:  $R^2 = 0.5889$ ,  $F(1, 5) = 9.595$ ,  $p = 0.02693^*$

---



*Figure 3.1:* Theoretical framework: Linking positive emotions to race/ethnicity, gender, low income status, prior experience, and age. This framework is adapted from (Rego, et al, 2012).



## **Chapter 4**

### **General Conclusion**

This chapter contains the general conclusion of the dissertation. An overview of the research results is presented, a discussion of the limitations of the study, and directions of future research is provided. Additionally, implications for practice at the community college and in higher education are provided.

### **Overview of Research Questions and Results**

The primary research question asked in this study was focused on the investigation of the relationship between positive emotions and developmental mathematics at the community college. To investigate this question a study was designed to measure positive emotions of students in developmental mathematics courses at a community college. The measure was determined based on usage in the research of the Broaden-and-Build Theory of Positive Emotions (Fredrickson 2009). The survey known as the modified Differential Emotions Scale (Fredrickson, 2013) was given three times during a semester and results from these surveys were aggregated and analyzed with the students' final course grades in the developmental mathematics courses.

The results showed that for male students there was a statistically significant and moderately positive correlation between positivity ratio and final course grades. Also, for the male subgroup there was a weak predictive ability for the positivity ratio to predict final course grades. Another result appeared for students with a high positivity ratio (above 3:1); there was a statistically significant negative correlation

between positivity ratio and final course grades. For the Asian subgroup there was moderately positive correlation between positivity ratio and final course grades; however, the result did not achieve the acceptable p-value of 0.05 ( $p=0.072$ ).

The correlation and regression results for the male students were expected based on the Broaden-and-Build Theory presented and summarized in Fredrickson (2013). The correlation and regression results seen for students with high positivity ratio were aligned with the results seen in Fredrickson and Losada (2005), Rego, Sousa, Marques, and Pina e Cunha (2012), and Waugh and Fredrickson (2006). While these expected results were found and other results for some demographic groups were slightly outside of the acceptable 0.05 p-value of significance, there is room to investigate further the application of the Broaden-and-Build Theory of Positive Emotions to educational settings and through investigation of data disaggregated by demographic groups.

### **Limitations of the Study**

While the present study found conclusions for two subgroups of students, there are several limitations to the present study that may be addressed to hopefully strengthen and expand these results. Limitations to this study include the sample size of the population studied, the participant's ability to understand the questions in the mDES survey, and the grading consistency between instructors. Finally, the study analyzed the results of the mDES administered three times over the course of the semester. This analysis may have limited the potential for the study to reveal correlations and predictability of the positivity ratio at different time periods during a semester.

Contributing to the sample size limitation was the consistency in participation throughout the term the surveys were administered. While reasonable number of participants completed all three surveys (82), there was the potential of almost 150 participants that could have completed all three surveys had they all been present in class or chosen to participate consistently throughout the term. Future research should attempt to conduct the study with more course sections as well as multiple semesters to increase the number of participants.

The use of the mDES became a limitation because the survey was in English and it was not translated into the native languages of the students in the study. Some students at the community college site were not native English speakers and therefore may not have the English proficiency to accurately respond to the survey. Additionally, there may have been cultural differences between the participants and the survey itself. Future research should consider determining the most prevalent native languages used on campus, translating the mDES into those languages for more accurate measurement of emotions, and potentially revising some items to reflect cultural issues.

There was also potentially some inaccuracy in the collection of previous mathematics coursework. Many participants did not answer the question about what their previous mathematics class was and when they took that class. Future consideration should be given to clarifying the questions regarding previous coursework and the dates of the previous course.

Variability in grading practices may have been another limitation of this study. Instructors at the research site had autonomy in exam content, weighting of

course grades, and format of exams. Gathering data and sorting anonymously by instructors could potentially normalize the grade results and lead to more precise results during the analysis. Additionally, sorting by instructors would necessitate surveying more sections over the course of several semesters to achieve a large enough sample size to analyze results disaggregated by demographic group.

A final limitation of the present study may be in the decision to analyze the positivity ratio as an aggregate of three surveys administered over the course of a semester. Perhaps some consideration can be given to analyzing each survey result (beginning, middle, and end of semester separately) as a means to determine if there are times during the semester that relate or predict the outcome of final course grade. Results from this modification of the study could result in a variant on the scope of the positivity ratio research.

### **Suggestions for Future Research**

As mentioned above, future research should include a larger number of students, particularly if gathering data over an entire semester. There should also be some form of clarification of how to define previous coursework or placement of students into the current course. In terms of grading consistency future research may consider surveying multiple sections taught by the same instructor as an attempt to maintain some internal consistency of grading. However, future research looking at surveying several sections of an instructor should consider that an instructor could influence the student positivity ratios.

The results of correlations of the students that participated in each survey administration did not show any significant results as indicated in Tables 4.1 through

Table 4.3. Using the demographic breakdown of each survey as seen in Table 4.4 an investigation of the correlations of several demographic groups was conducted. Utilizing the results seen in Tables 4.5 through 4.11, there is another potential direction for future research. This would be in the form of analyzing how each survey administration relates to the outcome of final course grade. The following analyses provide some evidence that this may be a fruitful line of inquiry.

There appear to be differences within different demographic groups and the correlations between their positivity ratio and final course grade. These results are presented here to provide the evidence for pursuing future research. The male subgroup showed a correlation of significance between positivity ratio and final course grade on all survey administrations, while the underplaced subgroup showed a correlation of significance on the first and second administration and the Asian subgroup showed a correlation of significance on the third administration.

For male students with the W grade excluded there was a statistically significant ( $p < 0.05$ ) positive correlation between positivity ratio and final course grade on all three survey administrations (Table 4.5, Table 4.9, and Table 4.11). These results indicate that future research could consider determining if positivity ratio serves as an early predictor of course success in male students.

Underplaced students showed a similar correlation on the first and second survey administrations where their positivity ratios correlated positively and significantly ( $p < 0.05$ ) with final course grades (Table 4.6 and Table 4.10), however this correlation only appeared when the W grade (or withdrawing from the class) was included in the grade calculation. It is important to note that a W grade is indicative

of an early withdraw from a course and a student designated as underplaced may have reasons for withdrawing that are beyond the scope of this study. To better understand the choice of a student to withdraw from a course, perhaps a qualitative approach through exit interviews would yield more informative results as to the reasons for that withdrawal.

The Asian subgroup of students showed a positive correlation of significance ( $p < 0.05$ ) on the third (final) survey administration. This could be an indicator that, for the Asian subgroup, there is a relationship between positivity and end of semester final course grade during the timeframe of the end of the semester. Further research with a larger sample and perhaps a variety of courses to determine if this particular result was an anomaly. Also, future research that includes qualitative interviews might determine the ways in which Asian students describe their approach to the end of the semester. Finally, future research should consider, if available, disaggregating the larger Asian group into the subgroups of Asian race/ethnicities for additional detail and cultural differences within the Asian population.

Consideration could be given to examining the effects of positivity ratio variability throughout a term. Many students experience changes in emotional state over time due variation in life experiences. For example, students may experience a death in their family, a change in housing situation, or financial stressors. Any of these events could result in a change in positivity ratio on one of the surveys given during the term. Future research could examine the variance for individuals over the course of the study and potentially interview participants to better understand the reasons for any anomalies in positivity ratio.

The experiences of student groups may vary and affect positivity ratios. Consideration in future research should be given to the relationship between student experiences and positivity ratios. For example, veterans may experience post-traumatic stress disorder or specific racial/ethnic groups may experience stresses or negative emotions within social contexts. Accounting for these differences remains an important focus and interviews of participants would provide additional detail beyond that of the mDES about the specific experiences of student groups.

Another area of interest is the relationship between positivity ratio and other academic areas. Perhaps mathematics is not unique in its relationship between student final grades and positivity ratio. Consideration should be given to investigating positivity ratio and a student's overall grade point average for a term. These investigations should also consider the implications for practice. Knowing the relationship between positivity ratio and student final grades can provide a point of early intervention to help students raise their positivity ratio in hopes of improving student success.

### **Implications for Practice**

Research has shown that individuals can learn to change their emotional state over time and therefore their positivity ratio (Fredrickson, 2009). While the present study does not definitively establish a strong relationship between positive emotions and course grades in developmental mathematics courses, the present study did show some relationships, and future research is needed to determine if there is a strong relationship.

Administrators, such as vice presidents of student services and instruction or deans of student services and instruction, should consider the emotional well-being of students as a factor when deciding which initiative or program to support. A positive emotional component may one day become a powerful and untapped support for students in their pursuit of a degree. The present study supports the possibility of positive emotions to support student learning, and administrators should consider this as evidence to keep an open mind to the possibility that positive emotions could be a factor in student success.

Counselors and advisors should also consider this research as a starting point from which to begin recommending support to students. Additionally, professional development for counselors around the benefits of positive emotions may help in other areas of a students' development. As a potential first point of contact for students seeking emotional or psychological help, counselors are well positioned to make recommendations of interventions to students.

Faculty interact with students in the classroom on a regular basis and the results from this study are the starting point for faculty to place some emphasis on positive emotions in the classroom. Faculty can easily make a more positive environment for students in the classroom, while maintaining rigor of course content. However, as the present study showed, very high positivity ratios correlated negatively with course grades; indicating a need to be mindful that this could be a detriment to the students' success in the course. Even with this in mind, faculty's role in the classroom make them well positioned to have a direct impact on student emotions and be the initiators of positive emotion interventions.



Finally, student organizations (such as student senates or student government) are the voice of students on campus and in this role they are in a position to advocate for students. If these results are an indicator of where the future of student support is headed, then student groups or student government are the voice of the students that could advocate the colleges for changes in practice surrounding emotional and psychological well-being on campus.

The present study has shown that implications for practice include emotional interventions for groups of students with too high of a positivity ratio, male students, and potentially Asian students. It should be noted that the present study is not currently advocating for interventions, but that these interventions could be useful pending the results of future studies. That being said, positive emotion development should be considered as a means for improving psychological health and well-being of students for the purpose of improving overall quality of life, not just course grades.

This study should help raise the awareness that a student's emotional health and well-being represent a factor in their education and development. Whether grades cause emotions to arise, or emotional state predicts final course grades, educational institutions should consider students' emotional states when making policy decisions, changes in classroom practice, or the overall student experience on campus. Emotions remain a complex and integrated part of a student's educational experience, thus student emotions deserve consideration in research and practice in all of higher education.

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Table 4.1

*Correlation Results – Course Grade and Positivity Ratio First Survey Administration (N=151, df = 149)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.1054	-

---

Note:  $t=1.2939$ ,  $p = 0.1977$

---

Table 4.2

*Correlation Results – Course Grade and Positivity Ratio Second Survey Administration (N=138, df = 136)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.1426	-

---

Note:  $t=1.681$ ,  $p = 0.0951$

---

Table 4.3

*Correlation Results – Course Grade and Positivity Ratio Third Survey Administration*  
( $N=126$ ,  $df = 124$ )

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.1509	-

---

Note:  $t=1.699$ ,  $p = 0.09167$

---

Table 4.4

*Number of Participants for Each Demographic Group and Each Survey Administration*

<u>Group</u>	<u>Survey 1</u>	<u>Survey 2</u>	<u>Survey 3</u>
All	151	138	126
African American	25	28	20
Asian	29	29	30
Filipino	8	7	7
Hispanic/Latino	51	44	42
Pacific Islander	4	3	3
White	21	18	19
Multi-Race	13	9	5
Male	50	50	49
Female	99	86	75
Unknown Gender	2	2	2
Yes Low Income	102	102	85
No – Low Income	49	36	41
Younger than 20	66	57	52
20 to 24	42	42	33
25 to 39	25	24	27
40 or older	18	15	14

Table 4.5

*Correlation Results – Course Grade and Positivity Ratio - Survey 1 Male  
Participants W Grade Excluded (N = 50, df = 48)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.2944	-

---

Note:  $t=2.1343$ ,  $p = 0.03795$

---

Table 4.6

*Correlation Results – Course Grade and Positivity Ratio - Survey 1 Underplaced  
Participants W Grade Included (N = 41, df = 39)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.3512	-

---

Note:  $t=2.3427$ ,  $p = 0.02434$

---

Table 4.7

*Correlation Results – Course Grade and Positivity Ratio - Survey 1 Underplaced Participants W Grade Excluded (N = 39, df = 37)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.3262	-

---

Note:  $t=2.0989$ ,  $p = 0.04271$

---

Table 4.8

*Correlation Results – Course Grade and Positivity Ratio - Survey 2 Male Participants W Grade Included (N = 54, df = 52)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.3925	-

---

Note:  $t=3.0771$ ,  $p = 0.003331$

---

Table 4.9

*Correlation Results – Course Grade and Positivity Ratio - Survey 2 Male Participants W Grade Excluded (N = 50, df = 48)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.3979	-

---

Note:  $t=3.0046$ ,  $p = 0.004218$

---

Table 4.10

*Correlation Results – Course Grade and Positivity Ratio - Survey 2 Underplaced Participants W Grade Included (N = 29, df = 27)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.3927	-

---

Note:  $t=2.219$ ,  $p = 0.03508$

---



Table 4.11

*Correlation Results – Course Grade and Positivity Ratio - Survey 3 Male Participants W Grade Excluded (N = 49, df = 47)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.2884	-

---

Note:  $t=2.065$ ,  $p = 0.04446$

---

Table 4.12

*Correlation Results – Course Grade and Positivity Ratio - Survey 3 Asian Participants W Grade Excluded (N = 30, df = 28)*

---

	1	2
1. Positivity ratio	-	
2. Course Grade	0.42435	-

---

Note:  $t=2.4798$ ,  $p = 0.01943$

---

Table 4.13

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 1 Male Participants W Grade Excluded (N = 50, df = 48)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>P</u>
Constant	1.1949	0.4129	2.894	0.0057**
Positivity ratio	0.3935	0.1844	2.134	0.0383*

---

Note:  $R^2 = 0.08667$ ,  $F(1, 48) = 4.555$ ,  $p = 0.03795^*$

---

Table 4.14

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 1 Underplaced Participants W Grade Included (N = 41, df = 39)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	0.8568	0.5167	1.658	0.1053
Positivity ratio	0.5195	0.2218	2.343	0.0243*

---

Note:  $R^2 = 0.1234$ ,  $F(1, 39) = 5.488$ ,  $p = 0.02434^*$

---

Table 4.15

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio - Survey 1 Underplaced Participants W Grade Excluded (N = 39, df = 37)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.0757	0.5162	2.084	0.0441*
Positivity ratio	0.4589	0.2186	2.099	0.0427

---

Note:  $R^2 = 0.1064$ ,  $F(1, 37) = 4.405$ ,  $p = 0.04271^*$

---

Table 4.16

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio - Survey 2 Male Participants W Grade Included (N = 54, df = 52)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	0.5809	0.4296	1.352	0.18212
Positivity ratio	0.6139	0.1995	3.077	0.00333**

---

Note:  $R^2 = 0.154$ ,  $F(1, 52) = 9.469$ ,  $p = 0.003331^{**}$

---

Table 4.17

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 2 Male Participants W Grade Excluded (N = 50, df = 48)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	0.7778	0.4219	1.844	0.07142
Positivity ratio	0.5817	0.1936	3.005	0.00422**

---

Note:  $R^2 = 0.1583$ ,  $F(1, 48) = 9.028$ ,  $p = 0.004218^{**}$

---

Table 4.18

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 2 Underplaced Participants W Grade Included (N = 29, df = 27)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	0.9990	0.6020	1.659	0.1086
Positivity ratio	0.5897	0.2657	2.219	0.0351*

---

Note:  $R^2 = 0.1542$ ,  $F(1, 27) = 4.924$ ,  $p = 0.03508^*$

---

Table 4.19

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 3 Male Participants W Grade Excluded (N = 49, df = 47)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.4295	0.3701	3.862	0.000343***
Positivity ratio	0.3519	0.1704	2.065	0.044464*

---

Note:  $R^2 = 0.08318$ ,  $F(1, 47) = 4.264$ ,  $p = 0.04446^*$

Note: No male students in this group had a W grade.

---

Table 4.20

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
- Survey 3 Asian Participants W Grade Excluded (N = 30, df = 28)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.6777	0.4155	4.037	0.00038***
Positivity ratio	0.5031	0.2029	2.480	0.01943*

---

Note:  $R^2 = 0.1801$ ,  $F(1, 28) = 6.149$ ,  $p = 0.01943^*$

Note: No Asian students in this group had a W grade.

---

## **Chapter 5**

### **Personal Reflection**

This document contains my personal reflections on the entire pursuit of the doctorate degree. This process has impacted me on several levels that the reflections are separated by professional, leadership, and academic reflections. My professional reflection focuses on my career and work, leadership reflection focuses on my current pursuits in academic leadership, and academic reflection focuses on my future goals for research.

### **Professional Reflection**

I began the of the pursuit of a doctoral degree in hopes that the degree and experience in the Community College Leadership Program would help me gain the experience needed to transition into an administrative position at a community college. Since beginning the degree I have had the opportunity to serve as an administrator at a community college. Ultimately, I found the work did not align with my expectations, and I have since decided to return to teaching in the classroom. As a result of returning to the classroom, upon completion of the doctoral degree, I plan to pursue faculty leadership positions more so than administrative leadership positions.

I have not ruled out the possibility of pursuing administrative leadership in the future, but have for the time being decided that I find more professional and personal fulfillment in a faculty position. In addition, in my current role as a faculty member and given my experience, I feel that I am more effective as a mentor to new faculty

and as a resource to my department colleagues. I greatly enjoy helping my colleagues and the fulfillment that comes along with the role.

### **Leadership Reflection**

As I have been in different positions in the college, I feel that leadership takes on many different forms. In some cases, leadership is advising and providing consultation to those we serve. I believe that taking on the role of advisor and counsel is well within my comfort level. Leadership may take on the role of management of others, and it was clear from my experience as an administrator that I am not comfortable with the management of others. Given that my comfort zone is as an advisor and mentor, I believe that I am best suited (for now) as a leader by example in the faculty role. Being in the faculty role and leading through example, means I am always working to improve my craft as an instructor and maintain strong organizational and decision making skills.

Leading from the faculty role provides a certain amount of credibility to faculty members and staff. Somehow being in the same “level” provides those we serve with some comfort and trust; there is an aspect of default trust that exists between faculty members that does not exist in some faculty to administrator discussions. Leading by example provides that additional credibility; it is not a matter of I would do this or I have done that, but I am doing this and I just yesterday did that. There is something of a community of practitioners that I am back to being a part of that I was not a part of when I was an administrator. As a leader from within, I am credible, accepted, heard, and comfortable. At the moment I cannot think of a good reason to leave this comfortable role, perhaps I never will, but I am open to the



idea of changing positions, and I will not let my experience as an administrator keep me from having an open mind about the future.

### **Academic Reflection**

Another result of earning a doctoral degree is the ability to conduct research in a field of study. While I do not currently work at a research institution, I believe it is within my abilities to consider one day looking for adjunct positions at the local universities. Perhaps I can consider speaking engagements and partnering with the local area universities to conduct research. I do not want to close any potential doors that the doctoral degree opens, nor do I want to deny myself the opportunity to try a new endeavor after completing my degree.

I have interest in researching further the nuances of emotions in the classroom and new educational modalities such as online learning and makerspaces. Current technologies have improved, and content is continually growing on the internet such that individuals may not necessarily need the formal educational institutions we currently have in place. Perhaps even more so, higher education needs to consider how we might adapt our current institutions to the changing dynamics of the availability of information to our students. Doing so would necessitate significant research and analysis of the systems in place and the new developing models that exist to help individuals learn and acquire new skills.

### **Conclusion**

Nearly 15 years ago as a mathematics student I would not have considered emotions an integral component to my education. As a mathematics instructor at a community college I began to see the impact emotions have on the students I

interacted with every day. The original purpose of this project was to motivate, through research, the need to address the importance of emotions in the mathematics classroom. As this journey ends for me, I see that the process of testing a theory, or even adding to a theory or body of research, is an arduous task just as difficult and challenging as attempting to solve an unsolved problem in mathematics. Any one person may add to the theory or contribute to the support of a theory, but the theory and the research conducted must be extremely profound to significantly change the underlying beliefs. Thus, anyone in research must accept that projects move the needle of theory and progress in any field. While one may choose or desire to change the system in which they work or live, they must accept that changes to the system begin with small and incremental changes.

The process of finding a topic, reading and learning about an associated theory, planning a research project, executing the project, analyzing the data, and drawing conclusions have at times felt overwhelming. However, the process and even the finished product are not what should be valued; what is of true value to this whole endeavor is the direction that the results point and experiencing the challenges of the work involved. This new direction or new idea that is presented will represent an untold future of possibilities. This future is that value of the work done, the final paper is nice to have, but ultimately not a measure of the potential that could come from the existence of the paper in the world.

At the start of this journey I was told by a close friend that the completion of the degree will open doors to a future, and the choice is mine whether to walk through those doors or not. It is true that several doors have been opened as a result of

pursuing this degree, and I have at times chosen to walk through those doors and at times return back to my original location. I have found that learning anything, writing, reflecting, and contemplating problems are all passions I have in the world of higher education. Leading and mentoring those new to the community college system is also my personal passion. If I could continue my personal growth and continue to help others grow into their positions, then I will have a fulfilled personal and professional career.

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**APPENDICES**

## Appendix A

### Growth Mindset

This appendix outlines some recent work in the field of positive psychology known as mindsets, specifically the growth mindset (Dweck, 2008). In recent years, this area of positive psychology has shown promise in its application to the educational setting. The results of several studies, summaries, and policy papers have recommended a focus on the growth mindset as a means for improving academic outcomes (Boaler, 2013; Claro, Paunesku, & Dweck, 2016; Hochanadel & Finamore, 2015; Rattan, Savani, Chugh, & Dweck, 2015; Sun, 2018). Some have shown applications in mathematics specifically, others in overall academic achievement, at a variety of levels (K-12 to college/university levels) (Howard & Whitaker, 2011; Claro, Paunesku, & Dweck, 2016; Sun, 2018). These illustrated how positive psychology could be applied to the educational setting, however they were outside the scope of the present paper which focused on positive emotions and the potential to theoretically be applied to the setting of community college developmental mathematics.

Sun (2018) surveyed 40 middle school teachers to determine their mindsets, selected 8 of those teachers in pairs based on courses taught and one with a fixed mindset and one with an growth mindset. Through a case study and semi-structured interview analysis the author observed classroom teaching and interaction with students around mindsets and beliefs about mathematics. To analyze the data a codebook was created and based on a theoretical framework of twelve practices similarities and differences were identified and gave rise to a continuum from fixed

mindsets to growth mindsets. This study examined teaching from a holistic perspective across many different teaching strategies. The author concluded that the framework developed (The Mathematics Teaching for Mindset Framework) could serve as a lens to view teaching practices.

Analyzing a national data set from Chile of 10<sup>th</sup> grade students in public schools Claro, Paunesku, and Dweck (2016) found that students with a growth mindset out performed those without the growth mindset view, even when accounting for socioeconomic factors. Concluding that growth mindset students were more likely to have higher academic achievement even when holding all other variables equal. Also, lower income were shown to have more of a fixed mindset and the students' mindset was a stronger predictor of success in lower income students. While these results supported the value of the growth mindset, the authors concluded that the growth mindset (or any psychological factor) were not necessarily more important than other social or structural factors. Future research was recommended to explore how psychological factors may reveal ways to better help students succeed.

Using a phenomenological study, Howard and Whitaker (2011) qualitatively studied the perceptions of newly successful students in developmental mathematics at a large four year college. The researchers used interviews, classroom observations, researcher journals, and student work to understand the successful students' perceptions moving from unsuccessful to successful. Three themes were found in this study: the turning point when students felt they began to be unsuccessful in mathematics, motivation to become more successful in mathematics, and strategies that helped the students achieve success. One conclusion of particular importance

was that when students were successful they exhibited qualities of the growth mindset and that these qualities were associated with success in mathematics.

Hochanadel and Finamore (2015) presented a brief literature review, an examination of what educators can do to foster a growth mindset and grit, and made recommendations for increasing persistence in college students. The review of the literature focused on the growth mindset and grit and summarized some key conclusions about the theories such as: grit can be developed by having a growth mindset; grit predicted achievement beyond measures of talent; a fixed mindset contributes to a lack of learning. Thus, developing grit in college students as a means to change the student perception of a fixed mindset.

Boaler (2013) summarized the literature behind the growth mindset and developing the growth mindset in school with focus on areas such as tasks students complete, questions asked of the students, grading and feedback policies, mistakes students make, setting norms, and grouping students. This article specifically focused on the areas of ability grouping and student mistakes. Ability grouping was defined as a cultural practice that communicated to the students the fixed mindset. Mistakes and reactions to mistakes in mathematics was the other area of focus. If mistakes were presented as a learning opportunity and a focus was placed on why the mistake occurred then this will foster learning. Ultimately, the author concluded that the findings from research show; the human brain has plasticity, student and teacher mindsets are crucial for learning, and practice in grouping students communicates a fixed mindset. The final recommendation of the author was that schools have a sense of urgency to shift from a fixed mindset practices to growth mindset practices.

In a policy paper, Rattan, Savani, Chugh, and Dweck (2015) drew attention to the concept of academic mindsets and the strategy of changing students' academic mindsets. Specifically, the growth/fixed mindset and the sense of belonging mindset. The growth mindset promotes learning and persistence while the sense of belonging mindset narrows achievement gaps and promotes underrepresented groups to pursue disciplines in which they are underrepresented. The authors concluded with policy recommendations that funds be directed to programs (both existing and new) that promote these academic mindsets. Suggestions were given for the Federal, State, and local level policy makers. Some suggestions included funding programs, changes in grading practices, and evaluation of programs with mindsets as interventions to make improvements in the programs. The authors admitted this is not an exhaustive review, and emphasize that the policy recommendations presented are focused on two areas of academic mindsets (growth/fixed and sense of belonging).

The concept of the growth mindset has clearly entered the world of education in practice and policy. The recommendations of researchers and practitioners of the growth mindset are valuable and popular at this time, however caution must be given not to consider the growth mindset a remedy that fixes all educational ailments. The growth mindset should be considered another tool in the toolkit of practitioners and policy makers as they make practical decisions in education.

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## Appendix B

### Philosophical Approach

For the purpose of this study a post-positivist philosophical approach will be taken. “Postpositivism recognizes that knowledge is “relative rather than absolute” but “it is plausible, using empirical evidence, to distinguish between more and less plausible claims” (Patton, 2002, p. 93). To better understand this world view the positivist world view is briefly discussed.

According to Schutt (2004) positivists believe in a reality apart from those that perceive the reality. Through well-designed tests of hypotheses, one can develop understanding of social processes. Furthermore, positivism values objective observation and does not value the researcher’s values, interpretations, and feelings (Borg & Gall, 1989). Positivists have a long history and have a strong philosophical belief in absolute truth and the ability to find it.

Such beliefs are similar to mathematics as mathematics is known to be an area of absolute truths based on sound logic. While studying mathematics I came to believe in this absolute truth and sought to find it. As a mathematics instructor working with students every day I realized that this is very difficult, if not impossible, within human endeavors.

Four criticisms of positivism led to the development of post-positivism. First, the assumption that theories can be confirmed or not via objective observations is problematic. Second, the assumption that observations used to test validity are value-free may not be possible. Third, the requirement that tests of knowledge can be reduced to observable phenomena can be difficult. Finally, the assumption that



knowledge claims in one setting once found to be true will carry over to another setting may or may not hold (Borg & Gall, 1989).

Both Schutt (2004) and Borg and Gall (1989) claimed that the post-positivist theoretical point of view states that there is an objective reality which is biased by the theories and values of the observers and researchers. In fact, as Schutt (2004) pointed out that, the post-positivist has more confidence in the community of researchers than in any one researcher. This intersubjective agreement is made by different observers about what is happening in the social world (Schutt, 2004). Stage and Manning (2003) agreed that the post-positivist seeks the consistency of results from across an array of studies.

As a researcher, I believe in seeking out the truth in an objective reality, however due to personal, observational, and value biases it is not possible to be 100% certain that the objective truth was discovered. Nevertheless, with an existing body of research produced by a community of researchers, I believe it is possible to replicate measurements in different environments to establish a new community of researchers through which we are more likely to discover a reasonable approximation of the truth. Due to this set of beliefs and desires, I have chosen a post-positivist philosophical approach for this study.

The goal of this study is to take an existing body of research (The Broaden-and-Build Theory) and apply it in a different setting (the community college) utilizing an explanatory research design (Creswell, 2012). Since a theoretical foundation already exists, the basis for this study is to investigate the relationship between the theory and student achievement in developmental mathematics. Efforts will be made

to account for potentially confounding variables (race/ethnicity, gender, age, income level, and previous experience in mathematics) in order to keep the study focused on positive emotions and the positivity ratio.

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**Appendix C**

Survey Instrument

Instructions: Please think back to how you have felt during the past 2 weeks. Using the 0–4 scale below, indicate how often you have experienced each of the following feelings.

1 = never  
 2 = rarely  
 3 = some of the time  
 4 = often  
 5 = most of the time

How often have you felt...	Response
1. fun-loving, or silly?	never - 1 2 3 4 5 - most of the time
2. angry, irritated, or annoyed?	never - 1 2 3 4 5 - most of the time
3. ashamed, humiliated, or disgraced?	never - 1 2 3 4 5 - most of the time
4. awe, wonder, or amazement?	never - 1 2 3 4 5 - most of the time
5. contemptuous, scornful, or disdainful?	never - 1 2 3 4 5 - most of the time
6. disgust, distaste, or revulsion?	never - 1 2 3 4 5 - most of the time
7. embarrassed, self-conscious, or blushing?	never - 1 2 3 4 5 - most of the time
8. grateful, appreciative, or thankful?	never - 1 2 3 4 5 - most of the time
9. guilty, repentant, or blameworthy?	never - 1 2 3 4 5 - most of the time
10. hate, distrust, or suspicion?	never - 1 2 3 4 5 - most of the time
11. hopeful, optimistic, or encouraged	never - 1 2 3 4 5 - most of the time
12. inspired, uplifted, or elevated?	never - 1 2 3 4 5 - most of the time
13. interested, alert, or curious?	never - 1 2 3 4 5 - most of the time
14. joyful, glad, or happy?	never - 1 2 3 4 5 - most of the time
15. love, closeness, or trust?	never - 1 2 3 4 5 - most of the time
16. proud, confident, or self-assured?	never - 1 2 3 4 5 - most of the time
17. sad, down-hearted, or unhappy?	never - 1 2 3 4 5 - most of the time
18. scared, fearful, or afraid?	never - 1 2 3 4 5 - most of the time
19. serene, content, or peaceful?	never - 1 2 3 4 5 - most of the time
20. stressed, nervous, or overwhelmed?	never - 1 2 3 4 5 - most of the time

Adapted from Fredrickson (2013).

## Appendix D

### Results from Imputed Data

An imputation of missing data was conducted to determine if there were differences in the results based on using average scores on a particular question to impute blank or double answered responses. The primary findings of this study were not changed as a result of this imputation. The tables that follow show the correlation results for the male, Asian, and positivity ratio above or equal to 3 groups.

Regression results are also presented.

Table D.1

*Correlation Results – Course Grade (dependent variable) and Positivity Ratio All Survey Administrations with Imputation Male Participants (N=30, df = 28)*

	1	2
1. Positivity ratio	-	
2. Grade Points	0.36895	-

Note:  $t=2.1005$ ,  $p = 0.04482^*$

Table D.2

*Correlation Results – Course Grade (dependent variable) and Positivity Ratio All Survey Administrations with Imputation Asian Participants (N=16, df = 14)*

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	1	2
1. Positivity ratio	-	
2. Course Grade	0.462499	-

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Note:  $t=1.9518$ ,  $p = 0.07126$

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Table D.3

*Correlation Results – Course Grade (dependent variable) and Positivity Ratio All Survey Administrations with Imputation Participants with Positivity Ratio Above or Equal to 3 (N=7, df = 5)*

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	1	2
1. Positivity ratio	-	
2. Course Grade	-0.77268	-

---

Note:  $t=-2.7218$ ,  $p = 0.04169^{**}$

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Table D.4

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
All Survey Administrations with Imputation Male Participants (N=30, df = 28)*

---

	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.0306	0.5568	1.851	0.0748
Positivity ratio	0.5481	0.2609	2.100	0.0448*

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Note:  $R^2 = 0.1361$ ,  $F(1, 28) = 4.412$ ,  $p = 0.04482^*$

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Table D.5

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
All Survey Administrations with Imputation Asian Participants (N=16, df = 14)*

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	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	1.4435	0.7702	1.874	0.0819
Positivity ratio	0.7552	0.3869	1.952	0.0713

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Note:  $R^2 = 0.2139$ ,  $F(1, 14) = 3.81$ ,  $p = 0.07126$

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Table D.6

*Linear Regression Results – Course Grade (dependent variable) and Positivity Ratio  
All Survey Administrations with Imputation Participants with Positivity Ratio Above  
or Equal to 3 (N=7, df = 5)*

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	<u>B</u>	<u>SE B</u>	<u>t</u>	<u>p</u>
Constant	6.8485	1.5244	4.493	0.00644**
Positivity ratio	-1.1846	0.4352	-2.722	0.04169*

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Note:  $R^2 = 0.597$ ,  $F(1, 5) = 7.408$ ,  $p = 0.04169^*$

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**Appendix E**

## Exploratory Factor Analysis

Table E.1

*Summary of Exploratory Factor Analysis Results for First Survey Administration (N = 134)*

Item	Factor Loadings	
	Positive Emotions	Negative Emotions
Fun-loving or silly	<b>0.60</b>	
Awe, wonder, or amazement	<b>0.58</b>	0.14
Grateful, appreciative, or thankful	<b>0.73</b>	
Hopeful, optimistic, or encouraged	<b>0.54</b>	-0.14
Inspired, uplifted, or elevated	<b>0.76</b>	-0.16
Interested, alert, or curious	<b>0.67</b>	
Joyful, glad, or happy	<b>0.76</b>	-0.22
Love, closeness, or trust	<b>0.68</b>	-0.20
Proud, confident, or self-assured	<b>0.57</b>	-0.23
Serene, content, or peaceful	<b>0.65</b>	-0.26
Angry, irritated, or annoyed	-0.24	<b>0.58</b>
Ashamed, humiliated, or disgraced		<b>0.72</b>
Contemptuous, scornful, or disdainful		<b>0.47</b>
Disgust, distaste, or revulsion		<b>0.41</b>
Embarrassed, self-conscious, or blushing		<b>0.60</b>
Guilty, repentant, or blameworthy		<b>0.66</b>
Hate, distrust, or suspicion	-0.21	<b>0.55</b>
Sad, down-hearted, or unhappy	-0.19	<b>0.68</b>
Scared, fearful, or afraid		<b>0.61</b>
Stressed, nervous, or overwhelmed	-0.20	<b>0.54</b>

*Note:* Factor loadings over .40 appear in bold.

Cronbach Alpha Positive Subscale = 0.88

Cronbach Alpha Negative Subscale = 0.84

Table E.2

*Summary of Exploratory Factor Analysis Results for Second Survey Administration*  
(*N* = 119)

Item	Factor Loadings	
	Positive Emotions	Negative Emotions
Fun-loving or silly	<b>0.68</b>	-0.14
Awe, wonder, or amazement	<b>0.62</b>	0.13
Grateful, appreciative, or thankful	<b>0.63</b>	
Hopeful, optimistic, or encouraged	<b>0.77</b>	
Inspired, uplifted, or elevated	<b>0.78</b>	
Interested, alert, or curious	<b>0.57</b>	-0.19
Joyful, glad, or happy	<b>0.72</b>	-0.32
Love, closeness, or trust	<b>0.65</b>	
Proud, confident, or self-assured	<b>0.68</b>	-0.27
Serene, content, or peaceful	<b>0.73</b>	-0.17
Angry, irritated, or annoyed	-0.26	<b>0.60</b>
Ashamed, humiliated, or disgraced		<b>0.77</b>
Contemptuous, scornful, or disdainful		<b>0.74</b>
Disgust, distaste, or revulsion	-0.15	<b>0.72</b>
Embarrassed, self-conscious, or blushing		<b>0.61</b>
Guilty, repentant, or blameworthy		<b>0.63</b>
Hate, distrust, or suspicion	-0.13	<b>0.65</b>
Sad, down-hearted, or unhappy	-0.21	<b>0.65</b>
Scared, fearful, or afraid	-0.17	<b>0.64</b>
Stressed, nervous, or overwhelmed	-0.21	<b>0.62</b>

*Note:* Factor loadings over .40 appear in bold.

Cronbach Alpha Positive Subscale = 0.89

Cronbach Alpha Negative Subscale = 0.89

Table E.3

*Summary of Exploratory Factor Analysis Results for Third Survey Administration (N = 108)*

Item	Factor Loadings	
	Positive Emotions	Negative Emotions
Fun-loving or silly	<b>0.67</b>	-0.19
Awe, wonder, or amazement	<b>0.55</b>	
Grateful, appreciative, or thankful	<b>0.67</b>	
Hopeful, optimistic, or encouraged	<b>0.63</b>	
Inspired, uplifted, or elevated	<b>0.72</b>	-0.26
Interested, alert, or curious	<b>0.66</b>	-0.11
Joyful, glad, or happy	<b>0.73</b>	-0.38
Love, closeness, or trust	<b>0.61</b>	-0.32
Proud, confident, or self-assured	<b>0.68</b>	-0.31
Serene, content, or peaceful	<b>0.64</b>	-0.22
Angry, irritated, or annoyed	-0.23	<b>0.53</b>
Ashamed, humiliated, or disgraced	-0.19	<b>0.72</b>
Contemptuous, scornful, or disdainful	-0.17	<b>0.53</b>
Disgust, distaste, or revulsion	-0.16	<b>0.59</b>
Embarrassed, self-conscious, or blushing		<b>0.61</b>
Guilty, repentant, or blameworthy		<b>0.67</b>
Hate, distrust, or suspicion		<b>0.67</b>
Sad, down-hearted, or unhappy	-0.16	<b>0.79</b>
Scared, fearful, or afraid		<b>0.69</b>
Stressed, nervous, or overwhelmed	-0.25	<b>0.53</b>

*Note:* Factor loadings over .40 appear in bold.

Cronbach Alpha Positive Subscale = 0.90

Cronbach Alpha Negative Subscale = 0.87