

Frustration discomfort and growth mindsets of preservice teachers in mathematics

by

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B.S., Emporia State University, 2009

M.S., Emporia State University, 2011

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

Department of Curriculum and Instruction  
College of Education

KANSAS STATE UNIVERSITY  
Manhattan, Kansas

2022

## **Abstract**

Undergraduate students in an education program, or preservice teachers, are expected to practice and teach productive struggle in mathematics as they prepare for their career. Productive struggle in mathematics requires students to persevere in solving rigorous tasks, despite their frustration in doing so. Therefore, a student's level of frustration discomfort and the degree to which they have a growth mindset may impact their ability to practice productive struggle. Is there a relationship between a student's degree of growth mindset and their level of frustration discomfort? This study used a correlation research design to investigate a relationship, if any, between degree of growth mindset and levels of frustration discomfort among preservice teachers.

*Keywords: productive struggle, growth mindset, preservice teachers*

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## **Dedication**

This dissertation is dedicated to Eli and Rose, my muse for passion, perseverance, and compassion.

## **Chapter 1 - Introduction**

Eli, a third grader, sits stuck at his desk staring at a mathematics task his teacher has asked the class to solve. Eli anxiously rereads the problem and embarrassingly looks around the classroom at his peers beginning to solve. Although Eli is capable of solving addition and multiplication procedural problems, the mathematics task is a real-world situation that requires a conceptual understanding of solving for perimeter and area. Eli feels frustrated that his peers are discussing strategies to solve. He tries to reread the problem again but reluctantly gives up. Noticing his head down and blank paper, the teacher approaches with intentions to encourage Eli to get started on the mathematics task. The teacher remembers Eli's lack of confidence and pattern of shutting-down when new topics are introduced in mathematics. The teacher knows how easily Eli gets frustrated and that he believes that he will never be good at math, but isn't sure how to adapt math practices and teaching strategies to address Eli's pattern of behavior.

Chapter I will briefly explain how Eli's story presents a problem in mathematics education concerning students' growth mindset and frustration discomfort that supports this research study. An overview will focus on the association of these dispositions with the mathematical teaching practices as foundation to the research problem, purpose, and questions. Last, Chapter I will touch on the design of the study, possible limitations and delimitations, and the definition of terms. The topics presented in Chapter I will be explored further in the Chapter II Literature Review. Chapter III will provide a detailed description of the research design, methods, and data collection of the proposed study.

### **Overview**

Trends in teaching pedagogy tend to follow patterns of teaching philosophy and learning theories, like constructivism. Recent research has examined specific teaching pedagogical beliefs

that promote such a rich learning environment. Inquiry-based instruction (Richardson et al., 2008), which may seem most appropriate for a science lesson, has become a topic to study in a mathematics classroom as well. In the realm of questioning and exploring is another hot topic in the research of mathematics education, growth mindset (Sun 2018). Student-led instruction (Buchbinder et al., 2019) also follows this pedagogical trend within the constructivist learning theory and supports conceptual understanding of mathematics. Teachers in these classrooms allow for mathematics lessons to follow the students' progression of understanding concepts rather than an assigned long-range plan. They also provide learning environments for students to discuss, argue, collaborate, and reason with their mathematical ideas amongst peers.

Another pedagogical trend in research of mathematics education is to investigate the positive effects on teaching and learning when teachers have a strong awareness of their students' individual mathematical abilities (Campbell et al., 2014, Clark et al., 2014). Studies show a positive relationship between students' content knowledge and the level of their teachers' student awareness (Campbell et al., 2014, Clark et al., 2014). Research indicates that students feel valued and have deeper connections with their teachers, specifically in more diverse urban districts, when student awareness is present (Maloney et al., 2020). In addition, the studies show that teachers with a higher level of mathematics content knowledge, also had higher levels of student awareness (Campbell et al., 2014, Clark et al., 2014). Therefore, the skills necessary to understand mathematics concepts are also necessary in order to be able to understand your students' mathematics abilities. Topics like growth mindset, student awareness, and connectedness may increasingly be present in educational literature and teaching resources to support teaching and learning under this pedagogy.

The National Council of Teachers of Mathematics (2017) defines *productive struggle* as “perseverance in completing difficult, yet attainable, goals that often have led to feelings of empowerment, efficacy, and hope.” Researchers are finding students that learn through the teaching strategy of productive struggle have a higher mathematical ability (Barlow et al., 2018, Vazquez et al., 2020). Productive struggle provides opportunities for students to build on previous mathematics experiences so various problem-solving methods can be attempted. Productive struggle is founded on a student-led and inquiry-based pedagogy through collaboration and discussions with peers in the classroom.

The heterogeneity of research in mathematics education makes it difficult to find profound literature on a particular topic with an isolated audience. There is a need for more research on the levels of frustration discomfort and in the degrees of growth mindset in preservice teachers to examine how we can best prepare future teachers and students for mathematics. Undergraduate students in education programs, or preservice teachers, are required to take courses to learn the mathematics content and teaching methods. The current trends, as described earlier, in mathematics education cover teaching strategies and pedagogy that foster a learning environment ideal for productive struggle. However, little research focuses only on the dispositions required to be successful at practicing productive struggle.

The field of education has given much attention to the issue of students’ mindsets. Carol Dweck and Jo Boaler have researched the characteristics of a fixed and growth mindset of students, specifically within mathematics (Boaler 2016 and Dweck 2000). A student's mindset falls somewhere on a scale between fixed (I will never be able to do it) and growth (I can’t do it yet) (Boaler 2016). These beliefs can be constructed from experiences and relationships within family, teachers, or simply society. Often preservice teachers in my mathematics courses share

their previous negative experiences struggling to learn mathematics. It is critical for them to share their stories to better understand where and why they fall on the mathematical mindset scale between fixed and growth. More importantly, preservice teachers must reflect to determine how this may affect their own teaching of mathematics. Although much research has been done on the mathematical mindset of students, more is still needed on preservice teachers and this translation into the professional mathematics classroom. This study used Carol Dweck's Theories of Intelligence Scale (TIS) to study the mindsets of preservice teachers.

It is common for students with a fixed mindset in mathematics to feel frustrated and anxious when practicing mathematics. From elementary students to undergraduates and beyond, those with a fixed mindset tend to shut down when faced with a rigorous mathematical problem. Some students may begin to attempt strategies to solve, but others allow their fear of failing to overtake their courage to simply try. Researcher, Dr. Neil Harrington (2005c), developed an instrument, the Frustration Discomfort Scale (FDS), based on the Rational Emotive Behavior Therapy (REBT) theory. In conjunction with the TIS, preservice teachers were given the FDS to measure frustration discomfort. This study investigated the relationship, if any, between the degree of growth mindset and the level of frustration discomfort in preservice teachers.

Education programs in higher education commonly require courses on mathematics with content and procedural knowledge, and thereafter require preservice teachers to observe and intern, or student teach, mathematics lessons in the classroom (Krebs et al., 2006). For example, a mathematics course in such a program emphasizes on number sense in an effort to improve the awareness and proficiency of mental computation and number relationships of preservice teachers (Fung et al., 2010). However, the instruction in this course focuses on the students' ability to compute mentally and not on the application of such mathematical skills from teacher

to student. Therefore, when students are observing during their internship, they often make surface-level observations instead of deeper mathematical thinking observations when watching mathematical lessons in classrooms (Krebs et al., 2006). There can be a disconnect between the content learned in the mathematics course in the teacher preparation program and the application to use the skills as a student teacher. It would be beneficial for mathematics methods courses to include opportunities for preservice teachers to practice both roles, that of the student learning the mathematics concepts and also as the teacher observing, guiding, and supporting the learning (Krebs et al., 2006). Further it may be valuable for preservice teachers to have the opportunity to identify and reflect on their own mathematical mindsets and frustration tolerances during their internship to support application into the mathematics classroom.

### **Statement of the Problem**

There may be a relationship between a student's degree of growth mindset and their level of frustration discomfort. This knowledge could support individualized learning and improve instruction in mathematics for students. It would be beneficial to begin the examination of these two dispositions at the collegiate level with preservice teachers to identify their degree of growth mindset and level of frustration discomfort before they begin teaching.

### **Research Purpose**

The purpose of this study was to determine if a relationship exists between a preservice teacher's degree of growth mindset and their level of frustration tolerance. Data collected from this study was analyzed to support future decisions in mathematics education and research.

### **Research Questions:**

- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of frustration discomfort towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of *discomfort intolerance* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *entitlement* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *emotional intolerance* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *achievement frustration* towards mathematics?

### **Design of the Study**

This quantitative study used online survey software to deliver the FDS and TIS instruments to preservice teachers. Participants were collegiate students from a Midwest university at the undergraduate level within teacher preparation programs. The self-administered survey included the FDS with 28 items from four subgroups, discomfort intolerance, emotional intolerance, achievement frustration, and entitlement (Appendix B), and the TIS of 8 items from two subgroups, fixed mindset and growth mindset (Appendix C).

### **Limitations and Delimitations of the Study**

One limitation with using a correlation study is that data did not conclude causation of either constructs. While the data analysis could show if there is a correlation between the degree of growth mindset and the level of frustration tolerance, it did not determine if one variable causes the other. This study also had possible limitations with researcher bias and perceptual misrepresentation due to a small percentage of the sample surveyed being preservice teachers from the teacher preparation program at the university that the researcher attended.

Delimitations were found in the participants and procedures of this research study. The convenience sample in this study served as a delimitation purposely put in place due to the characteristics of the sample population of undergraduate students preparing to be teachers. Additionally, the specific sample population of preservice teachers mostly identified as mostly female, Caucasians and live in Kansas.

### **Definition of Terms**

- Elementary students: Kindergarten through sixth grade, according to the Kansas Elementary Teaching License at [ksde.org](http://ksde.org)
- Secondary students: seventh grade through twelfth grade, according to the Kansas Secondary Teaching License at [ksde.org](http://ksde.org)
- Mathematics Standards and Practices: collection of Kansas College and Career Ready Standards for Mathematics and the Mathematical Practices, as listed at [ksde.org](http://ksde.org)
- Productive struggle: the learning process of perseverance in completing difficult, yet attainable, goals, and that leads to feelings of empowerment, efficacy, and hope, as described by the National Council of Teachers of Mathematics at [nctm.org](http://nctm.org) (2017)
- Preservice teachers: undergraduates in an education program

### **Summary**

The purpose of this study was to provide additional information to the field of mathematics education regarding the mathematical mindset of preservice teachers. The goal of this study was to determine if there was a relationship between a preservice teacher's degree of a growth mindset and their level of frustration discomfort. It was beneficial to the success of preservice teachers if a correlation could be identified between these two variables. This knowledge provided insight into the dispositions preservice teachers held during their preparation for a career in education. The literature in Chapter II highlighted existing research supporting the need for such dispositions, like a growth mindset and high frustration tolerance, to be successful in mathematics that is rigorous, demands a conceptual understanding, and practices productive struggle.

## Chapter 2 - Literature Review

### Introduction

Over the past decade, classroom teachers have been encouraged to adapt their mathematics teaching to align with the focused, coherent, and rigorous Common Core State Standards (CCSS) (Achieve the Core, 2020). In 2010, a committee of Kansas State Board of Education (KSDE) staff and Kansas educators evaluated the CCSS and other standards developed by national organizations [like NCTM] to develop the Kansas College and Career Ready Standards (KCCRS), and in 2017, KSDE published the Kansas Mathematics Standards (Kansas Association of School Boards, 2013; KSDE, 2017b). To elevate students' learning from knowledge to application, the content standards for mathematics are joined with the 8 Standards for Mathematical Practices (SMP)(Figure 2.1) to provide a deeper understanding of mathematics concepts (O'Connell and SanGiovanni, p. xii, 2013).

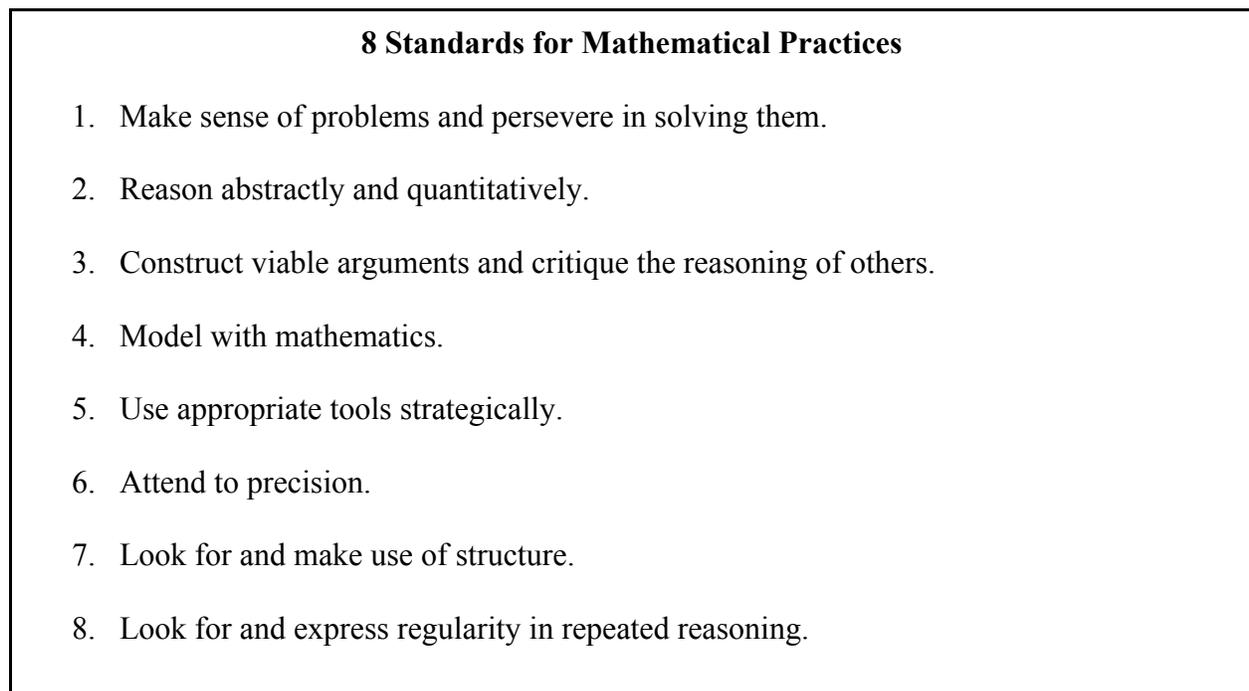


Figure 2.1 8 Standards for Mathematical Practices

Rigorous math tasks require students to engage in the SMP, advocating for a variety of approaches to solving the task and may include multiple solutions. The math content that K-12 students learn is defined by the Kansas Mathematics Standards, yet how they persevere, reason, and model with mathematics are at the heart of the SMP.

Teachers continue to struggle to identify instructional strategies for mathematics tasks and assessments that meet the cognitive demand of these standards and practices (O’Connell and SanGiovanni, 2013, p. xi). Mathematics education has evolved from a stagnant subject of rote memorization of facts and drill practices to problem solving, discussion, and justification of thinking (Ellis and Berry III, 2005; O’Connell and SanGiovanni, 2013, p. 2). The transition toward innovative mathematics instruction that aligns with the Kansas Mathematics Standards and uses the SMP is still underway from teacher preparation programs at the university level to experienced teachers already in the field. The publication of the Kansas Mathematics Standards includes the SMP, as well as the 8 Effective Mathematics Teaching Practices (MTP) adopted from NCTM (Figure 2.2) (KSDE, 2017b).

### **8 Effective Mathematics Teaching Practices**

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.

8. Elicit and use evidence of student thinking.

Figure 2.2 Effective Mathematics Teaching Practices (National Council of Teachers of Mathematics (NCTM), 2014)

The MTP are a teaching foundation for mathematics instruction and learning that provides teachers a framework to improve instructional practices (KSDE 2017b). While the content standards and the SMP determine what and how students learn mathematics, the MTP inform teacher actions that support student engagement in the SMP. According to the Kansas State Department of Education's Higher Education Program Standards (Figure 2.3), as preservice teachers enter the professional teaching field, they are expected to have been trained on the Kansas Mathematics Standards, which includes the SMP and MTP (KSDE, 2017a).

**Kansas State Department of Education Higher Education Program Standards**

**Standard 3: Mathematics, Function 1: Content Knowledge 1**

3.1.1 CK The teacher candidate knows and identifies the K-6 student mathematical content standards counting and cardinality, operations and algebraic thinking, number and operation in base ten and fractions, measurement and data, geometry, ratios and proportional relationships, statistics and probability) and learning progressions as appropriate.

**Standard 3: Mathematics, Function 3: Instruction: Content Knowledge 2**

3.3.2 CK The teacher candidate knows the variety of mathematical practices (problem solving, reasoning, modeling, attending to precision, identifying elements of structure, generalizing, engaging in mathematical communication, making connections).

Figure 2.3 Adapted from the Kansas State Department of Education Higher Education Program Standards (KSDE, 2017a)

While there is not a one-to-one correspondence between the SMP and the MTP, there are obvious connections. This study highlights the first SMP, *Make sense of problems and persevere in solving them* and the seventh practice of the MTP, *Support productive struggle in learning mathematics*. The following sections will explore the connections between “perseverance” and “productive struggle,” as these are paramount to this study. According to the MIND Research Institute (2021), “productive struggle is a state of engagement that enables students to work through increasingly challenging problems and new problems they have never seen before, thus requiring students to persevere”. Productive struggle is a complex process for teachers to implement in their classroom, just as perseverance is a strenuous disposition for students to acquire. The literature below will elaborate on two distinct dispositions; having a growth mindset to “persevere” and the discomfort with frustration associated with “productive struggle.”

Teachers can foster a growth mindset when their students engage in hard work, implement strategies, and demonstrate focus and perseverance (Dweck, 2006). Productive struggle requires rigorous mathematics tasks to be within a students’ reach, otherwise high levels of frustration may be counterproductive to developing understanding (Baker et al., 2020). Preservice teachers need to be prepared to handle students’ frustration and promote a growth mindset to enable students to struggle productively. A good place to start is by having them examine their own growth mindset and discomfort with frustration.

There is limited research into the relationship between preservice teachers’ discomfort with frustration and mathematical mindset. Researchers of growth mindset have studied elementary and secondary students and practicing teachers on the construct, but not preservice teachers (Dweck et al., 2007; Dweck, 2008; Sun, 2008). Similarly, discomfort with frustration has been studied in undergraduate students and adults, but not those studying or practicing teaching

(Harrington, 2005a, 2005b, 2006; Meindl et al., 2019; Wilde 2012). The ultimate goal of investigating the existence of a relationship, if any, between growth mindset and discomfort with frustration of preservice teachers, is to improve mathematics education. This study aimed to push the boundary of frustration and mindset towards mathematics of students preparing to enter a career in education.

### **Productive struggle**

NCTM (2014) made a significant contribution to the field of mathematics education with the publication of *Principles to actions: Ensuring mathematical success for all*. It outlined eight essential MTP developed to assist educators in teaching the math content and the SMP at a deeper conceptual level. As previously mentioned, one of the MTP is the practice of productive struggle for students to engage in when faced with rigorous mathematics tasks. NCTM (2014, p. 10) states the MTP on productive struggle as follows:

Support productive struggle in learning mathematics. Effective teaching of mathematics consistently provides students, individually and collectively, with opportunities and supports to engage in productive struggle as they grapple with mathematical ideas and relationships.

According to NCTM (2014), productive struggle in mathematics occurs when students are given “opportunities for delving more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct solutions” (p.48). Teacher actions that support productive struggle allow students to immerse deeply within a mathematics concept instead of simply skimming the surface of understanding and quickly moving on to the next topic. The purpose is for students to wade around in the structure and relationships within the mathematics task, rather than follow a solution-driven

mathematics objective. Applicable to any mathematics standard and to any grade level, productive struggle is a powerful tool in students' conceptual understanding of mathematics concepts.

Researchers find that students who learn through productive struggle have a higher mathematical ability than students who do not (Barlow et al., 2018; Vazquez et al., 2020). This is because in a time of struggle when mistakes are made, the brain is challenged and synapses grow in the brain (Boaler, 2016). Struggle is an expected part of learning mathematics; however, not all struggle is the same. When designing a mathematics task that uses productive struggle, it is important that the learning experience is within students' reach, and that the struggle leads students to a deeper understanding of mathematics (Huinker and Bill, 2017). Many researchers and teachers have scrutinized over what productive struggle actually looks like in the classroom to clarify lesson preparation and student assessment. Figure 2.4 is a checklist of what productive struggle is and is not in mathematics (Baker et al., 2020):

<b>Productive Struggle Checklist</b>	
Productive struggle is	<ul style="list-style-type: none"><li>• using existing understandings to engage with problems that do not have immediate apparent solutions</li><li>• persevering in making sense of mathematics during problem solving</li><li>• solving problems and grappling with key mathematical ideas that are within reach</li></ul>
Productive struggle is not	<ul style="list-style-type: none"><li>• waiting for information to be presented so it can be memorized or practiced</li><li>• feeling despair because the mathematics makes little sense</li><li>• experiencing needless frustration or extreme levels of challenge with overly difficult</li></ul>

problem
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Figure 2.4 Productive Struggle Checklist (Baker et al., 2020)

A major factor of the Mathematics Teaching Practice of productive struggle is to provide students opportunities to “collectively engage” with peers as they “grapple with mathematical ideas and relationships” (NCTM, 2014). For such classroom discourse in mathematics, teachers use strategies like “teachers pressing” and “students providing,” which are discourse actions that promote student access to a productive struggle (Candela et al., 2020). Teachers use probing questions like “why,” “how,” and “what” to link ideas and encourage student contribution to a whole group discussion of productive struggle (Candela et al., 2020). These conversations are not only supporting students’ mathematical struggle by providing a deeper level of processing to test various problem solving strategies, but also allowing teachers to identify students’ mathematical misconceptions and individual degrees of understanding (Baker et al., 2020). As teachers circle the classroom facilitating discourse, they may observe a student’s contributions being overlooked within a small group of students. This quiet student could be struggling to complete the mathematics task, or worse, is full of fear and unable to begin the task. This student is not struggling productively and is not utilizing peer support within their group to complete the mathematics task. Now the teacher acts as both a facilitator and a model of discourse expectations by expressing praise and encouragement in a public manner (Boaler and Staples, 2005). The teacher is modeling appropriate and respectful group interactions for all group members by publicly stating observations of effort to encourage perseverance and communication among group members. Figure 2.5 is an example of sequential observations of the teacher supporting and the students practicing productive struggle in the mathematics classroom:

### **Sequence of Productive Struggle in the Classroom**

1. The teacher poses a mathematics task where a solution isn't visible right away but is within students' reach. The teacher provides a scaffold support to students, like referencing visuals, manipulatives, or previous mathematical experiences, to help students get started.
2. The students begin to solve by writing, drawing, and/or creating with visuals and manipulatives. The students try various strategies to solve and participate in classroom discourse.
3. The teacher praises students' effort and perseverance as they attempt to solve the mathematics task. The teacher facilitates classroom discourse by posing purposeful questions. The teacher resists taking over students' thinking when they are stuck.
4. The students persevere to solve when strategies aren't applicable and solutions aren't accurate. The students participate in mathematics classroom discourse about various paths towards the solution.

Figure 2.5 Sequence of Productive Struggle in the Classroom

Productive struggle stems from a student-led and inquiry-based pedagogy that consists of collaboration and discussions with peers in the classroom (Baker, et al., 2020; NCTM, 2014; Vazqueze, 2020). In preparation for leading this type of learning in the classroom, this opportunity should also be present in the mathematics course in teacher preparation programs. Preservice teachers' experiences with productive struggle, including the perseverance and communication of the problem solving process, contribute to their ability to model and facilitate the process efficiently with students as an intern and later as a teacher.

Many current trends in mathematics education focus on a teaching pedagogy that fosters a learning environment ideal for productive struggle. The term “productive struggle” can be found in mathematics education research, but what is lacking is literature that explains the purpose and function of using it in the mathematics classroom. Furthermore, teachers need to be educated on the variety of student responses to productive struggle, like visible and verbal signs of frustration, to be more attuned to particular students’ reactions and signs of thinking (Baker et al., 2020).

### **Frustration Discomfort**

In *Principles to Actions*, NCTM (2014) addresses the typical teacher’s reaction to a student’s frustration with productive struggle in mathematics;

Teachers sometimes perceive student frustration or lack of immediate success as indicators that they have somehow failed their students. As a result, they jump in to “rescue” students by breaking down the task and guiding students step by step through the difficulties. ...Thinking about these in advance allows teachers to plan ways to support students productively without removing the opportunities for students to develop deeper understanding of mathematics (NCTM, 2014, pp. 48-49).

A discomfort with frustration is the inability or unwillingness to persist in an activity, due to unpleasant feelings associated with the task, which can influence academic success (Wilde, 2012). In these situations, when severe, students can be so consumed with frustration that they are unable to begin the task and shut down. Although there is psychological research on frustration discomfort among other cognitive and behavioral factors, like self-esteem (Harrington, 2005c), procrastination (Harrington, 2005b), self-control (Harrington, 2005a), and

measures of depressed mood, anxiety, and anger (Harrington, 2006), little research can be found within educational research, especially mathematics education, on frustration discomfort.

Researchers (Harrington, 2015b; Wilde 2012) hypothesized the contribution of discomfort with frustration to academic procrastination with undergraduate students. A discomfort with frustration is a central belief to the theory of Rational Emotive Behaviour Therapy (REBT), distinguishing itself from beliefs relating to self-worth within the REBT (Harrington 2005c). REBT suggests that emotional and behavioral problems are based on irrational beliefs that reality should be as we wish it to be (frustration discomfort), like “Life must be easy and free of hassle,” and that we should meet certain absolute conditions (self-worth), like “I must succeed to be worthwhile” (Harrington 2005c). Therefore, frustration discomfort and self-esteem were separately studied as predictors of procrastination. Self-esteem was assessed using the Rosenberg Self-Esteem Scale, whereas the researcher of this study, Dr. Neil Harrington, developed an instrument to measure discomfort with frustration, the Frustration Discomfort Scale (FDS). The 28-item multidimensional FDS has four subscales (7 items in each) that were influenced by REBT literature: discomfort intolerance, emotional intolerance, achievement frustration, and entitlement. Harrington (2005c) tested the internal consistency of the FDS’s four subscales resulting in coefficient alphas of .87 (emotional intolerance), .88 (discomfort intolerance), .85 (entitlement), .84 (achievement), and a full scale of .94.

In Harrington’s study (2005b), procrastination was characterized by gaining immediate relief when indulging in enjoyable distractions (emotional intolerance), avoiding boring or difficult tasks (discomfort intolerance), oppositional behavior and resentment (entitlement), anger, revenge, and perfectionist achievement. To measure academic procrastination, the study used a 10-item revised version of the Procrastination Assessment Scale for Students (PASS),

which contained two factors, each contributing to the purpose of this study. The PASS assessed fear of failure (coefficient alpha of .87), which relates to self-esteem, and task aversiveness (coefficient alpha of .74), which relates to frustration discomfort. This study separately measured the distinct relationship between each predictor (self-esteem and each of the four subscales of frustration discomfort) to assure that there was no shared variance between the commonalities of self-worth and discomfort with frustration by controlling self-worth beliefs in a regression strategy (Harrington 2005c).

Researchers surveyed 86 undergraduate psychology students using the Rosenberg Self-Esteem Scale (coefficient alpha of .87), FDS, and PASS instruments, each using a Likert-type scale. Supporting the researcher's hypothesis that the two subfactors of the PASS were relatable to self-esteem and frustration discomfort, fear of failure had no significant relationship with any of the FDS subscales but did with self-esteem ( $r=1.46$ ,  $p<.001$ ), yet task aversiveness was significantly correlated with the discomfort subscale ( $r=.31$ ,  $p<.01$ ) and not self-esteem. To separate the contributions of self-esteem and frustration intolerance to procrastination, a series of multiple regression analysis was conducted. Since the PASS assess frequency of procrastination and procrastination problems independently, a hierarchical multiple regression analysis was done for each factor with the blocking of self-esteem and the four FDS subscales. Results of both multiple regression analysis indicated that only discomfort intolerance and self-esteem were predictors for procrastination frequency and procrastination problems. Interestingly, emotional intolerance was a significant predictor of reduced procrastination frequency. Another surprising finding was from a partial correlation analysis that showed an overlap between emotional intolerance and self-esteem, which led to the controlling of self-esteem that showed an almost

nonexistent relationship between emotional intolerance and procrastination problems without self-esteem.

In conclusion the Rosenberg Self-Esteem Scale and the discomfort intolerance and emotional intolerance subscales of the FDS were correlated with the severity of procrastination, yet only self-esteem and discomfort intolerance were significant predictors in a regression analysis (Harrington 2005b). However, the research did support the validity of the FDS and the dimensions within the FDS. This study also mimicked the REBT in distinguishing self-esteem from frustration intolerance as independent predictors in the study of procrastination. One limitation may be that there is some bias in the sample due to the specific criteria of participants in this study (undergraduate psychology students in a competitive course).

Another study that investigated a specific college student population studied the self-confidence of mathematical ability among undergraduate traditional students and nontraditional students (adult learners) from a questionnaire of three measurements; the Abbreviated Math Anxiety Scale, the Mathematics Self-Efficacy Scale, and the Self-Description Questionnaire III to assess math concepts (Jameson and Fusco, 2014). Researchers concluded that adult learners identified themselves as having lower levels of self-efficacy and higher levels of anxiety in mathematics more than traditional students. Additional research may bring awareness to the differences in frustration tolerance and growth mindset between traditional students and adult learners in teacher preparation programs.

Although current research on frustration intolerance and academic achievement has represented a student population of all or various college majors (Harrington, 2005a, 2005b, 2006; Meindl et al., 2019; Wilde 2012), very little has the topic of frustration intolerance been sought in students studying to be teachers. It is assumed that preservice teachers have various

mathematical abilities and experiences that they bring to the teacher preparation program. It is also hypothesized that preservice teachers will use this information to reflect on their practices in relation to students' understanding of mathematics, and make instructional decisions based on these understandings (Cady, 2006).

Does a student's academic history impact their ability to tolerate frustration in academics? Researcher Dr. Jerry Wilde (2012) studied undergraduate education majors to see if the FDS would be a better indicator for first-year college students' GPA than traditional measures, like standardized test scores and GPA from high school, since high school grades and standardized test scores have been analyzed to predict 25% of students' actual college GPA (Wilde, 2012). In an attempt to predict academic achievement in college students, psychological factors and academic self-efficacy may account for up to 14% of the variance in college students' grade point average (GPA), and the variance continues to increase each year of college (Wilde, 2012). In this study that specifically investigated the relationship between students of education majors' frustration intolerance and academic achievement, Wilde (2012) found that the FDS was statistically significant at the .000 level and accounted for 23% of the variance when predicting students' GPA. Wilde (2012) writes:

Intolerance to frustration can influence academic achievement in a number of ways.

Students who have difficulties tolerating frustration might experience increased difficulties with procrastination, which could negatively influence achievement.

Studying can easily become a frustrating experience and students struggling with frustration intolerance might spend less time reviewing their studies.

Participants were given the FDS has 28 items divided into four subcategories, frustration intolerance, emotional intolerance, entitlement, and achievement frustration, on a 5-point Likert-

type scale. Multiple linear regressions were significant between GPA and three of the four DFS subcategories, entitlement, emotional intolerance, and achievement frustration. Achievement frustration had the strongest correlation with GPA (Frustration Achievement,  $\beta = .43$ ,  $t(100) = 4.07$ ,  $p = .000$ ) (Wilde 2012), indicating that students were willing to experience frustration discomfort for academic achievement. Researchers conducted a one-way analysis of variance (ANOVA) to see if there was a relationship between students' FDS scores and their overall GPA. The ANOVA results were statistically significant,  $F(4, 100) = 7.52$ ,  $p < .000$  ( $r = .231$ ), between lower FDS scores (a high tolerance for frustration discomfort) and a higher overall GPA.

A limitation to this research would be the unique set of skills and personality traits associated with the graduate and undergraduate education majors that would affect their FDS scores (Wilde, 2012). For example, participants' GPA had the strongest relationship with the FDS subcategory "achievement frustration" (Wilde, 2012). The highest loaded item in this subcategory was, "Tasks that I attempt absolutely must not be too difficult. Otherwise, I can't stand doing them," (0.68) (Harrington, 2005). Wilde (2012) expressed interest in future studies with the FDS to determine if frustration tolerance can be taught to students, in addition to self-efficacy, perfectionism, and procrastination, to support students transitioning from high school to college. It may also be beneficial for future studies to examine the relationship between FDS and perfectionism in preservice students.

Another factor that could affect preservice teachers' frustration tolerance in mathematics is their intellectual development, or internal locus of control, that attributes to their ability to critically reflect, reason, and persevere (Cady, 2006). Achieving important goals is widely assumed to require confronting obstacles, failing repeatedly, and persisting in the face of frustration (Meindl et al., 2019). In classrooms where teachers display a strong empathetic

pedagogy and students feel emotionally supported and their contributions valued, there is a positive correlation between the amount of teacher care and the students' perceived value and relevance of mathematics (Maloney et al., 2020). Students feel they are an active participant in the mutual caring relationship with the teacher, thus developing a sense of connectedness (Maloney et al., 2020).

Growth mindset is related to frustration tolerance in that it should encourage students to interpret frustration as less ego-threatening, and by enduring frustration and sticking to challenging tasks, students can make breakthroughs in their understanding of difficult academic material (Meindl et al., 2019). Besides providing a rich mathematics task that leads to productive struggle, teachers are also responsible for the undertaking of their students' insecurities and anxieties about mathematics. Research on the relationship, if any, between frustration tolerance and mathematical mindsets will try to define the teaching and practice of productive struggle in mathematics education.

### **Mathematical Mindset**

Teachers have always held the potential to mold students' mindsets, setting them up for success in mathematics beyond the classroom and into their careers. During the development of the educational system within our country, two major learning theories, behaviorism and constructivism, have influenced debates about the learning process. Theorist William A. Brownell (1944) argues against the "pseudo-learning, memorization, and superficial, empty verbalization" of behaviorism and states that a student should be;

called upon to perform at a level higher than any he has yet attained and given no guidance to reach the higher level, the child has but three courses of action open to him.

(a) He can refuse to learn. Refusal may take several different forms. One form is, "I

won't." Under ordinary conditions of schooling this form is not common. Another form is, "I can't"; a third is, "I don't want to," or "I don't care." The result of refusal, by whatever form, is indifference toward mathematics or dislike of it, which may be accompanied by widespread feelings of frustration (p.32).

Over the years, additional research and practices in education have fine-tuned appropriate ways for a constructivist theoretical framework to be implemented in the classroom. And while the pendulum has swung to each behaviorism and constructivism in the past, attention is increasingly centered on the constructivism approach for the modern student (Brownell, 1944; Cuban, 1993; Lambdin and Walcott, 2007; Matthews, 2003; Sriraman, 2010; Vygotsky, 1978).

The theory of having a growth mindset for learning is deeply rooted in the history of education. According to constructivist theorist John Dewey, "Since growth is the characteristic of life, education is all one with growing; it has no end beyond" (Matthews, 2003, pp. 53-54). Dewey's ideas for education were based on the individual's natural development tendencies and potential instead of an established external source of information (Matthews 2003). A child's natural development, the learning environment around them, and social interactions all contribute to experiencing and understanding new ideas. Another theorist, Lev Vygotsky (1978), describes the relationship between learning and development as, "the processes of child development are independent of learning. Learning is considered a purely external process that is not actively involved in development. It merely utilizes the achievements of development rather than providing an impetus for modifying its course (p. 79)." Vygotsky's (1978, pp.90) Zone of Proximal Development Theory is "for the higher mental functions that we feel can be applied to its entirety to children's learning processes." This mimics the cognitive demand of practicing productive struggle in mathematics. According to Vygotsky (1978), the Zone of Proximal

Development Theory “awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers” (p. 90). The direct relationship between internal development and processes and learning can be seen in the classroom. For example, the teaching practices that support Vygotsky’s Zone of Proximal Development Theory (i.e., scaffolding) and his Social Constructivist Theory (i.e., classroom discourse) encourage students to have a mathematical mindset.

Constructivists theorize child-centered learning as a tender-minded pedagogy of transformative knowledge discovered by the learner, like “rich clay in the hands of an artist” (Cuban 1993). As retiring veteran teachers from the Back to the Basics movement are replaced by teachers of the 21st century, constructivism is more accepted and implemented now than ever. The first step in this direction was the development and adoption of the CCSS for mathematics and SMP that focused on higher-level thinking skills. Although the CCSS and SMP were an unified approach to education and outlined the content and practices for students, the introduction of the *Standards for Mathematical Practice* initiated conversations about the processes and practices of how we were teaching with the publication of the MTP (NCTM, 2014). Leaders in education realized that there was still a need for 21st century skills, specifically an interpersonal domain (communication skills, social skills, teamwork, cultural sensitivity, dealing with adversity) and an intrapersonal domain (self-management, self-regulation, time management, self-development, adaptability, executive functioning) (Kyllonen 2012 pp. 8-9). These skills, like communication and self-development, are not only essential to the learning process of academic standards but are now seen as capacities to be a productive citizen.

Not only do some teachers still struggle with teaching 21st century skills within the CCSS of mathematics so that students are considered to be “college and career ready,” but teacher preparation programs truly hold the responsibility to adequately prepare future teachers to meet these demands. It isn’t that teachers do not know what the standards and skills are in their curriculum, since these are often posted in teacher manuals, textbooks, and on the walls of their classroom. It is the implementation that has been proven difficult to clarify. As a response, leaders in education have taken an effort to build frameworks for teachers that answer how to teach rather than what to teach, like the National Council of Teachers of Mathematics’ Mathematics Teaching Practices and the Five Essential Elements of Effective School Mathematics Programs (NCTM, 2014). However, students may still be unable to succeed without a proper mathematical mindset. Each student holds experiences and attitudes towards mathematics that may hinder their academic abilities (Boaler, 2016; Dweck, 2006, 2008).

Carol Dweck (2000), a psychologist and developer of the fixed and growth mindset, has researched motivation and why and how people succeed. Researcher Jo Boaler (2016) describes the fixed and growth mindsets as opposite ends of a scale that our mind falls somewhere on. A fixed mindset is the belief that others can do something, but you cannot. It can also be the belief that you will never be able to do something, no matter how hard you try. Therefore, a growth mindset is the belief that learning is attainable, requires focused effort, and surrounds the “power of yet” (Boaler, 2016; Sun, 2018). A growth mindset uses mistakes as learning opportunities within the problem-solving process, proven by the growth of synapses when a known or unknown mistake is made (Boaler, 2016). Unfortunately, adults have the most negative experiences with mathematics from a young age, more than any other subject and often maintain a negative relationship with mathematics for the rest of their lives (Boaler, 2016). There is also

an inequity problem with mathematics with the belief that there is a “math gene” or “math brain” that separates the elites of the mathematics culture from the rest (Boaler, 2016). Mathematics education for preservice teachers should address these factors that affect a student’s growth mindset.

Carol Dweck (2000, 2006, 2008) and Jo Boaler’s (2016) research on growth mindset has provided guidelines for teachers to follow when wanting to foster a growth mindset in mathematics within their classrooms. It can be difficult for teachers to identify students with a fixed mindset because these students may not appear to struggle at all. For example, the most social student in the classroom, whose mathematics anxiety is disguised by their outgoing personality may actually have a fixed mindset (Dweck, 2016). Other disguised fixed mindsets may include the strongest reader in the classroom or the fastest student at reciting mathematics facts but is unable to infer and problem solve when asked.

When it comes to celebrating students in mathematics, teachers may not be aware that it is better to congratulate students on their effort than on their correct answers, as this sends the message that the teacher only notices whether students’ answers are right or wrong (Dweck 2016). Whether a student is headed towards the correct answer or not, teachers should applaud their effort in trying to use a mathematical strategy to solve. In fact, studies on hundreds of students show that praising intelligence actually harms student motivation and performance (Dweck 2008, 2016). These shifts toward a growth mindset dialogue establish a public understanding within the classroom that effort is valued more than accurate answers. This is a disposition preservice teachers can practice within their mathematics methods courses and observe in their student teaching to witness the teaching of growth mindset. The stronger the preservice teachers’ mathematics content and pedagogical knowledge, the more it significantly

influences students' achievement in mathematics and their mathematical disposition (Campbell et al., 2014; Clark et al., 2014).

Research on growth mindset has uncovered a pattern of teaching strategies that seem effective in moving students' mindsets from fixed to growth in mathematics. Interestingly, these research-based best practices are founded on the same learning theories popular during the "Meaningful Arithmetic Phase" and the "New Math" era (Lambdin and Walcott, 2007). The Zone of Proximal Development Theory states that a teacher should guide learners through problem solving and leave the learner in control of the problem solving process (Sriraman and English 2010). This describes the technique of scaffolding where teachers provide opportunities for students to complete a task that is just within their reach independently.

Sociocultural theory and situated learning theory are also relevant in the teaching of growth mindset with the importance of social and cultural contexts within the learning of mathematics. Knowledge evolves from the relationships between people and one's participation within a sociocultural community, with or without structured teaching (Haneda, 2006; Lave 2009). Researcher Jean Lave (2009) states;

Knowledgeability is routinely in a state of change rather than stasis, in the medium of socially, culturally, and historically ongoing systems of activity, involving people who are related in multiple and heterogeneous ways, whose social locations, interests, reasons, and subjective possibilities are different, and who improvise struggles in situated ways with each other over the value of particular definitions of the situation, in both immediate and comprehensive terms, and for whom the production of failure is as much a part of routine collective activity as the production of average, ordinary knowledgeability (p. 207).

Researcher Paul Cobb (1994) argues that constructivism and sociocultural theory can coexist due to their individualized support in mathematics development. The sociocultural perspective frames the environment and participants' interactions of the mathematics exercise, whereas the constructive approach identifies the developmental and learning processes of mathematics that are taking place (Cobb, 1994). Through the use of language in classroom discourse mathematical thinking and processing expand a growth mindset.

Another example of a constructivist theory associated with the practices of growth mindset is Jerome Bruner's Discovery Learning Theory (2007) and the use of manipulatives to support a concrete to abstract progression of learning mathematics concepts (Lambdin and Walcott, 2007). Teachers wanting to encourage students to have a growth mindset in mathematics can use modeling to simplify real-world situations with mathematical representations using manipulatives, pictures, or equations as they persevere through the problem-solving process (Boaler, 2016, pp.194-198).

Now is the time for higher education to consider these historical theoretical approaches to mathematics education, as the foundation and knowledge preservice teachers need to develop their own understanding. It is the responsibility of the teacher preparation programs to provide the field with future teachers that hold the knowledge and skills necessary to foster a growth mindset in mathematics. Through advances in education research, progressive methods courses, authentic student internships, and supportive first-year mentors, we can change preservice teachers' and therefore, elementary and secondary students' mathematical mindsets in all classrooms.

### **Preservice teachers**

It is necessary to identify where the field of mathematics research is regarding the study of students of teacher preparation programs. I've discussed the importance of merging the topics of frustration tolerance and mathematical mindsets when preparing preservice teachers to support students in the practice of productive struggle. Current research themes with teacher preparation programs include content knowledge, teaching pedagogy, and as of recently, students' social and emotional needs.

One mixed-method study examined the relationship between the responsive classroom approach to teaching, like creating a social environment in the classroom, and standards-based teaching practices (Ottmar et al., 2013), but participants were professional teachers instead of preservice teachers. It is interesting to note that data from all participants showed that Mathematics Teacher Efficacy Beliefs Inventory was positively related to standards-based mathematics teaching practices, although Mathematical Knowledge for Teaching Assessment was not (Ottmar et al., 2013). Rather than content knowledge, efficacy beliefs were more prominent factors in standards-based teaching, therefore mathematics courses for preservice teachers may need to reevaluate the ratio of teaching dispositions and mathematics content within their curriculums. When teachers have the will to design their own standards-based lessons, they can create a learning environment and allow sufficient time for a responsive classroom approach to support students learning through productive struggle in mathematics.

In one mixed-methods longitudinal study (Cady et al., 2006), one which did use preservice teachers as participants, instructional mathematics practices were analyzed from surveys, observations, and interviews at various points from student to professional teacher. Data showed that when the students entered the research project as students of the teacher preparation program and again as they finished their student-teaching internship, one was at the dualistic

level that views the world in terms of dichotomies and relies on an external authority to make decisions, and the other participant was at the relativistic level with an internal locus of authority (Cady et al., 2006). Then the researchers met with the participants as during their first-year and again during their fifth year of professional teaching, where a difference in instructional mathematics practices was evident between the two teachers (Cady et al., 2006). The participant that held a dichotomous view of mathematics as a student, slightly evolved their beliefs to the multiplicity level, but then plateaued staying with an external locus of authority. However, the participant that had been at the relativistic level as a student was able to continuously increase into the commitment level. At this level a teacher critically reflects on his or her own knowledge and experiences before committing to a view or perspective. Therefore, if preservice teachers are able to have a mathematical mindset at the relativistic level prior to entering the teaching field, they have a greater chance of continuing to grow their mindset through critical self-reflection.

Another study that focused on the relationship between theory and practice within teacher preparation programs highlighted the transition from theory to practice that continues to be an area of improvement within education programs. This case study included college faculty and administration interviews, a questionnaire for preservice teachers, and a preservice teacher focus group (Goodnough et al., 2016). Conclusions from this study were that teacher preparation programs should embed a practicum model that includes classroom experience throughout the program rather than at the end after theory has been taught, and preservice teachers should be given a topic to focus on when observing the elementary classroom (Goodnough et al., 2016). Another suggestion on how to teach preservice teachers mathematical mindsets is through the real-world application of case studies where preservice teachers read or watch to analyze a record of students completing mathematics tasks. Often, such cases are a part of licensure exams

that students must take and pass to become a licensed professional teacher. One study of preservice teachers found that half (51%) indicated when surveyed that course curriculum should align with licensure exams, and a majority of participants (77.1%) marked that analyzing case studies within the mathematics methods courses would support the teaching and learning process (Childs et al., 2002).

After students of a teacher preparation program were surveyed at another university, researchers found that after the mathematics methods course, preservice teachers' conceptual knowledge significantly improved, but at a minimal level (Kajander, 2010). Therefore, the elementary education program at this university added additional optional mathematics courses and a mandatory mathematics examination at the conclusion of the mathematics methods course (Kajander, 2010). Instructors of mathematics education courses in teacher preparation programs should also emphasize learning goals instead of performance goals for the preservice teachers to positively impact preservice teachers' motivation, mathematics thinking, and mathematical conversations (Harkness, 2009). These instructional suggestions for teacher preparation programs emphasize the need for preservice teachers to have a growth mindset. Constructivist learning theories are the foundation of a mathematical mindset, which is a critical component of persevering through feelings of frustration when practicing productive struggle in mathematics.

## Chapter 3 - Methodology

### Introduction

Of all school subjects, people have the most fixed mindset about mathematics and feelings of frustration threaten their self-esteem (Boaler, 2016; Meindl et al., 2019). In fact, “the negative attitudes and beliefs that people hold about mathematics have seriously limited them, both in their daily lives and in their long-term options” (Burns, 1998, page ix). What is it about mathematics that draws fear instead of confidence? Emotions may have originated from childhood experiences learning mathematics themselves or possibly from their teacher’s judgments and attitudes towards mathematics. The direction of the “education pendulum” and the theoretical framework of the mathematics curriculum could also influence a student’s mathematical mindset and frustrations with mathematics.

In teacher education programs, preservice teachers learn about the content, practices, and pedagogy of mathematics. For example, according to the Kansas State Department of Education’s Higher Education Program Standards, as preservice teachers enter the professional teaching field, they are expected to be trained on the Kansas Mathematics Standards, which include the Standards for Mathematical Practices (SMP) and the 8 Effective Mathematics Teaching Practices (MTP) (KSDE, 2017a, 2017b). The SMP, *Make sense of problems and persevere in solving them* and the MTP, *Support productive struggle in learning mathematics* highlight the importance of certain dispositions that support mathematics education.

The judgments, attitudes, habits, ideals, and ambitions towards mathematics need to also be addressed in teacher education to support student learning in elementary and secondary classrooms. These dispositions of preservice teachers may impact their ability to instruct, assess,

and adapt their lessons in mathematics to meet their students' needs. Similarly, studying the relationship between common beliefs and attitudes towards mathematics may impact the curricula of mathematics education. The following sections will describe the purpose, design and methods of this research agenda.

### **Purpose of Study**

The purpose of this study was to investigate a preservice teacher's level of frustration intolerance and discomfort with mathematics in relation to their degree of fixed or growth mindset toward mathematics. Furthermore, this multivariate correlational study examined each of the subfactors of frustration discomfort; discomfort intolerance, entitlement, emotional intolerance, and achievement frustration, in relation to fixed and growth mindsets. The following demographic data of participants was also collected to identify patterns within each construct:

- Age
- Gender
- Elementary or Secondary Education Major
- Year in College
- Primarily Online or Face-to-face Student
- Number of Math Courses Completed at the College Level

This foundational research intended to explore the covariance and regression of these dispositions to determine how future research could benefit the teachings of mathematics and mathematics education. The sections that follow described the design and methodology of this study, including a rationale for the instruments used to survey preservice teachers. A nondirectional hypothesis that the level of frustration discomfort relates to the degree of a growth mindset supports the research questions that follow.

## Research Questions:

- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of frustration discomfort towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of *discomfort intolerance* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *entitlement* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *emotional intolerance* towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *achievement frustration* towards mathematics?

## Null Hypothesis

There is no relationship between a preservice teacher's degree of growth mindset and their level of frustration discomfort.

## Research Design and Methods

### Research Design

The purpose of this study was to disclose and measure relationships between growth and fixed mindsets and factors of frustration discomfort towards mathematics. "A correlational

research design measures two or more factors to determine or estimate the extent to which the values for the factors are related or change in an identifiable pattern” (Privitera, 2013, p. 240). When assessing the covariance of naturally occurring variables, this associational research studies the relationship, if any, without any attempts to influence the variables (Asamoah, 2014). Thus, this study used the correlation research design to investigate the existence and strength of the relationships between mindsets and frustrations towards mathematics of preservice teachers in an elementary or secondary teacher education program. Specifically, the multivariate correlation study analyzed beliefs towards mathematics from the correlation coefficients between degree of fixed and growth mindsets in relation to each of the sub factors that form the instrument measuring frustration discomfort; discomfort intolerance, emotional intolerance, achievement frustration, and entitlement (Harrington, 2004). Figure 3.1 presented a model of the possible correlations between these constructs. The strength and direction of the residuals help to explain if frustration discomfort and mindsets towards mathematics deviate in a positive or negative relationship or none at all. For example, the stronger the level of frustration discomfort towards mathematics a preservice teacher has, the more of a fixed mindset they may have in mathematics because both variables deviate from the mean in the same direction.

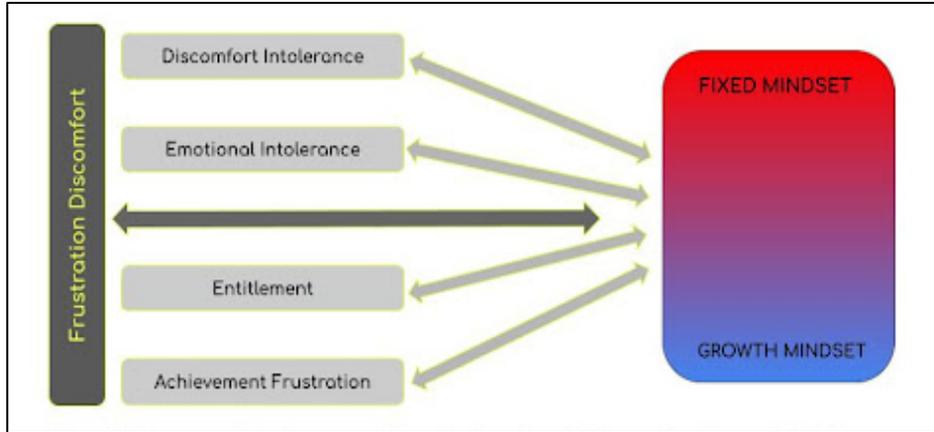


Figure 3.1 Construct correlations between overall frustration discomfort and fixed or growth mindsets and each of the FDS factors; discomfort intolerance, emotional intolerance, entitlement, and achievement frustration, and fixed or growth mindsets.

Furthermore, multiple regression analyses was run to see if generalizations can be made about preservice teachers based on predicted deviations from the means of each variable (Figure 3.2). A linear model was used to fit the data in predicting a preservice teachers' degree of fixed or growth mindset based on their current year in college or the number of college mathematics courses completed. A similar linear model was used to predict achievement frustration of preservice teachers based on their current year in college or the number of college mathematics courses completed. Additional regression analysis was used to see if the level of fixed or growth mindset predicts their total score of achievement frustration from the FSD.

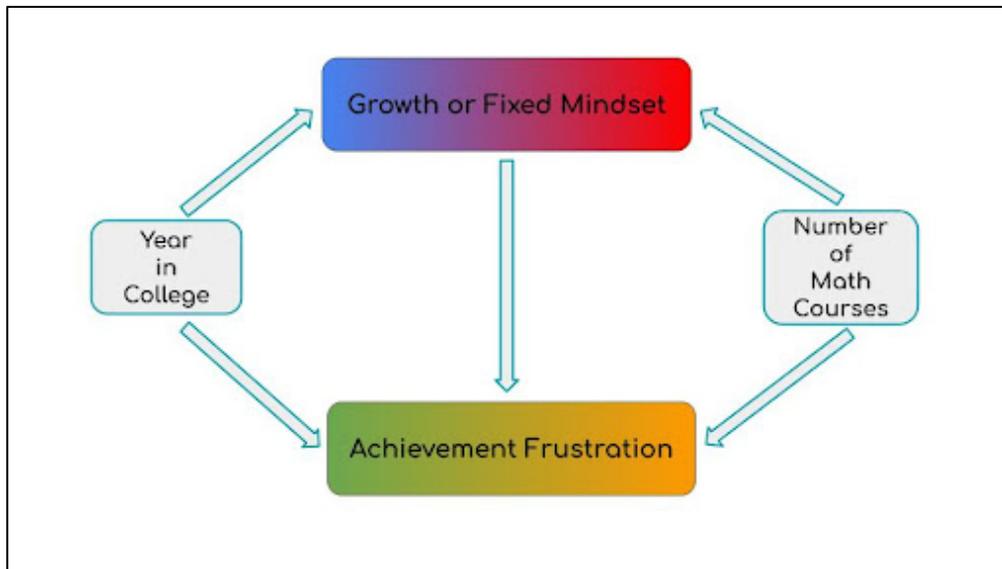


Figure 3.2 Predictive relationships between preservice teachers' year in college and growth or fixed mindsets and achievement frustration, number of math courses completed and preservice teachers' growth or fixed mindsets and achievement frustration, and growth or fixed mindsets and achievement frustration.

Achievement frustration was chosen as a response in the regression analysis because it had been found to be the strongest predictor of a college students' GPA (Achievement,  $\beta = .43$ ,  $t(100) = 4.07$ ,  $p = .000$ ), compared to all of the other FDS factors (discomfort intolerance, emotional discomfort, and entitlement) (Wilde, 2012). This direct relationship indicated that students are willing to experience discomfort in order to reach higher achievement, and in fact, the higher the need to achieve, the more frustration discomfort students were willing to experience (Wilde, 2012). Similarly, achievement frustration has been found to have a significant negative correlation with the frequency of procrastination ( $r = -.27$ ,  $p < .05$ ), meaning that frustration leads to an increase in activity rather than avoidance (Harrington, 2005b). Accordingly, a preservice teacher's college year in the teacher preparation program, number of college mathematics courses completed, or their degree of fixed or growth mindset may correlate or possibly predict their level of achievement frustration in mathematics. Such data analysis

improves mathematics education by highlighting the beliefs and needs of students in mathematics.

### **Research Method**

Quantitative survey research was the most appropriate to use in this study because systematic and comparable data must be obtained directly from a relatively large number of participants to investigate a wide range of research questions (Coleman and Briggs, 2002). Participants in this survey research were students enrolled in the College of Education at a Midwestern university studying to be elementary or secondary education teachers. The survey research design also provided a “quantitative or numerical description of trends, attitudes, opinions of a population by studying a sample of that population” (Cresswell and Cresswell, 2017, p. 155). This study used an anonymous online survey to collect data on the beliefs towards mathematics to identify possible relationships and patterns among preservice teachers' degrees of growth and fixed mindsets in mathematics and their levels of frustration discomfort towards mathematics.

### **Participants**

Preservice teachers, like most undergraduate students, begin college with the view that the acquisition of knowledge is supportive of a traditional view of learning and teaching mathematics (Cady, et al., 2006). “As preservice teachers continue through a preparation program, they begin to prefer learning environments where they can use their own knowledge to work through ambiguous situations” (Cady et al., 2006, p. 5). These beliefs support an educational reform allowing a preservice teacher educator’s role to be that of a facilitator to provide opportunities for their students to grapple with problems connecting mathematics and the real world (Cady, et al., 2006).

The participants in this study were students in teacher preparation programs at a university in the Midwest of the United States. An administrator forwarded a message (Appendix G) explaining the purpose of this educational study to 884 students enrolled in elementary and secondary education within the College of Education at this university. The message sent to participants also described the importance of their contribution, as preservice teachers, to the research on frustrations and mindsets towards mathematics. The participants of this anonymous survey consented to participate (Appendix A) and were offered an optional incentive as gratitude for participating in this study, and thereby needed to share an email address at the conclusion of the survey to be entered into a drawing. Two days before the survey expired, participants were sent an email reminding them to complete the survey and highlighting the optional incentive.

## **Data Collection**

### **Instruments**

To collect data in this study, an anonymous online survey was distributed to participants consisting of two validated and reliable instruments, as well as items identifying demographics of the participants. One of the instruments in the survey was the Frustration Discomfort Scale (FDS) that used a 5-point Likert scale to measure students' level of frustration discomfort according to four factors; discomfort intolerance, emotional intolerance, achievement frustration, and entitlement. The other instrument in the survey, the Theories of Intelligence Survey (TIS), used a 6-point Likert scale to measure participants' degrees of a growth and fixed mindset. Both the FDS and the TIS were designed to measure beliefs in general toward each construct. However, in this study, the wording was revised to include "beliefs towards mathematics" in the emails to students, the introduction and consent of the survey, and in each of the instruments' directions. The purpose of this change was to encourage participants' responses to reflect their

attitudes towards and their experiences with learning and practicing mathematics. Therefore, preservice teachers' frustrations and mindsets towards mathematics were able to be measured using the originally developed items and scales of the FDS and the TIS in conjunction with the addition of the term "mathematics." The survey also includes demographic items to gather data on students' age, gender, college year, education degree (elementary or secondary), education platform (online or in-person), and the number of mathematics courses completed in college.

### ***Frustration Discomfort Scale***

An intolerance of frustration is one of two central beliefs of the theory of Rational Emotive Behaviour Therapy (REBT), the other being beliefs relating to self-worth (Harrington 2005a). REBT suggests that irrational beliefs of frustration discomfort and self-worth lead to emotional and behavioral problems. The frustration discomfort belief that reality should be as we wish it to be is represented in statements like, "*Life must be easy and free of hassle.*" Whereas, the statement, "*I must succeed to be worthwhile*" is associated with the self-worth belief that we should meet certain absolute conditions (Harrington 2005a). Since the instrument developed to measure REBT assessed both frustration discomfort and self-worth, Dr. Neil Harrington began to study these constructs separately.

Harrington (2005a) believed that beyond the REBT, the content and factor structure of frustration intolerance beliefs, and their relationship with specific problems, had remained largely unexplored and one-dimensional. Through the development of the FDS, there were two studies to develop a multidimensional scale for content analysis of frustration intolerance beliefs and to clarify its factor structure using clinical and student samples. Both Study I: Preliminary Frustration Discomfort Scale: Development and Analysis and Study II: Revised Frustration Discomfort Scale: Development and Analysis used Harrington's (2005a) FDS instrument and the

Rosenberg Self-Esteem Scale to study these constructs separately. The structure of the FDS items in Study I were influenced by the REBT theory using compound sentences with an “absolute must” phrase followed by a demand statement that purposely separated the frustration discomfort and the self-worth belief components for distinction between these two similar constructs that both had derived from the REBT theory (Harrington, 2005a). Figure 3.3 displays the structure of the FDS preliminary version that allowed for frustration intolerance and self-worth beliefs to be rated separately for each demand statement on the scale of (0) absent, (1) mild, (2) moderate, (3) strong, or (4) very strong.

<b>Preliminary FDS Item and Scale</b>					
I absolutely must not be kept waiting					
Because I can't tolerate waiting					
0	1	2	3	4	
It would totally lower my self-esteem					
0	1	2	3	4	

**Figure 3.3 Preliminary FDS Item and Scale (Harrington, 2005a)**

To satisfy content validity of frustration intolerance, the factor structure of the initial FDS included content domains suggested by the REBT, like demands for achievement and comfort, and were tested in a small pilot study (n = 30) to revise items with poor comprehension and extreme frequency distributions, resulting in 74 items for Study I (Harrington, 2005a).

Preliminary data analysis of Study I resulted in removing 10% of missing data and six extreme outliers with 329 cases remaining in the factor analysis; 242 in the clinical group of consecutive therapy referrals to an adult clinical psychology department and 87 in the student group of psychology undergraduates (Harrington, 2005a). To separately examine frustration intolerance

and self-worth beliefs from the REBT, the initial FDS asked participants to score each statement's subscales independently to determine which construct was most salient (Figure 3.3). Subscale score results were not meaningful, but four items were removed due to greater self-worth subscale scores than frustration intolerance subscores. Harrington (2005a) continued to test for discriminative validity by determining if the two constructs, frustration intolerance and self-worth, were conceptually unrelated by analyzing the FSD scores (frustration intolerance subscale data only) and the Rosenberg Self-Esteem Scale scores. After comparison of corrected item-total correlations, eight more problematic items were removed leaving 66 items for exploratory factor analysis.

Since theoretically frustration discomfort dimensions are likely to be closely associated, the preliminary study used exploratory factor analysis to conduct a principle component analysis employing a varimax orthogonal rotation to assume loading on one factor also indicates zero loadings on other factors, that was then compared with an oblique rotation to identify factor clusters (Harrington, 2005a). After a screen plot analysis, the categorization of the FDS was tested in a four, five, and six-factor structure. The largest cumulative variance of 42.58% was in the four-factor structure, therefore best representing the data and resulting in Factor I accounting for 13.96%, Factor II for 11.35%, Factor III for 10.25%, and Factor IV for 7.02% variance (Harrington, 2005a). All items had a salient loading on at least one factor, and the pattern of factors and item order from the four-factor oblique rotation closely matched that of the orthogonal rotation (Harrington, 2005a).

Careful consideration also went into the naming and descriptive items for each of the factors. Harrington (2005a) labeled the first factor, *emotional intolerance*, included items describing the uncertainty, controllability, and aversiveness of emotion with the highest-loading

item being, “I absolutely must be free of distressing feelings as quickly as I can. I can’t stand for them to continue” (0.716). The highest loading item on the second factor, *entitlement*, was “I absolutely must not be taken for granted. I can’t stand being unappreciated,” (0.661) with similar items addressing demands for immediate gratification and for fairness (Harrington, 2005a). Demands that life should be easy, comfortable, and free of hassle comprised of the third factor, *discomfort intolerance*. These beliefs, like the highest loading item, “Tasks that I attempt absolutely must not be too difficult. Otherwise, I can’t stand doing them” (0.680), have traditionally been central to the REBT concept of frustration discomfort (Harrington, 2005a). The last factor was labeled *achievement* referred to task related frustration, with the highest loading item being, “I absolutely must not leave work unfinished. I can’t bear to leave work unfinished” (.745).

After further analysis, Harrington (2005a) decided that frustration discomfort items were “better worded in terms of negative states, such as deprivation and aversiveness, rather than as a need for positive gratification.” Study II: Revised Frustration Discomfort Scale: Development and Analysis used a revised FDS with a single frustration discomfort statement in each item, for example *I can’t stand doing things that involve a lot of hassle*. With a similar clinical sample of 254 patients and 79 undergraduate psychology students, the simplified questionnaire resulted in fewer responses in the “absent” category (12% from 21%) and with reduction in overlapping and redundant content, the final FDS contained 28 items, 7 from each of the four factors (Harrington, 2005a). Harrington (2005a) reported good internal consistency that the subscale alpha coefficients were (mean inter-item correlation in brackets showing item homogeneity) discomfort intolerance 0.88 (0.50), entitlement 0.85 (0.42), emotional intolerance 0.87 (0.49), and achievement 0.84 (0.43).

The Frustration Discomfort Scale (FDS) was developed as a multidimensional measure of frustration intolerance, with reliability and factor structure being proven in previous studies (Harrington, 2005a; 2005b; 2005c). Analyses of the scale revisions displayed good psychometric properties and supported construct validity, while factor analysis indicated that four factors best describe frustration intolerance (Harrington, 2005a). The revised FDS (Appendix B) lists the items organized by factor. However, when given to participants, survey items were mixed and not divided by factor. Once scores were reorganized and analyzed for each factor, a low mean score represents the absence of or high tolerance of that frustration belief.

### ***Theories of Intelligence Scale***

Researchers have tried to identify key implicit beliefs and their relevance for processing social information, leading to the identification of implicit theories as a framework for analyzing and interpreting human actions, specifically how implicit beliefs influence people's inferences, judgments, and reactions in the face of negative events (Dweck, et al., 1995). The implicit theory of intelligence refers to two opposing assumptions, the first being that intelligence is a fixed trait and is not malleable (the entity theory) and that although people can learn new things, their level of intelligence remains the same. The other contradicting assumption is that intelligence is malleable and cultivable (the incremental theory) (Dweck, et al., 1995). Furthermore, negative outcomes result in someone of the entity theory to blame their intelligence, whereas someone that holds the incremental theory of intelligence would understand the negative outcomes in terms of their efforts and strategies (Dweck, et al., 1995). Researchers of implicit theories of intelligence are not trying to determine that one is better than the other; instead their goal is to develop a framework that fosters judgments and reactions (Dweck, et al., 1995).

The Theories of Intelligence Scale (TIS) (Appendix C) used a 6-point Likert scale and contains four items associated with the entity theory describing beliefs that we have a fixed intelligence (Questions #1, #2, #4, and #6) and four items associated with the incremental theory describing beliefs that our intelligence is malleable (Questions #3, #5, #7, and #8). When given, the eight items were mixed, but then the four responses intended for a growth mindset were reverse coded for analytical purposes. Once the Growth Mindset Items were reverse-coded, a low mean score of 1.00 to 3.00 indicated a growth mindset, 4.00 to 6.00 a fixed mindset, whereas between 3.01 and 3.99 represented an undecided mindset (Dweck 2000). Researchers (Dweck, et al., 1995) conducted six studies to validate the reliability and validity of the TIS showing high internal reliability ranging from .94 to .98. The research concluded that entity theorists predicted a less adaptive, helpless pattern of coping with failure than incremental theorists. The validity and reliability of Dweck's Theories of Intelligence Scale's scores were studied using factor analysis of the internal structure by Cook, Castillo, Gas, and Artino (2017). Cook, et al., (2017) determined the internal consistency reliability was acceptable for both entity and incremental items, Cronbach's alphas 0.78 and 0.79, respectively. Although there are variations of this survey, depending on the number of items and the background and age of the participants, the specific version of the TIS in this study includes all of the items (i.e., 4 entity statements and 4 incremental statements) and is intended for adult participants (e.g., preservice teachers).

## **Procedures**

This study used an online survey that included the 28-items of the FDS in a mixed order (uncategorized by each of the four subcategories), the 8-item TIS, and several demographic items to gather data from a large sample of preservice teachers. The survey link was electronically shared with students seeking degrees in education at a Midwest university. An

email message was then forwarded by university administration to students stating the purpose of the study, contact information, and the survey link. Quantitative data was collected anonymously using the Qualtrics software. Although the survey was anonymous, participants were given the opportunity to share an email address to be included in a drawing for a small monetary incentive. Participants were also regularly encouraged to complete the anonymous online survey before it expired on the 14th day. Then, the participants' email addresses that were voluntarily entered in the survey were removed from the data set before analysis occurred. These email addresses were entered into an online random number generator to choose a winner that was contacted through email.

### **Data Analysis**

The mixed items within the FDS portion of the survey were sorted by each of the four subfactors with a subscore computed for Factor I Frustration Intolerance, Factor II Emotional Intolerance, Factor III Entitlement, and Factor IV Achievement Frustration. Cronbach's alpha coefficient tested the reliability of the FDS instrument showing the average of the correlation of every item on the assessment. Cronbach's alpha showed internal consistency between the items within each FDS subfactor and the items within the TIS instrument. Descriptive statistics of frequency distributions determined how many participants' responses fit into each factor and measures of central tendency will provide a mean, median, and mode. An analysis of variance of standard deviations used the z-scores of a normal distribution to determine if 95% of values fall within 2 standard deviations of the mean. The mean score of each of the FDS factors was compared to the TIS mean score to identify any relationships between the frustration discomfort factors and growth and fixed mindset. For example, Factor I of the FDS is Frustration Tolerance with statements like, "*I can't stand having to push myself at tasks.*" According to the FDS scale,

a low mean score represented participants not believing that statement and a high score that they strongly believed it. When compared to the TIS mean score, a positive correlation indicated that the two variables moved together in the same direction; the greater the level of the frustration belief (or a low tolerance for frustration), the greater the degree of a fixed mindset. A negative correlation was possible; the lower the level of the frustration belief (or a high tolerance for frustration), the greater the degree of a fixed mindset.

If changes coincided in the bivariate correlation of the two variables, then multiple regression analysis was conducted to see if there was any causation. Specifically, a linear model was used to fit the data in predicting a preservice teachers' degree of fixed or growth mindset based on their current year in college. Another regression model was used to see if the degrees of fixed and growth mindset were predicted by the number of math courses completed.

### **Reliability and Validity**

This survey research study followed the Tailored Design Method to control the sources of error, to establish appropriate procedures, and to encourage response and completion from respondents (Dillman, et al., 2014). There are four sources of error that the Tailored Design Method monitors. One is the coverage error, meaning the sample doesn't accurately represent the population. One example of a coverage error is if the sample is chosen from a list that doesn't include all of the population. Therefore, the results of the study wouldn't represent the population, since not all of the population was sampled from. Other errors the Tailored Design Method control are sampling error, unresponsive error, and measurement error. A sampling error occurs when the researcher only surveys some participants from the frame, a nonresponsive error is when there are differing characteristics between respondents and non-respondents that could affect results, and a measurement error is due to inaccurate responses. Lastly, the Tailored

Design Method encourages participants to respond and complete the survey by using social exchange concepts. Respondents in this study were motivated to participate in the survey when the benefits of completion outweighed the costs and when the respondent believed that the research purpose was important or interesting.

This study used the FDS and TIS instruments that have established psychometric properties by the creators and researchers since (Harrington, 2005; Dweck, 2000). Each instrument had been proven to have validity to measure the construct it was created for; FDS for frustration discomfort and TIS for growth mindset, and reliability to repeat these measures. Each instrument had also been accurately duplicated to include all original items as they were written and developed and the identical Likert scale that was originally used by the researcher. This resulted in one survey with two instruments of different scales. Although the FDS used a 5-point scale and the TIS used a 6-point scale, careful consideration had been made for each scale to remain as intended by their developer. After consulting with faculty of the College of Education and consultants at the Statistical Lab at the university, it was determined that data analysis will not be affected by the use of a 5-point and 6-point scale in this study. Therefore, the original scales of both the FDS and TIS were used to sustain the validity of the instruments.

Further evidence that contributes to the credibility of this research was the pilot studies conducted prior to this investigation. With a small sample from a similar population, the pilot studies practiced the return and analysis of respondents and forced consideration of the methods of presentation (Bell, 2002, pp. 167-168). Researcher Kajander (2010), who studied preservice teachers' conceptual knowledge of mathematics, developed and piloted a scale to use in her questionnaire. In another study, a pilot study was done to examine the familiarity of terms

associated with inductive and deductive reasoning in mathematics with preservice teachers (Morris, 2002).

One method used to improve survey questions before conducting a study is to share the draft with a panel of experts (Dillman et al., 2014). As part of the piloting process, a researcher should seek feedback from experts in their field of research on the development and format of the survey. In spring of 2021 a convenience sample of students (n = 33) enrolled in the researcher's mathematics education course at another Midwest university were given a Qualtrics survey containing the FDS instrument and several demographic questions. The FDS was organized by factor with 7 items listed under each. Results showed some errors in demographic responses due to confusion in the wording of the question. In the summer of 2021 the TIS instrument and an optional incentive were added to the anonymous online survey and administered to a small sample (n = 14) at the researcher's university. Upon feedback and reflection from research experts at the universities, the wording and order of survey items, as well as the purpose for each demographic question, were revised. In fall of 2021 a revised survey was given to a new cohort of preservice teachers at the same university (n = 104). The FDS items in this edition of the survey were mixed and not categorized by factor, similar to how this instrument has been used in previous research.

### **Limitations and Delimitations of the Study**

#### **Limitations**

The researcher in this study was measuring the degree of growth mindset and level of frustration discomfort among preservice teachers to examine the existence of a relationship between these two constructs. The researcher did not conclude causation of either construct, rather examined the strength and direction of the relationship, if any, between growth mindset

and frustration discomfort. Researchers in the future may investigate to see if one construct causes the other from additional quantitative research and with the addition of qualitative research. However, at this time, the design and methodology of this study was to determine if a relationship existed between growth mindset and frustration discomfort.

The researcher of this study relied on the distribution of the online survey through an administrator within the College of Education at the university the participants were attending. Undoubtedly, it was also possible for participants to have a perceptual misrepresentation due to the researcher disclosing their doctoral student status at the same university. This could have affected participants' authenticity and transparency when completing a survey about their beliefs of intelligence and frustration.

### **Delimitations**

The convenience sample of the population being studied was preservice teachers of the College of Education at a Midwestern university. The defined characteristics of preservice teachers within this population were mostly female and Caucasian. Data was collected from over 200 survey respondents to provide a sample ( $n = 176$ ) that more accurately represented the population of preservice teachers. However, the generalizability of this study was limited to a population of students of other universities and from outside of the Midwest, which may have included other races, cultures, and genders.

The study was conducted within the first week of the university's semester, according to their academic calendar, and was given to students enrolled in the College of Education. The purpose of this timing was to limit the amount of knowledge that preservice teachers would have on productive struggle, growth mindset, and frustration discomfort in mathematics education. Although college students have their own experiences with mathematics education, these

participants may have had more knowledge of productive struggle, growth mindset, and frustration tolerance.

### **Summary**

The methodology of the study described in this chapter was supported by the literature and teaching experience of the researcher. The survey design of the study appropriately met the needs of the researcher to gather data quickly and efficiently from students in a teacher preparation program. The instruments used in the survey have proven validity and reliability to measure the constructs previously described. The data was analyzed to identify the strength and direction, if any, of the multivariate correlations between frustration discomfort and growth mindset in mathematics. Multiple regression analyses were also used to determine if specific demographics and dispositions were predictors to certain beliefs towards mathematics. This study hoped to contribute findings to future research in mathematics education.

## Chapter 4 - Results

### Introduction

Beliefs, attitudes, and judgments towards mathematics are uniquely molded by each individual's experiences in practicing mathematics. These perceptions towards mathematics may affect students' ability to perform mathematical practices like, *Make sense of problems and persevere in solving them*, and affect teachers' ability to *Support [students'] productive struggle in learning mathematics* (KSDE, 2017a, 2017b). This study aimed to explore the patterns and relationships associated with these mathematical dispositions through the discomforts, intolerances, and theories of intelligences concerning mathematics education.

The purpose of this study was to investigate preservice teachers' views towards mathematics through the Frustration Discomfort Scale (FDS) and the Theory of Intelligence Scale (TIS). This multivariate correlation study examined each of the four factors of FDS; discomfort intolerance, entitlement, emotional intolerance, and achievement frustration, in relation to the entity theory of intelligence (fixed mindset) and the incremental theory of intelligence (growth mindset) within the TIS. Statistical results in this chapter addressed the following research questions:

- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of frustration discomfort towards mathematics?
  - What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of *discomfort intolerance* towards mathematics?

- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *entitlement* towards mathematics?
- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *emotional intolerance* towards mathematics?
- What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *achievement frustration* towards mathematics?

This chapter examined the results of the survey data. First, the sample was described through the demographic data collected. Details of the sample provided a clear picture of the types of undergraduate preservice teachers that responded to this survey. A description of the instruments used in this study followed, including the frequency of responses to each item within the FDS and TIS. Here, patterns and trends emerged within the tables of participants' responses. Next, the FDS, TIS, and demographic data was analyzed to find correlation and regression relationships between the constructs. Analysis was organized through the sequence of FDS Factor I Discomfort Intolerance, then Factor II Entitlement, Factor III Emotional Intolerance, and last Factor IV Achievement Frustration. However, much of the correlation and regression analysis focused on Factor I Discomfort Intolerance due to the increase in statistical significance of the data within this domain compared to the other FDS Factors.

### **Description of the Sample**

Data was gathered from an anonymous online survey distributed to students enrolled in the College of Education at one Midwest university. The generalization of this study was based

on the total sample size of participants that answered all survey questions within the one-week time frame given. Representing the undergraduate student population of elementary and secondary majors at a Midwest university, a total population of 886 students was surveyed. Using a 95% confidence level and a 5% margin of error, the ideal sample size was calculated to be 268 participants. This study began in Spring 2022 with 253 students that consented to participate in the survey, but after removing incomplete responses from participants that did not answer all survey items, a small sample size of 176 emerged. Although the small sample size may affect the reliability of the results from this study's data in comparison to a larger, similar population, the reliability of the instruments used remains to support the theories behind frustration intolerance and mindsets towards mathematics.

Of the 176 preservice teachers that participated in this survey, 51.7% were seeking a degree in elementary education and 48.3% in secondary education. Due to the similar sizes of the sample of elementary preservice teachers and the sample of secondary preservice teachers, descriptive statistics of other demographic items were comparable by participants' degree. When participants were asked to indicate their gender, 82.4% responded female and 17.0% responded male, while one participant (.6%) chose not to disclose their gender. The ratio of female to male preservice teachers in elementary education differed to that of secondary education. While there were only 2 (2.2%) male elementary preservice teachers surveyed, 28 (32.9%) of secondary education students surveyed were male. Other demographic information gathered in this study was the participants' age, current year in college, and the number of mathematics courses completed at the college level. Table 4.1 described the demographic data of participants' gender, age, college year, and mathematics courses completed based on their degree responses on the survey.

Table 4.1  
*Summary of Participants' Demographic Data*

<u>Major</u>	<u>*Gender</u>	<u>Age</u>	<u>College Year</u>	<u>College Math Courses</u>
Elementary Education [n = 91]	Female: 89 (98%) Male: 2 (2%)	18-19: 25 (28%) 20-21: 54 (59%) 22-23: 10 (11%) 24-25: 0 26-30: 1 (1%) 31-35: 0 36+: 1 (1%)	Freshman: 11 (12%) Sophomore: 25 (28%) Junior: 35 (39%) Senior: 20 (22%)	1: 12 (13%) 2: 28 (31%) 3: 39 (43%) 4: 7 (8%) 5+: 5 (5%)
Secondary Education [n = 85]	Female: 56 (66%) Male: 28 (33%)	18-19: 36 (42%) 20-21: 39 (46%) 22-23: 9 (11%) 24-25: 0 26-30: 0 31-35: 0 36+: 1 (1%)	Freshman: 22 (26%) Sophomore: 18 (21%) Junior: 30 (35%) Senior: 15 (18%)	1: 26 (31%) 2: 29 (34%) 3: 8 (9%) 4: 3 (4%) 5+: 19 (22%)
Total [n = 176]	Female: 145 (82%) Male: 30 (17%)	18-19: 61 (35%) 20-21: 93 (53%) 22-23: 19 (11%) 24-25: 0 26-30: 1 (1%) 31-35: 0 36+: (1%)	Freshman: 33 (19%) Sophomore: 43 (24%) Junior: 65 (37%) Senior: 35 (20%)	1: 38 (22%) 2: 57 (32%) 3: 47 (27%) 4: 10 (6%) 5+: 24 (14%)

\*One secondary education participants' gender was undisclosed

Table 4.1 Summary of Participants' Demographic Data

### Description of the Instruments

#### Frustration Discomfort Scale

Aside from the demographic items, The Mathematical Mindset of Preservice Teachers survey included two instruments, the Frustration Discomfort Scale (FDS) and the Theories of Intelligence Scale (TIS) (see Appendix). The directions for the FDS section of the survey read, "Listed below are a number of common thoughts and beliefs that people may have when they are distressed or frustrated. Please consider your experiences learning and practicing **mathematics**

when you read each statement. Then decide how well this usually describes your own beliefs towards **mathematics** by using the following scale to record your answers.” The FDS used a 5-point Likert scale for participants to respond to seven items per factor; Factor I Discomfort Intolerance, Factor II Entitlement, Factor III Emotional Intolerance, and Factor IV Achievement Frustration. The 28 items of the FDS were in a mixed order when listed in the survey and measured the level of participants’ beliefs. Five scores makeup this scale; Absent (1), Mild (2), Moderate (3), Strong (4), and Very Strong (5). According to the data in Table 4.2, about 30% of participants believed they were moderately intolerant of each FDS Factor. The data also indicated that preservice teachers believed Factor I Discomfort Intolerance was the most “Mild” or nonexistent (“Absent”) of the four Factors, whereas Factor IV Achievement Frustration had the most “Strong” or “Very Strong” responses from preservice teachers (Table 4.2).

	<u>Absent</u>	<u>Mild</u>	<u>Moderate</u>	<u>Strong</u>	<u>Very Strong</u>
Factor I Discomfort Intolerance	152 (12%)	464 (38%)	375 (30%)	189 (15%)	52 (4%)
Factor II Entitlement	129 (10%)	353 (29%)	368 (30%)	291 (24%)	91 (7%)
Factor III Emotional Intolerance	151 (12%)	349 (28%)	388 (31%)	264 (21%)	80 (6%)
Factor IV Achievement Frustration	72 (6%)	210 (17%)	373 (30%)	379 (31%)	198 (16%)

Table 4.2 Frequency of Responses, per FDS Factor

The first Factor of the FDS, Discomfort Intolerance, prompted participants to consider how they feel about uncomfortable situations. For example, only 18 (10%) preservice teachers responded “Strong” or “Very Strong” toward the belief statement, *Q2 I can’t stand having to push myself at tasks* (Table 4.3). In theory, a person with a growth mindset views rigorous

mathematics tasks as a learning opportunity and isn't afraid to make mistakes in an effort to persevere and problem solve. Therefore, in theory someone with a growth mindset in mathematics would respond to this belief with "Absent" or "Mild" rather than "Moderate," "Strong," or "Very Strong." Although the belief statement, *Q7 I can't stand doing tasks when I'm not in the mood*, had the most "Strong" and "Very Strong" responses (65, 37%) of Factor I Discomfort Intolerance, overall this Factor had the least amount of "Strong" and "Very Strong" responses compared to items in the other FDS Factors (Tables 4.3, 4.4, 4.5, and 4.6). Therefore, preservice teachers felt stronger about the belief statements of entitlement, emotional intolerance, and achievement frustration than they did towards discomfort intolerance.

Q1 I can't stand doing things that involve a lot of hassle.	32 (18%)
Q2 I can't stand having to push myself at tasks.	18 (10%)
Q3 I can't stand having to persist at unpleasant tasks.	36 (20%)
Q4 I can't stand doing tasks that seem too difficult.	26 (15%)
Q5 I can't stand the hassle of having to do things right now.	23 (13%)
Q6 I need the easiest way around problems. I can't stand making a hard time of it.	32 (18%)
Q7 I can't stand doing tasks when I'm not in the mood.	65 (37%)
Factor I Total	232 (19%)

Table 4.3 FDS Factor I Discomfort Intolerance Frequency of Strong and Very Strong Responses, per Item

The statements in the second FDS Factor described beliefs of feeling entitled in mathematics, like *Q5 I can't tolerate criticism especially when I know I'm right* (Table 4.4). Feelings of entitlement often contradict the collaborative nature of problem solving with a growth mindset in mathematics. The Effective Mathematics Teaching practice of supporting

students with productive struggle should include opportunities for classroom discourse and cooperative learning to increase collaboration and teamwork and decrease feelings of entitlement. According to the data, preservice teachers felt the most strongly towards the statement, *Q6 I can't tolerate being taken for granted*, with 56% of responses as “Strong” or “Very Strong” (Table 4.4). Here, the data suggested that preservice teachers need to feel their efforts in mathematics are appreciated. In doing so, teachers would be fostering a growth mindset by providing opportunities for cooperative learning that require accountability for each student and opportunities to reason and justify their mathematical thinking.

Q1 I can't bear it if other people stand in the way of what I want.	53 (30%)
Q2 I can't stand it if other people act against my wishes	48 (27%)
Q3 I can't stand having to give in to other people's demands.	23 (13%)
Q4 I can't stand having to change when others are at fault.	66 (38%)
Q5 I can't tolerate criticism especially when I know I'm right.	40 (23%)
Q6 I can't tolerate being taken for granted.	99 (56%)
Q7 I can't stand having to wait for things I would like now.	43 (24%)
Factor II Total	372 (30%)

Table 4.4 FDS Factor II Entitlement Frequency of Strong and Very Strong Responses, per Item

According to the data in Table 4.5, the two items within Factor III Emotional Intolerance that preservice teachers felt the most strong about were, *Q5 I can't stand to lose control of my feelings* (45%) and *Q6 I can't bear to feel that I am losing my mind* (55%). In theory the mathematical practice of productive struggle forces students to feel vulnerable to the uncertainty of a solution to a rigorous task. Tolerating such emotional feelings appears to align with the

purpose of practicing productive struggle in the mathematics classroom as a means to teach students how to use their intuition in choosing efficient strategies to problem solve.

Table 4.5	
<i>FDS Factor III Emotional Intolerance Frequency of Strong or Very Strong Responses, per Item (n =176)</i>	
Q1 I can't bear disturbing feelings.	41 (23%)
Q2 I can't bear to have certain thoughts.	32 (18%)
Q3 I must be free of disturbing feelings as quickly as possible. I can't bear it if they continue.	45 (26%)
Q4 I can't stand situations where I might feel upset.	39 (22%)
Q5 I can't stand to lose control of my feelings.	80 (45%)
Q6 I can't bear to feel that I am losing my mind.	97 (55%)
Q7 I can't get on with my life, or be happy, if things don't change.	20 (11%)
Factor III Total	354 (29%)

Table 4.5 FDS Factor III Emotional Intolerance Frequency of Strong or Very Strong Responses, per Item

Preservice teachers felt the strongest about achievement frustrations in mathematics compared to any other FDS Factor (Table 4.6). According to the data, the Factor IV Achievement Frustration items, *Q2 I can't stand feeling that I'm not on top of my work* (79%) and *Q4 I can't stand being prevented from achieving my full potential* (64%), had the most “Strong” and “Very Strong” responses of all 28 FDS items. The data suggested preservice teachers in this study had stronger feelings of frustration towards mathematics when they were unable to complete tasks well and efficiently. According to the Factor Totals in Tables 4.5 and 4.6, preservice teachers felt more frustrated with achieving their own goals (47%) than they did with tolerating their emotions with other people (29%).

Table 4.6	
<i>FDS Factor IV Achievement Frustration Frequency of Strong or Very Strong Responses, per Item (n =176)</i>	

Q1 I can't tolerate any lapse in my self-discipline.	43 (24%)
Q2 I can't stand feeling that I'm not on top of my work.	139 (79%)
Q3 I can't stand doing a job if I'm unable to do it well.	88 (50%)
Q4 I can't stand being prevented from achieving my full potential.	113 (64%)
Q5 I can't bear the frustration of not achieving my goals.	84 (48%)
Q6 I can't bear to move on from work I'm not fully satisfied with.	70 (40%)
Q7 I can't tolerate lowering my standards even when it would be useful to do so.	40 (23%)
Factor IV Total	577 (47%)

Table 4.6 FDS Factor IV Achievement Frustration Frequency of Strong or Very Strong Responses, per Item

### Theories of Intelligence Scale

Although the Theories of Intelligence Scale (TIS) was separated from the Frustration Discomfort Scale (FDS) in this survey on mathematics, like the FDS, the 8-items of TIS were in a mixed order. Within the TIS there were 4 entity theory items representing a fixed mindset (Table 4.7) and 4 incremental items representing a growth mindset (Table 4.8). Directions for the TIS section of the survey read, “The following statements were designed to investigate thoughts about intelligence. Please consider your experiences learning and practicing **mathematics** when you read each statement. Then decide how much you agree or disagree with each statement considering your beliefs towards **mathematics** by using the following scale to record your answers.” The TIS used a 6–point Likert scale to measure participants’ degree of fixed or growth mindset by giving a score to each statement on a scale of Strongly Disagree (1), Disagree (2), Mostly Disagree (3), Mostly Agree (4), Agree (5), and Strongly Agree (6). Tables 4.7 and 4.8 displayed the frequencies of responses for each TIS item according to the 6-point Likert Scale.

Of the four entity theory items that represented a fixed mindset towards mathematics in Table 4.7, the data indicated that the item, *Q4 You can learn new things, but you can't really*

*change your basic intelligence*, had at least three times more “Agree” responses than the other fixed mindset items. Responses in Table 4.7 also showed that there were less “Strongly Disagree” and “Disagree” responses to Q4 than the other items, yet more “Mostly Disagree” and “Mostly Agree” responses than the other fixed mindset items. This suggested that not only did preservice teachers agree with this fixed mindset statement more than the others, but that they were less decisive about claiming that your basic amount of intelligence can’t change. This implied that there might be degrees of which preservice teachers have a fixed or growth mindset towards intelligence when distinguishing “basic” intelligence. For example, you can learn new skills in mathematics, but you still can’t change your basic level of mathematical ability.

Table 4.7

*TIS Entity Theory (Fixed Mindset) Frequency of Responses, per Item (n = 176)*

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Mostly Disagree</u>	<u>Mostly Agree</u>	<u>Agree</u>	<u>Strongly Agree</u>
Q1 You have a certain amount of intelligence, and you can't really do much to change it.	40 (23%)	72 (41%)	30 (17%)	25 (14%)	7 (4%)	2 (1%)
Q2 Your intelligence is something about you that you can't change very much.	44 (25%)	78 (44%)	27 (15%)	20 (11%)	4 (2%)	3 (2%)
Q3 To be honest, you can't really change how intelligent you are.	41 (23%)	79 (45%)	35 (20%)	14 (8%)	6 (3%)	1(1%)
Q4 You can learn new things, but you can't really change your basic intelligence.	13 (7%)	60 (34%)	49 (28%)	30 (17%)	21 (12%)	3 (2%)

Table 4.7 TIS Entity Theory (Fixed Mindset) Frequency of Responses, per Item

The TIS incremental theory items in Table 4.8 represented a growth mindset towards mathematics and naturally showed opposing data compared to the fixed mindset items of Table 4.8. According to the data, preservice teachers “Agreed” (35%) and “Strongly Agreed” (19%) the more with the growth mindset item, *Q1 No matter who you are, you can significantly change*

*your intelligence level*, than any other TIS growth mindset item. According to the data in Table 4.8, although the growth mindset item, *Q4 You can change even your basic intelligence level considerably*, had the lowest percentage of “Strongly Agree” responses (13%) compared to the other growth mindset item, it had more “Strongly Agree” responses than the similar fixed mindset statement in Table 4.8, *Q4 You can learn new things, but you can't really change your basic intelligence*, had of “Strongly Disagree” responses. The Tables also show that, aside from both fixed and growth mindset *basic intelligence* items having 34% of “Disagree” (Q4, Table 4.7) and 34% of “Agree” (Q4, Table 4.8) opposing responses, preservice teachers were more willing to “Agree” and “Strongly Agree” with the *basic intelligence* growth mindset item (47%, Table 4.8) than they were willing to “Disagree” and “Strongly Disagree” with the *basic intelligence* fixed mindset item (41%, Table 4.7). According to the data, the pattern continued with 14% of the *basic intelligence* fixed mindset responses being “Agree” and “Strongly Agree” (Q4, Table 4.7), yet only 3% of the *basic intelligence* growth mindset responses were “Disagree” and “Strongly Disagree” (Q4, Table 4.8). This suggested that preservice teachers were more likely to agree with statements about changing basic intelligence when phrased as a growth mindset statement than disagree when the statement was phrased like a fixed mindset statement. Similarly the data proposed that preservice teachers were more likely to agree with the inability to change your basic intelligence than they were to disagree that you can change your basic intelligence.

	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Mostly Disagree</u>	<u>Mostly Agree</u>	<u>Agree</u>	<u>Strongly Agree</u>
Q1 No matter who you are, you can	2 (1%)	6 (3%)	21 (12%)	52 (30%)	62 (35%)	33 (19%)

significantly change your intelligence level.						
Q2 You can always substantially change how intelligent you are.	1 (1%)	12 (7%)	26 (15%)	59 (34%)	53 (30%)	25 (14%)
Q3 No matter how much intelligence you have, you can always change it quite a bit.	1 (1%)	3 (2%)	23 (13%)	69 (39%)	49 (28%)	31 (18%)
Q4 You can change even your basic intelligence level considerably.	0	6 (3%)	19 (11%)	68 (39%)	60 (34%)	23 (13%)

Table 4.8 TIS Incremental Theory (Growth Mindset) Frequency of Responses, per Item

Comparisons between the frequencies of the Fixed and Growth Mindset responses continued in Table 4.9. The data demonstrated an overall trend that preservice teachers were more decisive with fixed mindset statements than growth mindset statements. There were 138 (20%) “Strongly Disagree” responses to Fixed Mindset compared to only 112 (16%) “Strongly Agree” responses to Growth Mindset (Table 4.9). Similarly, the data showed that there were 289 (41%) “Disagree” responses to Fixed Mindset items compared to only 224 (32%) “Agree” responses to Growth Mindset items. This may account for the increase in “Mostly Agree” responses to Growth Mindset items (248, 35%) compared to the 141 (20%) “Mostly Disagree” responses to Fixed Mindset items. It would be beneficial to further analyze the pattern of responses to statements phrased as a fixed mindset item compared to a growth mindset item.

Table 4.9						
<i>TIS Frequency of Item Totals, per Each of the 6-Point TIS Response Choices (n = 176)</i>						
	<u>Strongly Disagree</u>	<u>Disagree</u>	<u>Mostly Disagree</u>	<u>Mostly Agree</u>	<u>Agree</u>	<u>Strongly Agree</u>
Fixed Mindset Items	138 (20%)	289 (41%)	141(20%)	89 (13%)	38 (5%)	9 (1%)
Growth Mindset Items	4 (1%)	27 (4%)	89 (13%)	248 (35%)	224 (32%)	112 (16%)

Table 4.9 TIS Frequency of Item Totals, per Each of the 6-Point TIS Response Choices

## **Data Analysis**

The Mathematical Mindset of Preservice Teachers Survey collected data to investigate the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of frustration discomfort. The instruments used in this study to collect such data were the Frustration Discomfort Scale (FDS) and the Theories of Intelligence Scale (TIS). Included in the FDS were seven items for each of the four factors, Factor I Discomfort Intolerance (FI), Factor II Entitlement (FII), Factor III Emotional Intolerance (FIII), and Factor IV Achievement Frustration (FIV). Each of the FDS Factors were analyzed in relation to each of the four TIS entity theory items measuring Fixed Mindset and each of the four TIS incremental theory items measuring Growth Mindset. Due to the opposing nature of the Fixed Mindset items compared to the Growth Mindset items, the researcher calculated a reverse-code for the Growth Mindset scores in order to draw conclusions from the cumulative TIS data, in relation to the FDS Factors and the demographic data. In this section of Chapter IV Results, patterns and relations from the survey results were identified between these two constructs and further analyzed based on the demographic information gathered from participants. In addition to the FDS and TIS instruments of this survey, preservice teachers were asked their age, gender, current year in college, whether they were seeking an elementary education or secondary education degree, if their instruction was primarily online or in-person, and how many mathematics courses they had completed at the college level.

### **Correlation Analysis**

As previously stated, the primary research question stated, *What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of frustration discomfort towards mathematics?* The data suggested

that there was not a significant correlation between the FDS mean score and the TIS mean score of the entire sample,  $r(174) = -.060, p = .427$ . Specifically, the data showed no significant correlation between the FDS and TIS mean scores of the secondary education preservice teachers,  $r(83) = .059, p = .592$ . However, there was a significant negative Pearson correlation between the FDS and TIS mean scores of the elementary education preservice teachers,  $r(89) = -.311, p = .003$ . This suggests that the more of a growth mindset they have, the less tolerant of discomfort in mathematics they are. Although, the literature seems to portray dispositions such as grit and perseverance as those supportive of a growth mindset, which, in theory, would make a person more tolerant of discomfort in mathematics. Further investigation would be beneficial between these two constructs with an elementary educator sample.

The relationship between a preservice teacher's degree of fixed or growth mindset and their level of discomfort within each of the four FDS Factors was also examined. The sections that follow addressed each of the four research questions, per FDS Factor; Factor I Discomfort Intolerance, Factor II Entitlement, Factor III Emotional Intolerance, and Factor IV Achievement Frustration, by examining the relationship between each FDS Factor, the TIS, and the demographic data. It is worth noting that the FDS Factor I Discomfort Intolerance had the most correlations with the other variables, and therefore the data analysis was far greater than the other three FDS Factors. Therefore, the analysis of FDS Factor I Discomfort Intolerance was more in depth than the other Factors and therefore was broken down by each of the 7 Factor I items.

### ***FDS Factor I Discomfort Intolerance***

Research Question: What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of *discomfort intolerance* towards mathematics.

The first research question addressed FDS Factor I Discomfort Intolerance and asks, *What is the strength and direction, if any, of the relationship between a preservice teacher's degree of fixed or growth mindset and their level of discomfort intolerance towards mathematics?* In Tables 4.10 and 4.11, the data suggested that there was not only a significant correlation between several FDS and TIS items, but also a significant correlation between the Factor I Discomfort Intolerance mean and the TIS mean score,  $r(174) = .199, p < .01$ . This positive relationship among the entire sample ( $n = 176$ ) suggested that the more of a growth mindset a preservice teacher has towards mathematics, the more they can tolerate feeling discomfort in mathematics. Further investigation revealed that this significant relationship was not present in preservice teachers of elementary education,  $r(89) = .061, p = .566$ , rather only in secondary education,  $r(83) = .287, p = .008$  and the entire sample  $r(174) = .199, p = .008$ .

Table 4.10

*Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Fixed Mindset Items (n = 176)*

<u>Discomfort Intolerance Items</u>	<u>Fixed Mindset Items</u>				Fixed Mindset Mean	TIS Mean
	FM Q1	FM Q2	FM Q3	FM Q4		
Q1 I can't stand doing things that involve a lot of hassle.	.186, p=.014	.158, p=.036	.147, p=.051	.203, p=.007	.205, p=.006	.181, p=.016
Q2 I can't stand having to push myself at tasks.	.149, p=.048	.120, p=.113	.093, p=.222	.144, p=.056	.150, p=.047	.112, p=.138
Q3 I can't stand having to persist at unpleasant tasks.	.159, p=.035	.113, p=.136	.061, p=.421	.167, p=.026	.149, p=.048	.143, p=.058
Q4 I can't stand doing tasks that seem too difficult.	.101, p=.183	.061, p=.424	.146, p=.054	.208, p=.006	.152, p=.044	.171, p=.023
Q5 I can't stand the hassle of having to do things right now.	.238, p=.001	.119, p=.114	.126, p=.095	.219, p=.005	.209, p=.005	.159, p=.035
Q6 I need the easiest way around problems. I can't stand making a hard time of it.	.127, p=.093	.121, p=.109	.086, p=.258	.163, p=.031	.147, p=.051	.109, p=.150
Q7 I can't stand doing tasks when I'm not in the	.076,	.028,	.038,	.141,	.085,	.093,

mood.	p=.318	p=.714	p=.616	p=.062	p=.262	p=.218
Factor I Mean	.213, p=.005	.147, p=.052	.142, p=.060	.257, p=.001	.225, p=.003	.199, p=.008
FDS Mean	-.049, p=.516	-.055, p=.467	-.102, p=.177	-.055, p=.468	-.076, p=.318	-.060, p=4.27
Significant at $p < .01$ , Significant at $p < .05$ , Not Significant at $p < .05$						

Table 4.10 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Fixed Mindset Items

<u>Discomfort Intolerance Items</u>	<u>Growth Mindset Items</u>				Growth Mindset Mean	TIS Mean
	GM Q1	GM Q2	GM Q3	GM Q4		
Q1 I can't stand doing things that involve a lot of hassle.	.160, p=.034	.055, p=.465	.101, p=.182	.087, p=.251	.122, p=.108	.181, p=.016
Q2 I can't stand having to push myself at tasks.	-.018, p=.812	.015, p=.814	.152, p=.044	.027, p=.726	.051, p=.504	.112, p=.138
Q3 I can't stand having to persist at unpleasant tasks.	.055, p=.465	.079, p=.300	.154, p=.041	.082, p=.278	.110, p=.145	.143, p=.058
Q4 I can't stand doing tasks that seem too difficult.	.127, p=.094	.088, p=.245	.210, p=.005	.114, p=.132	.161, p=.033	.171, p=.023
Q5 I can't stand the hassle of having to do things right now.	.067, p=.378	.039, p=.609	.095, p=.210	.053, p=.483	.076, p=.317	.159, p=.035
Q6 I need the easiest way around problems. I can't stand making a hard time of it.	-.040, p=.597	.004, p=.963	.109, p=.152	.098, p=.198	.047, p=.536	.109, p=.150
Q7 I can't stand doing tasks when I'm not in the mood.	.059, p=.439	.078, p=.301	.085, p=.264	.063, p=.406	.086, p=.258	.093, p=.218
Factor I Mean	.082, p=.278	.074, p=.328	.186, p=.013	.108, p=.152	.134, p=.077	.199, p=.008
FDS Mean	-.081, p=.286	-.015, p=.845	-.013, p=.869	.005, p=.948	-.033, p=.668	-.060, p=4.27
Significant at $p < .01$ , Significant at $p < .05$ , Not Significant at $p < .05$						

Table 4.11 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Growth Mindset Items

Table 4.12 displayed the FDS Factor I Discomfort Intolerance items with the strongest correlation ( $p < .05$ ) to the TIS mean. Although there was not a significant correlation ( $p < .05$ ) with these variables in the elementary preservice teachers data, there were small positive correlations between the TIS mean score and Factor I Questions #1, #4, and #5. The correlations between Factor I Questions #1, #4, #5, and the FI mean and individual TIS items supported these small correlations in Table 4.12.

Table 4.12		
<i>Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Mean, per Degree (<math>p &lt; .05</math>)</i>		
<u>Discomfort Intolerance Items</u>	<u>Secondary Education</u> (n = 85)	<u>Entire Sample</u> (n = 176)
Q1 I can't stand doing things that involve a lot of hassle.	.225	.181
Q4 I can't stand doing tasks that seem too difficult.	.260	.171
Q5 I can't stand the hassle of having to do things right now.	.215	.159

Table 4.12 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Mean, per Degree

As stated previously in Chapter III Methodology, the TIS instrument was made up of four entity theory (fixed mindset) items and four incremental theory (growth mindset) items. Table 4.13 examines the strongest correlations ( $p < .01$ ) between Factor I Discomfort Intolerance (Q1, Q4, and Q5), TIS Fixed Mindset (Q1, Q4, and the mean), and TIS Growth Mindset (Q2, Q3, and the mean). The data in Table 4.13 suggested that there are more significant ( $p < .01$ ) correlations among preservice teachers in secondary education compared to those in elementary education or the entire survey sample.

In this study, the data indicated that the preservice teachers earning a degree in secondary education had a positive correlation of medium strength between the TIS Fixed Mindset item, *Q6 You can learn new things, but you can't really change your basic intelligence*, and Factor I items that describe having to do difficult things right now (Q4 and Q5) (Table 4.13). According to the data, the FDS Factor I item, *Q4 I can't stand doing tasks that seem too difficult*, also had low to medium strengths of correlations with the Fixed Mindset item, *Q6 You can learn new things, but you can't really change your basic intelligence*,  $r(83) = .301$ ,  $p < .01$ , and the Growth Mindset items, *Q5 You can always substantially change how intelligent you are*,  $r(83) = .280$ ,  $p < .01$ , and *Q7 No matter how much intelligence you have, you can always change it quite a bit*,  $r(83) = .322$ ,  $p < .01$  (Table 4.13).

Table 4.13  
*Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items, per Degree ( $p < .01$ )*

<u>Discomfort Intolerance Items</u>	<u>TIS Items</u>					
	FM Q1	FM Q4	FM Mean	GM Q2	GM Q3	GM Mean
Q1 I can't stand doing things that involve a lot of hassle.		.203				.205
Q4 I can't stand doing tasks that seem too difficult.		.208 .301		.280	.210 .322	.280
Q5 I can't stand the hassle of having to do things right now.	.238 .293	.219 .331	.209			
Factor I Mean	.213	.257 .316	.225	.284	.305	.282

Entire Sample (n = 176), Elementary Education (n = 91), Secondary Education (n = 85)

Table 4.13 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items, per Degree

Although the strength of correlations between FDS Factor I Discomfort Intolerance and TIS didn't change significantly when males (n = 2) were removed from the elementary

preservice teachers, there was a distinct difference between the strength of correlations among male and female secondary preservice teachers. There were no significant Pearson correlations ( $p < .01$ ) between FDS Factor I Discomfort Intolerance and TIS items from the male-only secondary preservice teacher data ( $n = 28$ ). However, when the female-only secondary preservice teacher data ( $n = 57$ ) was analyzed, there were significant increases in strength of correlations between these variables (Table 4.14). According to the data, the largest increase in strength of a significant correlation ( $p < .01$ ) was between Factor I item, *Q4 I can't stand doing tasks that seem too difficult*, and Growth Mindset Item, *Q3 No matter how much intelligence you have, you can always change it quite a bit*. When the data of all secondary preservice teachers was analyzed, the Pearson correlation was  $r(83) = .300, p < .01$ , compared to the female-only secondary preservice teacher data with a correlation of  $r(55) = .430, p < .01$  (Table 4.14).

Table 4.14

*Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items, per Female Secondary Preservice Teachers ( $p < .01$ )*

	<u>FM</u> <u>Q4</u>	<u>FM</u> <u>Mean</u>	<u>GM</u> <u>Q2</u>	<u>GM</u> <u>Q3</u>	<u>GM</u> <u>Q4</u>	<u>GM</u> <u>Mean</u>	<u>TIS</u> <u>Mean</u>
Q1 I can't stand doing things that involve a lot of hassle.						.341	
Q4 I can't stand doing tasks that seem too difficult.	.314 .430	.347	.291	.300 .452	.361	.399	.387
Q5 I can't stand the hassle of having to do things right now.		.347 .361					
Factor I Mean	.313 .437	.362	.296 .345	.314 .419	.363	.293 .400	.293 .397

All Secondary Education ( $n = 85$ ), Female-Only Secondary Education ( $n = 57$ )

Table 4.14 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items, per Female Secondary Preservice Teachers

Further data analysis of participants' demographics concluded that 92.0% of preservice teachers surveyed were receiving their instruction in-person. When online instruction scores were removed (n = 14), existing correlations between FDS Factor I Discomfort Intolerance and TIS (Table 4.13) strengthened and additional significant correlations at the  $p < .01$  level were present (Table 4.15). For example, two positive correlations emerged between Factor I item, *Q1 I can't stand doing things that involve a lot of hassle*, and Fixed Mindset item, *Q4 You can learn new things, but you can't really change your basic intelligence*  $r(81) = .296, p < .01$ , and the Fixed Mindset mean  $r(89) = .304, p < .01$ , among in-person elementary education preservice teachers (n = 83). As a result, the strength of the correlation for the entire in-person sample (n = 162) also increased for Factor I Q1 and Fixed Mindset Q4, from a correlation of  $r(160) = .203, p < .01$  to a correlation of  $r(160) = .254, p < .01$ , and the correlation between Factor I Q1 and the Fixed Mindset Mean became significant  $r(160) = .251, p < .01$  (Table 4.15).

Table 4.15

*Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items for In-Person Instruction Only, per Degree ( $p < .01$ )*

<u>Discomfort Intolerance Items</u>	<u>TIS Items</u>							
	FM Q1	FM Q2	FM Q4	FM Mean	GM Q2	GM Q3	GM Mean	TIS Mean
Q1 I can't stand doing things that involve a lot of hassle.	.241	.219	.254 <i>.296</i>	.266 <i>.304</i>				.251
Q3 I can't stand having to persist at unpleasant tasks.	.203							
Q4 I can't stand doing tasks that seem too difficult.			.261 <i>.314</i>		.291	.222 <i>.300</i>		.207
Q5 I can't stand the hassle of having to do things right now.	.253 <i>.313</i>		.248 <i>.347</i>	.225				
Q6 I need the easiest way around problems. I can't stand making a hard time of it.					<i>-.289</i>			
Factor I Mean	.253		.287	.264	<i>.296</i>	.231	<i>.293</i>	.242

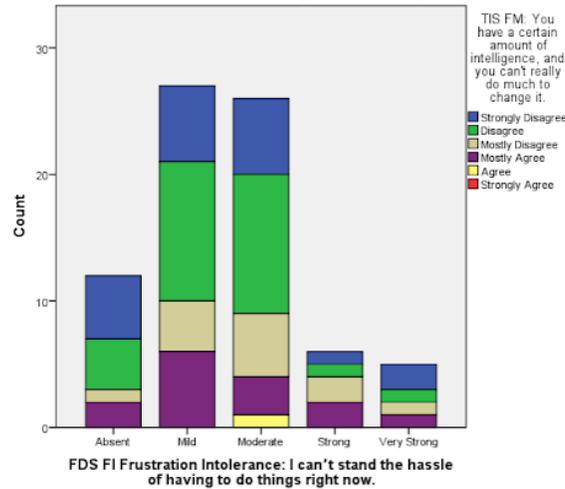
	.313	.314	.293
Entire Sample (n = 162), Elementary Education (n = 83), Secondary Education (n = 79)			

Table 4.15 Pearson Correlations between FDS Factor I Discomfort Intolerance Items and TIS Items for In-Person Instruction Only, per Degree

In this study, participants also indicated which year in college they were currently in; freshman, sophomore, junior, or senior. Using crosstabs, the data revealed that there is a distinct difference between freshmen and seniors' scores on the FDS and TIS instruments. Below in Table 4.16, the items from the survey that had the strongest correlation (Factor I Discomfort Intolerance Q5 and Fixed Mindset Q1 from Table 4.13) for the entire sample (n = 176) were further analyzed using crosstabs to distinguish the participants' scores according to their current college year. Students in teacher preparation programs typically take general education courses their freshman and sophomore years before being admitted into an elementary or secondary education program and taking content-specific educational courses. For this data analysis, the freshmen and sophomores were combined (n = 76) and the juniors and seniors were combined (n = 100). The graphs in Table 4.16 appeared to have a similar frequency of participants responding to the Factor I Discomfort Intolerance item, *Q5 I can't stand the hassle of having to do things right now*, no matter which college year participants responded with in the survey. However, the data did suggest that juniors and seniors had more of a fixed mindset when responding to FDS Factor I Discomfort Intolerance items and TIS Fixed and Growth Mindset items compared to freshman and sophomores.

<p>Table 4.16</p> <p><i>Frequency of Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1, per college year</i></p>
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**Freshmen and Sophomores (n = 76)**



**Juniors and Seniors (n = 100)**

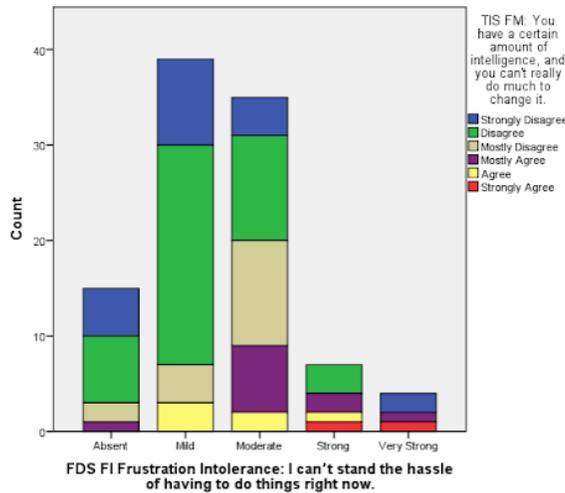


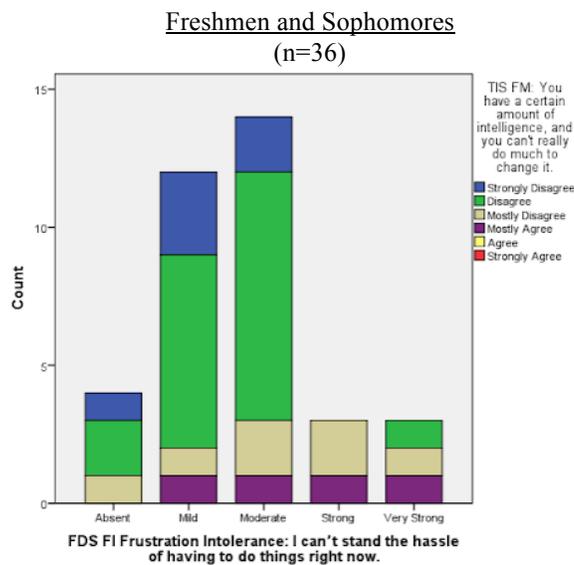
Table 4.16 Frequency of Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1, per college year

This pattern continued when data from only the secondary education sample and elementary education sample were separated by college year and analyzed. Table 4.17 displayed data from the elementary education preservice teachers, again showing that juniors and seniors (n = 55) have more of a fixed mindset than freshmen and sophomores (n = 36). There appeared to be a pattern of the majority of elementary freshmen and sophomores (n = 36) responding to FDS

Factor I discomfort Intolerance item, *Q5 I can't stand the hassle of having to do things right now*, with responses of little to no discomfort intolerance and of disagreement to TIS Fixed Mindset item, *Q1 You have a certain amount of intelligence, and you can't really do much to change it*. Similar to Table 4.16, Table 4.17 displayed a variety of responses from elementary juniors and seniors (n = 55), including responses indicating agreement with the fixed mindset statement (TIS Fixed Mindset Q1) and responses indicating preservice teachers are only mildly intolerant to discomfort (FDS Factor I Q5). However, in Table 4.17 it appeared that the elementary juniors and seniors had a similar pattern of responses as the elementary freshmen and sophomores, only that they responded more in agreement with the fixed mindset statement (TIS Fixed Mindset Q1) when they also responded to feeling strongly intolerant of discomfort (FDS Factor I Q5).

Table 4.17

*Frequency of Elementary Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1 (n = 91)*



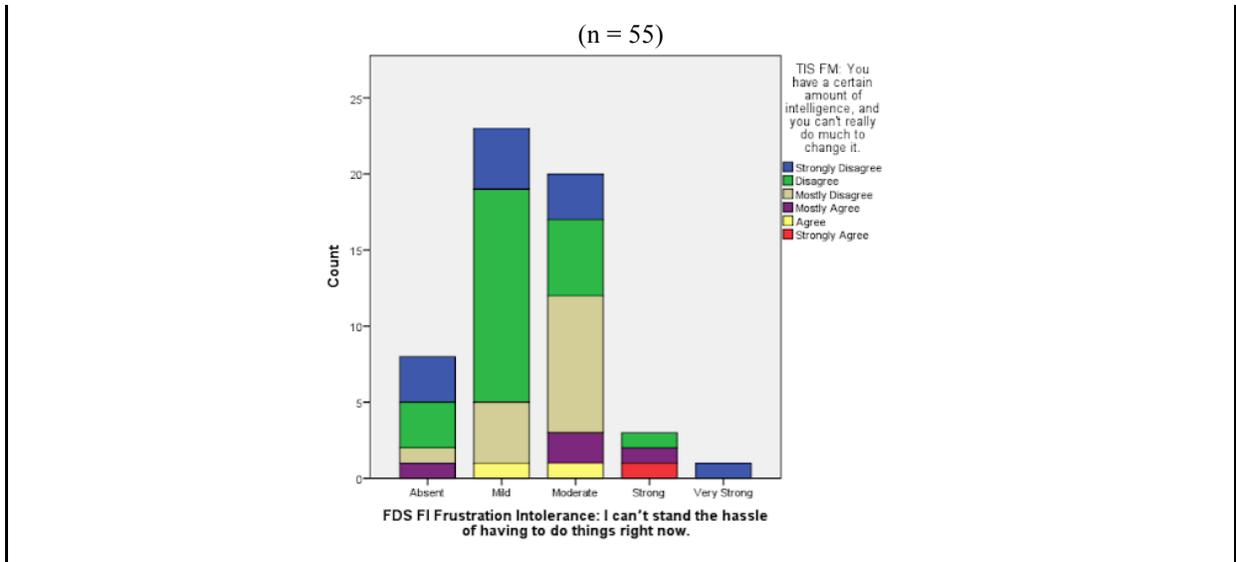


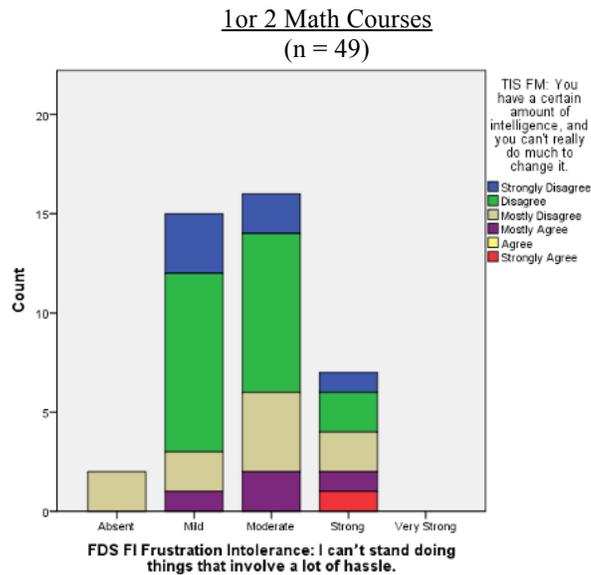
Table 4.17 Frequency of Elementary Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1

Next, data from FDS Factor I Discomfort Intolerance item, *Q5 I can't stand the hassle of having to do things right now*, and TIS Fixed Mindset item, *Q1 You have a certain amount of intelligence, and you can't really do much to change it*, were analyzed in relation to the number of completed mathematics courses at the college level for elementary education preservice students (Table 4.18). In this study, participants entering the elementary education program at this Midwest university are required to take at least two general mathematics courses as freshmen and sophomores before taking an elementary mathematics content course and an elementary mathematics methods course as juniors and seniors. Therefore, data was organized by survey responses of 1 course (n = 22) or 2 courses (n = 27), 3 courses (n = 24), or 4+ courses, which combined the responses of 4 courses (n = 3) and 5+ courses (n = 15). The secondary education sample was not analyzed in this way since it is unknown if secondary education preservice teachers are minoring in mathematics (taking more mathematics courses) or not. Table 4.18 displays the frequency of responses to FDS Factor I Q5 and TIS Fixed Mindset Q1 according to how many collegiate math courses elementary preservice teachers had completed.

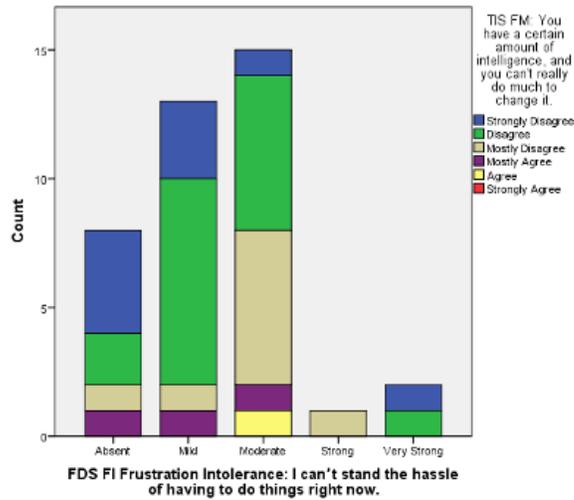
The data in Table 4.18 appeared to show that more elementary education participants that had only completed 1 or 2 math courses strongly agreed with Fixed Mindset item, *Q1 You have a certain amount of intelligence, and you can't really do much to change it*, compared to elementary education participants that had taken 3 courses or 4 or more collegiate math courses. The data also suggested in Table 4.18 that elementary education participants that only took 1 or 2 math courses strongly believed FDS Factor I item, *Q5 I can't stand doing things that involve a lot of hassle*, more than elementary education participants that had taken 3 courses or 4 or more math courses.

Table 4.18

*Frequency of Elementary Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1 for Elementary Preservice Teachers (n = 91)*



3 Math Courses  
(n = 24)



4+ Math Courses  
(n = 18)

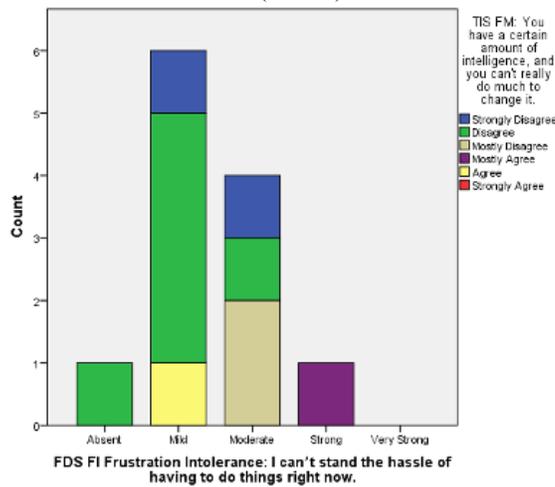


Table 4.18 Frequency of Elementary Responses for FDS Factor I Discomfort Intolerance Q5 and TIS Fixed Mindset Q1 for Elementary Preservice Teachers

Further analysis of the relationship between the FDS Factor I Discomfort Intolerance items and the number of collegiate mathematics courses participants had completed when surveyed is displayed in Table 4.19. The data suggested that there is a constant negative correlation between the number of math courses completed and all FSD Factor I Discomfort Intolerance items for participants in this study (Table 4.19). The negative correlation between

math courses and the Factor I mean for the entire sample,  $r(174) = -.281, p < .01$ , proposed that the more math courses elementary and secondary preservice teachers took, the less their discomfort intolerance was (Table 4.19) This correlation of an increase in discomfort tolerance as preservice teachers took more math courses also supported the graphs in Table 4.18 due to the decrease in *Moderate*, *Strong*, and *Very Strong* responses to FDS Factor I Discomfort Intolerance Q5 as participants completed more math courses.

Table 4.19

*Pearson Correlations Between FDS Factor I Discomfort Intolerance and Math Courses*

<u>Discomfort Intolerance Items</u>	<u>Completed Collegiate Mathematics Courses</u>		
	Entire Sample (n = 176)	Elementary Sample (n = 91)	Secondary Sample (n = 85)
Q1 I can't stand doing things that involve a lot of hassle.	$-.285, p = .000$	$-.263, p = .012$	$-.299, p = .005$
Q2 I can't stand having to push myself at tasks.	$-.149, p = .049$	$-.135, p = .203$	$-.165, p = .132$
Q3 I can't stand having to persist at unpleasant tasks.	$-.250, p = .001$	$-.204, p = .052$	$-.281, p = .009$
Q4 I can't stand doing tasks that seem too difficult.	$-.120, p = .112$	$-.079, p = .455$	$-.147, p = .179$
Q5 I can't stand the hassle of having to do things right now.	$-.231, p = .002$	$-.143, p = .176$	$-.293, p = .007$
Q6 I need the easiest way around problems. I can't stand making a hard time of it.	$-.156, p = .039$	$-.208, p = .047$	$-.125, p = .256$
Q7 I can't stand doing tasks when I'm not in the mood.	$-.173, p = .022$	$-.122, p = .251$	$-.216, p = .047$
Factor I Mean	$-.281, p = .000$	$-.252, p = .016$	$-.296, p = .006$

Significant at  $p < .01$ , Significant at  $p < .05$ , Not Significant at  $p < .05$

Table 4.19 Pearson Correlations Between FDS Factor I Discomfort Intolerance and Math Courses

### ***FDS Factor II Entitlement***

Research Question: What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *entitlement* towards mathematics?

Results from the entire sample data suggested that there are only three significant correlations between the FDS Factor II Entitlement items and the TIS Fixed and Growth Mindset items. According to the data, TIS Growth Mindset item, *Q4 You can change even your basic intelligence level considerably*, had significant Pearson correlations with Factor II Entitlement item, *Q3 I can't stand having to give in to other people's demands*,  $r(174) = .204$ ,  $p < .05$ , and the Entitlement item, *Q7 I can't stand having to wait for things I would like now*,  $r(174) = .173$ ,  $p < .05$ . The third significant correlation, according to the data, was between TIS Fixed Mindset item, *Q3 To be honest, you can't really change how intelligent you are*, and Factor II Entitlement item, *Q2 I can't stand it if other people act against my wishes*,  $r(174) = .172$ ,  $p < .05$ . These positive correlations indicated that the more preservice teachers felt entitled, the more of a fixed mindset they had.

According to the survey data, the only demographic that had a significant correlation with FDS Factor II Entitlement was with the preservice teachers' age. The data suggested that there was a negative Pearson correlation between age and Factor II Entitlement item, *Q1 I can't bear it if other people stand in the way of what I want*,  $r(174) = -.153$ ,  $p = .043$ . This implied that as a preservice teachers' age increased, their feelings of entitlement when others stood in their way of what they wanted decreased. However, there was a positive correlation between preservice teachers' age and the Factor II Entitlement item, *Q5 I can't tolerate criticism especially when I know I'm right*,  $r(174) = .150$ ,  $p < .05$ . Although both of these correlations were small, it is worth noting how one was positive and the other was negative. In fact, half (4/8) of the Factor II

Entitlement statements had negative correlations and the other half (4/8) had positive correlations.

When the elementary education preservice teachers' data was analyzed (Table 4.20), several significant negative correlations between entitlement and growth mindset emerged. According to the data in Table 4.20, the most significant negative Pearson correlations emerged between the FDS Factor II Entitlement item, *Q6 I can't tolerate being taken for granted*, and Growth Mindset items. This proposes that the more entitled elementary preservice teachers felt, the more of a growth mindset they had. Further investigation would benefit the understanding of the negative correlation between growth mindset and entitlement, since in theory a person with a growth mindset would tend to not feel entitled. There were no significant correlations of the elementary education data between FDS Factor II Entitlement data and the demographic data.

Table 4.20

*Pearson Correlations Between FDS Factor II Entitlement Items and TIS Growth Mindset Items of Elementary Preservice Teachers (n=91)*

<u>FDS Factor II Entitlement Items</u>	<u>TIS Growth Mindset Items</u>				Growth Mindset Mean
	Q1 No matter who you are, you can significantly change your intelligence level.	Q2 You can always substantially change how intelligent you are.	Q3 No matter how much intelligence you have, you can always change it quite a bit.	Q4 You can change even your basic intelligence level considerably.	
Q1 I can't bear it if other people stand in the way of what I want.	-.197, p=.061	<b>-.264, p=.011</b>	-.056, p=.601	-.184, p=.081	<b>-.224, p=.032</b>
Q2 I can't stand it if other people act against my wishes.	-.062, p=.561	-.055, p=.608	.093, p=.383	-.088, p=.406	-.035, p=.738
Q3 I can't stand having to give in to other people's demands.	-.077, p=.469	-.122, p=.249	-.156, p=.139	-.104, p=.325	-.144, p=.174
Q4 I can't stand having to change when others	.098, p=.358	.004, p=.972	.049, p=.646	.058, p=.587	.065, p=.541

are at fault.					
Q5 I can't tolerate criticism especially when I know I'm right.	-.128, p=.228	<b>-.221, p=.035</b>	.022, p=.835	-.163, p=.123	-.157, p=.138
Q6 I can't tolerate being taken for granted.	<b>-.243, p=.020</b>	-0.082, p=.439	<b>-.283, p=.007</b>	<b>-.238, p=.023</b>	<b>-.261, p=.012</b>
Q7 I can't stand having to wait for things I would like now.	.097, p=.362	-0.017, p=.871	.130, p=.219	.050, p=.635	.080, p=.450
Factor II Entitlement Mean	-.119, p=.261	-.173, p=.100	-.047, p=.657	-.154, p=.144	-.156, p=.140

Significant at  $p < .01$ , Significant at  $p < .05$ , Not Significant at  $p < .05$

Table 4.20 Pearson Correlations Between FDS Factor II Entitlement Items and TIS Growth Mindset Items of Elementary Preservice Teachers (n=91)

Data of the secondary education preservice teachers appeared in Table 4.21 to have significant correlations between TIS and Factor II Entitlement items Q2, *I can't stand it if other people act against my wishes*, and Q3, *I can't stand having to give in to other people's demands*. These two Entitlement belief statements were positively correlated with several TIS statements, suggesting the less a participant feels entitled, the more of a growth mindset they have (Table 4.21). There was another significant Pearson correlation between the secondary education preservice teachers' age and Factor II Entitlement Item, Q5 *I can't tolerate criticism especially when I know I'm right*,  $r(83) = .230$ ,  $p < .05$ . This positive correlation proposed that the older a secondary education preservice teacher is, the more likely they are to feel entitled.

Table 4.21			
<i>Pearson Correlations Between FDS Factor II Entitlement and TIS Items of Secondary Preservice Teachers (n=85)</i>			
	<u>Factor II Entitlement Items</u>		
<u>TIS Items</u>	<i>Q2 I can't stand it if other people act against my wishes.</i>	<i>Q3 I can't stand having to give in to other people's demands.</i>	FII Mean

FM Q2	.282, p=.009	.221, p=.042	.140, p=.201
FM Q4	.223, p=.040	.305, p=.004	.214, p=.049
FM Mean	.226, p=.037	.234, p=.031	.152, p=.164
GM Q2	.250, p=.021	.209, p=.055	.236, p=.030
GM Q3	.235, p=.030	.252, p=.020	.246, p=.023
GM Q4	.228, p=.036	.265, p=.014	.182, p=.095
GM Mean	.249, p=.021	.215, p=.048	.208, p=.056
TIS Mean	.250, p=.021	.237, p=.029	.188, p=.085
Significant at p<.01, Significant at p<.05, Not Significant at p<.05			

Table 4.21 Pearson Correlations Between FDS Factor II Entitlement and TIS Items of Secondary Preservice Teachers

### ***FDS Factor III Emotional Intolerance***

Research Question: What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *emotional intolerance* towards mathematics?

The third Factor of the FDS was Emotional Intolerance. Items like, *Q1 I can't bear disturbing feelings* and *Q2 I can't bear to have certain thoughts*, each had significant positive Pearson correlations with TIS Fixed Mindset items ranging in strength from  $r(174) = .150, p < .05$  to  $r(174) = .189, p < .05$ ). This data suggested that the more tolerant of emotions preservice teachers were, the more of a growth mindset they had. However, Factor III Emotional Intolerance item, *Q6 I can't bear to feel that I am losing my mind*, did appear to have significant

negative Pearson correlation with preservice teachers' current college year  $r(174) = -.171, p < .05$  and with the number of completed collegiate math courses  $r(174) = -.211, p < .01$ . These relationships proposed that the more math courses preservice teachers completed, the more tolerant of emotions they were, and the more years preservice teachers had been in college, the more tolerant of their emotions they were.

The significant Pearson correlations of elementary education preservice teachers' data with TIS and Factor III Emotional Intolerance were all negative (Table 4.22), yet most of the significant correlations with these variables of the secondary education preservice teachers' data were positive (Table 4.23). Therefore, the elementary education data proposed that the more tolerant of emotion they were, the more of a fixed mindset they had. Whereas, the secondary education data indicated that the more tolerant of emotion they were the more of a growth mindset they had. Further investigation would benefit the understanding of the negative versus positive correlations between a mindset in mathematics and emotional intolerance in elementary and secondary education students.

Table 4.22

*Pearson Correlations between FDS Factor III Emotional Intolerance Items and TIS Items for Elementary Preservice Teachers (n=91)*

	<u>Factor III Emotional Intolerance Items</u>			Emotional Intolerance Mean
	Q4 I can't stand situations where I might feel upset.	Q6 I can't bear to feel that I am losing my mind.	Q7 I can't get on with my life, or be happy, if things don't change.	
GM Q2	$-.262, p=.012$	$-.215, p=.041$	$-.288, p=.006$	$-.290, p=.005$
GM Q4	$-.212, p=.044$	$-.176, p=.095$	$-.247, p=.018$	$-.246, p=.019$
GM Mean	$-.229, p=.029$	$-.180, p=.087$	$-.257, p=.014$	$-.256, p=.014$

Significant at  $p < .01$ , Significant at  $p < .05$ , Not Significant at  $p < .05$

Table 4.22 Pearson Correlations Between FDS Factor II Entitlement and TIS Items of Secondary Preservice Teachers

Table 4.23

*Pearson Correlations between FDS Factor III Items and TIS Items for Secondary Preservice Teachers (n=85)*

Factor III Emotional Intolerance Items

	Q1 I can't bear disturbing feelings.	Q2 I can't bear to have certain thoughts.	Q3 I must be free of disturbing feelings as quickly as possible. I can't bear it if they continue.	Q7 I can't get on with my life, or be happy, if things don't change.	Emotional Intolerance Mean
FM Q1	.220, $p=.043$	.289, $p=.007$	.246, $p=.023$	.206, $p=.058$	.264, $p=.015$
FM Q2	.219, $p=.044$	.268, $p=.013$	.249, $p=.022$	.197, $p=.071$	.274, $p=.011$
FM Q3	.130, $p=.234$	.173, $p=.113$	.228, $p=.036$	.207, $p=.058$	.194, $p=.075$
FM Q4	.227, $p=.037$	.302, $p=.005$	.132, $p=.230$	.269, $p=.013$	.285, $p=.008$
FM Mean	.223, $p=.040$	.289, $p=.007$	.236, $p=.030$	.245, $p=.024$	.284, $p=.008$

Significant at  $p < .01$ , Significant at  $p < .05$ , Not Significant at  $p < .05$

Table 4.23 Pearson Correlations between FDS Factor III Items and TIS Items for Secondary Preservice Teachers

***FDS Factor IV Achievement Frustration***

Research Question: What is the strength and direction, if any, of the relationship between a preservice teacher's degree of growth mindset and their level of *achievement frustration* towards mathematics?

According to the data of the entire sample ( $n = 176$ ), several TIS Fixed Mindset items had significant negative correlations with the FDS Factor IV Achievement Frustration item, *Q3 I can't stand being prevented from achieving my full potential* (Table 4.24). These significant correlations in Table 4.24 appeared to support the significant correlation between the Factor IV

Achievement Frustration mean scores and the TIS Growth Mindset item, *Q3 No matter how much intelligence you have, you can always change it quite a bit*,  $r(174) = -.259$ ,  $p = .013$ . The data suggested that preservice teachers with a growth mindset are frustrated when they are prevented from achieving their full potential. In theory, someone with a growth mindset strives to persevere through obstacles to achieve their full potential, and therefore may be frustrated when they are prevented from doing so.

Table 4.24

*Pearson Correlations between FDS Factor IV Item, Q3 I can't stand being prevented from achieving my full potential, and TIS Items for the Entire Sample (n=176)*

	FM Q2	FM Q3	FM Mean	GM Q1	GM Q3	GM Mean	TIS Mean
FIV Q3 I can't stand being prevented from achieving my full potential	$-.174$ , $p=.021$	$-.271$ , $p=.000$	$-.191$ , $p=.011$	$-.222$ , $p=.003$	$-.230$ , $p=.002$	$-.207$ , $p=.006$	$-.217$ , $p=.004$

Significant at  $p<.01$ , Significant at  $p<.05$ , Not Significant at  $p<.05$

Table 4.24 Pearson Correlations between FDS Factor IV Item, Q3 I can't stand being prevented from achieving my full potential, and TIS Items for the Entire Sample

### Regression Analysis

The researcher conducted a hierarchical linear regression analysis to identify variables that may predict the Theories of Intelligence (TIS) mean scores, and therefore predict a growth mindset. The predictors for this outcome were the number of mathematics courses completed at the college level, participants' current year in college, participants' age, and the mean scores for Frustration Discomfort Scale's (FDS) four Factors; Factor I Discomfort Intolerance, Factor II Entitlement, Factor III Emotional Intolerance, and Factor IV Achievement Frustration. The section below summarized the results from this multiple regression analysis. As with the

correlations, FDS Factor I Discomfort Intolerance regression analysis was described first, followed by analyses of the other FDS Factors and demographic data.

A multiple regression with enter method was used to predict a preservice teachers' degree of growth mindset in mathematics from their level of discomfort intolerance, number of collegiate math courses completed, year in college, and age. This model explained a small statistically significant amount of variance in growth mindset  $F(1, 174) = 7.15, p = .008, R^2 = .039, R^2_{adjusted} = .034$ . Discomfort intolerance was a significant predictor of growth mindset,  $\beta = .153, t(174) = 1.99, p = .048$ . The model suggested that discomfort intolerance (FDS Factor I) accounted for 3.9% of the variance in growth mindset (TIS) and generalized a 0.5% shrinkage to the population, with a simple correlation of  $r(174) = .199, p < .05$ . Thus, the regression analysis from the FDS and TIS proposed that preservice teachers' level of discomfort intolerance had a significant correlation with and was a significant predictor of growth mindset.

Data from the multiple regression analysis also confirmed a single correlation coefficient of  $r(174) = -.207, p < .05$  between growth mindset and the number of completed math courses. The model also suggested a multiple correlation of  $r(174) = .254, p < .05$  among growth mindset, discomfort intolerance, and number of math courses completed, accounted for 6.4% of the variance in growth mindset, and generalized a 1% shrinkage to the population. This was an increase of 2.5% variance over discomfort intolerance alone, and produced an F-ratio of 4.606, significant at  $p < .05$ . The Analysis of Variance (ANOVA) showed that the model with two predictors is not more significantly fit to the data compared to the model with one predictor (or simple correlation), but both models were significantly better predictors of growth mindset than means. The regression analysis also suggested that if the number of math courses was held constant, then an increase of discomfort intolerance by 1 unit produced an increase in growth

mindset by .190. Yet, if discomfort intolerance was held constant, then increasing the number of math courses completed by 1 unit produced a decrease in growth mindset by .109.

In addition, the charts below displayed the regression analysis of growth mindset (TIS) (Table 4.25) from the demographic information and discomfort intolerance (Table 4.26). The Histogram of Residuals appeared to be normal, as well as the Normal Probability Plot of the Standardized Residual, which showed a near perfect straight line. This suggested that the residuals were normally distributed, thus the assumption was met. The scatterplot showed that points were randomly and evenly spread out; hence the assumptions of homoscedasticity and linearity were met. The first Partial Regression Plot showed that discomfort intolerance is positively related to growth mindset, as the model suggested. The second Partial Regression Plot showed that the number of math courses completed is negatively related to growth mindset, according to the model. This second plot wasn't quite as linear as the first plot, since the points were more spread out from the line of best fit. Regression analysis using the stepwise method was also conducted, which revealed the same significant correlations and regression analysis as previously stated with the enter method.

Table 4.25

*Multiple Regression Analysis of Growth Mindset (TIS) in Mathematics of Preservice Teachers (N = 176)*

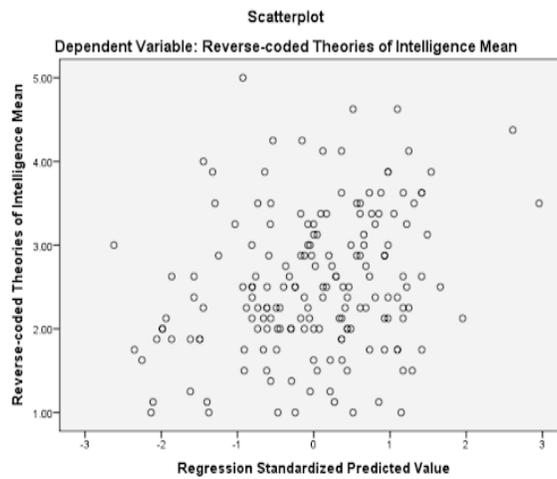
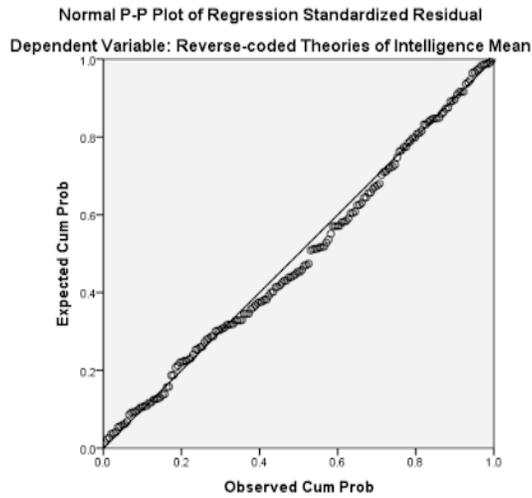
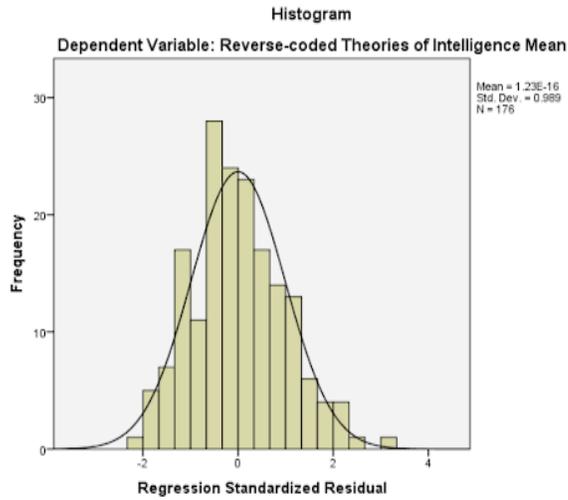
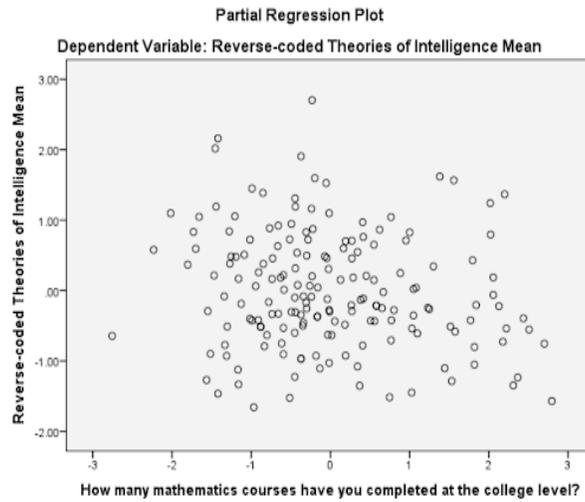
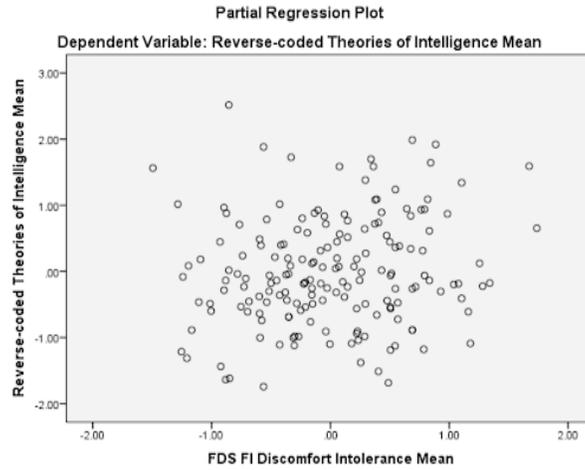


Table 4.25 Multiple Regression Analysis of Growth Mindset (TIS) in Mathematics of Preservice Teachers

Table 4.26

*Multiple Regression Analysis of Growth Mindset (TIS) from Discomfort Intolerance (FDS FI) in Mathematics and Demographic Information of Preservice Teachers (N = 176)*



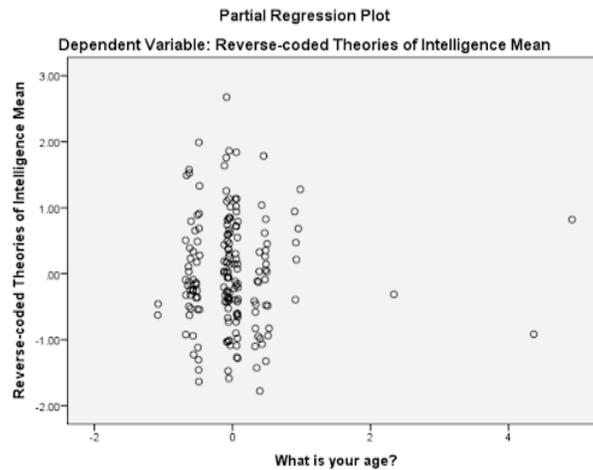
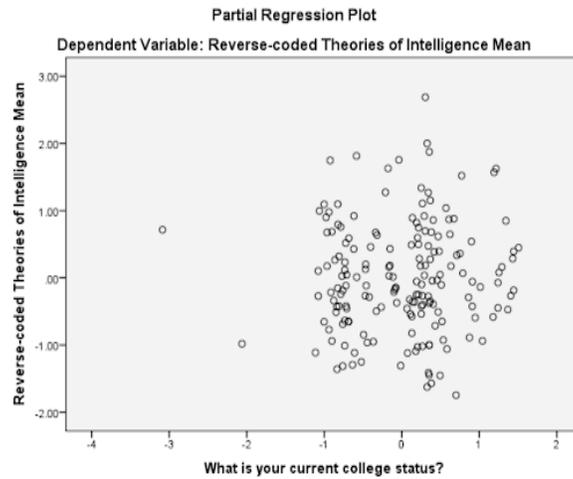


Table 4.26 Multiple Regression Analysis of Growth Mindset (TIS) from Discomfort Intolerance (FDS FI) in Mathematics and Demographic Information of Preservice Teachers

When the researcher ran a regression analysis on growth mindset (TIS mean score) with the FDS Factor II Entitlement, the model was not able to explain a significant variance in growth mindset  $F(1, 174) = 1.08, p = .301, R^2 = .006, R^2_{adjusted} = .000$  and indicated that there was no significant correlation between the two constructs  $r(174) = .078, p = .150$ . The model also indicated that entitlement was not a significant predictor of growth mindset,  $\beta = .078, t(174) = 1.04, p = .301$ . However, the model did display a significant multiple correlation of  $r(174) = .215, p < .01$  among growth mindset, entitlement, and the number of math courses completed.

The model also showed that the number of math courses continued to be a significant predictor for growth mindset,  $\beta = -2.02$ ,  $t(174) = -2.70$ ,  $p = .008$ , similar to the regression analysis previously discussed with FDS Factor I, and accounted for 4.6% of the variance in growth mindset and generalized a 0.35 shrinkage to the population. This was an increase of 4.0% variance over entitlement alone and produced an F-ratio of 7.295, significant at  $p < .01$ . The regression analysis also suggested that if the other predictors are held constant, then increasing the number of completed collegiate math courses by 1 would produce a decrease in growth mindset, according to Models 2, 3, and 4 (Table 4.27).

Table 4.27

*Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor II Entitlement and Demographic Data of Preservice Teachers (n = 176)*

Model		Coefficients				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.234	.289		7.726	.000
	FDS FII Entitlement Mean	.101	.098	.078	1.038	.301
2	(Constant)	2.652	.323		8.199	.000
	FDS FII Entitlement Mean	.076	.096	.059	.786	.433
	How many mathematics courses have you completed at the college level?	-.133	.049	-.202	-2.701	.008
3	(Constant)	2.577	.340		7.577	.000
	FDS FII Entitlement Mean	.072	.097	.056	.747	.456
	How many mathematics courses have you completed at the college level?	-.149	.054	-.226	-2.756	.006
	What is your current college status?	.049	.068	.059	.720	.473

4	(Constant)	2.579	.344		7.508	.000
	FDS FII Entitlement Mean	.072	.097	.056	.743	.458
	How many mathematics courses have you completed at the college level?	-.149	.054	-.225	-2.744	.007
	What is your current college status?	.052	.086	.062	.604	.547
	What is your age?	-.005	.095	-.006	-.058	.954

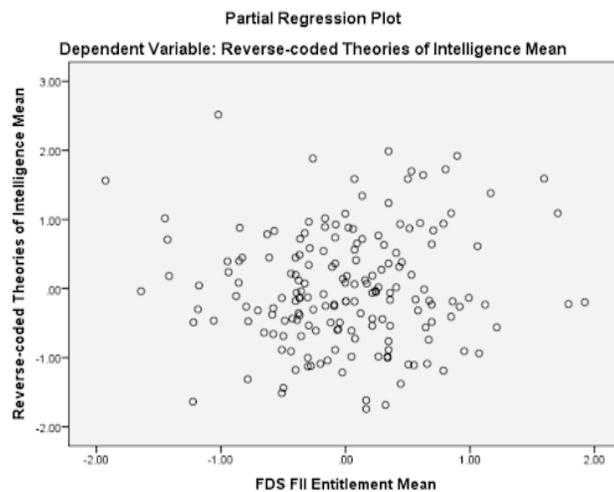


Table 4.27 Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor II Entitlement and Demographic Data of Preservice Teachers

FDS Factor III Emotional Intolerance was also examined as a predictor to growth mindset (TIS) in a regression analysis. Emotional intolerance, according to the models, was not significantly correlated to growth mindset,  $r(174) = .089$ ,  $p = .120$ , nor was it a significant predictor for growth mindset,  $\beta = .089$ ,  $t(174) = 1.18$ ,  $p = .241$  (Table 4.28). The multiple regression analysis was not able to explain a statistically significant variance in growth mindset from emotional intolerance,  $F(1, 174) = 1.39$ ,  $p = .241$ ,  $R^2 = .008$ ,  $R^2_{\text{adjusted}} = .002$  (see Appendix). However, again there was a statistically significant negative correlation between growth mindset and the number of collegiate math courses completed,  $r(174) = -.207$ ,  $p = .003$ , and between emotional intolerance and the number of collegiate math courses completed,  $r(174) = -.165$ ,  $p =$

.014. Again as previously stated, this model suggested that the number of math courses was a statistically significant predictor of growth mindset,  $\beta = -.198$ ,  $t(174) = -2.63$ ,  $p = .009$  (Table 4.28)

Table 4.28

*Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor II Entitlement and Demographic Data of Preservice Teachers (n = 176)*

		Coefficients				
		Unstandardized Coefficients		Standardized Coefficients		Sig.
Model		B	Std. Error	Beta	t	
1	(Constant)	2.216	.271		8.168	.000
	FDS FIII Emotional Intolerance Mean	.110	.094	.089	1.177	.241
2	(Constant)	2.668	.317		8.407	.000
	FDS FIII Emotional Intolerance Mean	.070	.093	.056	.746	.457
	How many mathematics courses have you completed at the college level?	-.131	.050	-.198	-2.630	.009
3	(Constant)	2.591	.335		7.729	.000
	FDS FIII Emotional Intolerance Mean	.067	.094	.054	.714	.476
	How many mathematics courses have you completed at the college level?	-.147	.055	-.222	-2.695	.008
	What is your current college status?	.049	.068	.059	.727	.468
4	(Constant)	2.593	.337		7.703	.000
	FDS FIII Emotional Intolerance Mean	.068	.094	.054	.718	.474
	How many mathematics courses have you completed at the college level?	-.147	.055	-.222	-2.678	.008
	What is your current college status?	.056	.086	.067	.649	.517
	What is your age?	-.011	.095	-.012	-.120	.905

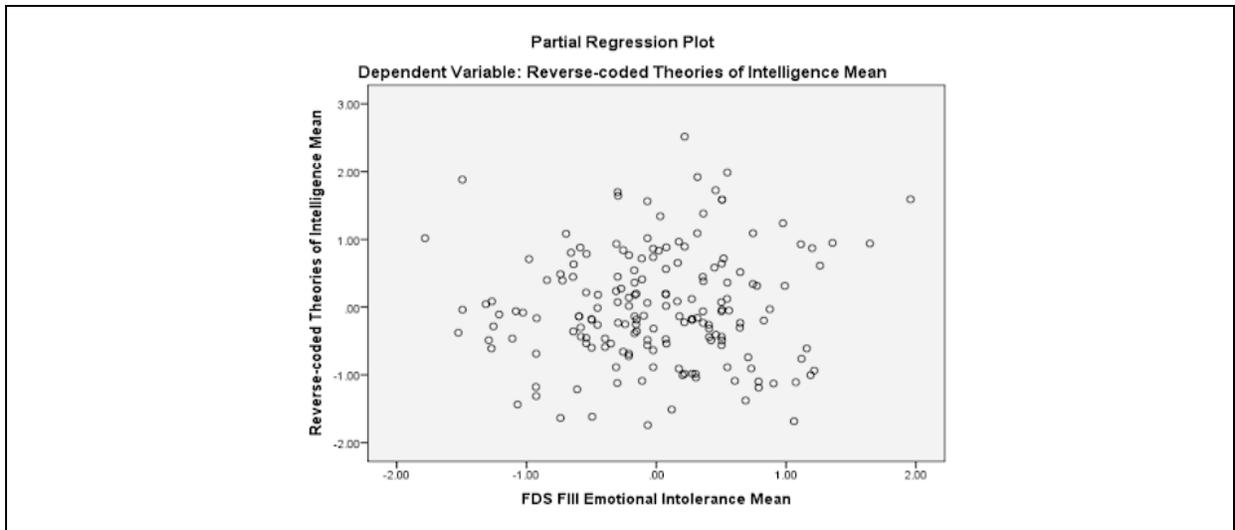


Table 4.28 Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor II Entitlement and Demographic Data of Preservice Teachers

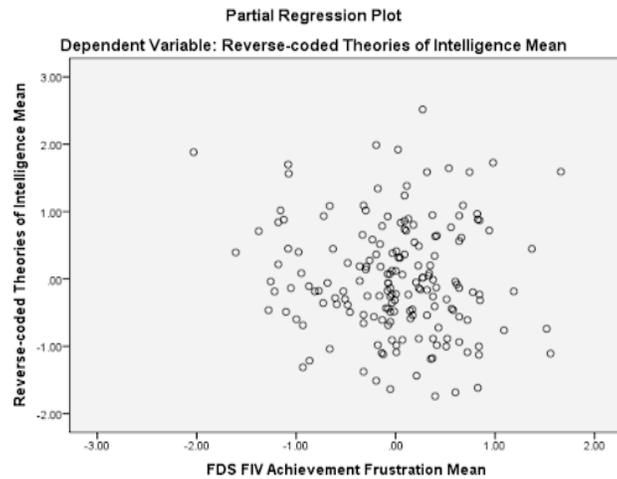
The final regression analysis included FDS Factor IV Achievement Frustration and demographics as predictors to growth mindset (TIS mean score). The model confirmed negative correlations between achievement frustration and growth mindset, math courses, college year, as well as age. Yet, the multiple regression analysis was not able to explain a statistically significant variance in growth mindset in relation to achievement frustration,  $F(1, 174) = .852$ ,  $p = .357$ ,  $R^2 = .005$ ,  $R^2_{\text{adjusted}} = -.001$ . Achievement frustration was not a significant predictor of growth mindset,  $\beta = -.070$ ,  $t(174) = -.923$ ,  $p = .357$ , although the number of math courses completed at the college level continued to be a significant predictor (Table 4.29).

Table 4.29

*Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor IV Achievement Frustration and Demographic Data of Preservice Teachers (n = 176)*

		Coefficients				
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.835	.339		8.356	.000

	FDS FIV Achievement Frustration Mean	-.092	.100	-.070	-.923	.357
2	(Constant)	3.323	.371		8.946	.000
	FDS FIV Achievement Frustration Mean	-.127	.098	-.096	-1.289	.199
	How many mathematics courses have you completed at the college level?	-.145	.049	-.219	-2.935	.004
3	(Constant)	3.226	.402		8.029	.000
	FDS FIV Achievement Frustration Mean	-.121	.099	-.092	-1.220	.224
	How many mathematics courses have you completed at the college level?	-.159	.054	-.240	-2.944	.004
	What is your current college status?	.044	.068	.052	.641	.522
4	(Constant)	3.232	.406		7.964	.000
	FDS FIV Achievement Frustration Mean	-.121	.099	-.092	-1.220	.224
	How many mathematics courses have you completed at the college level?	-.158	.054	-.239	-2.929	.004
	What is your current college status?	.050	.086	.060	.585	.559
	What is your age?	-.012	.094	-.012	-.126	.900



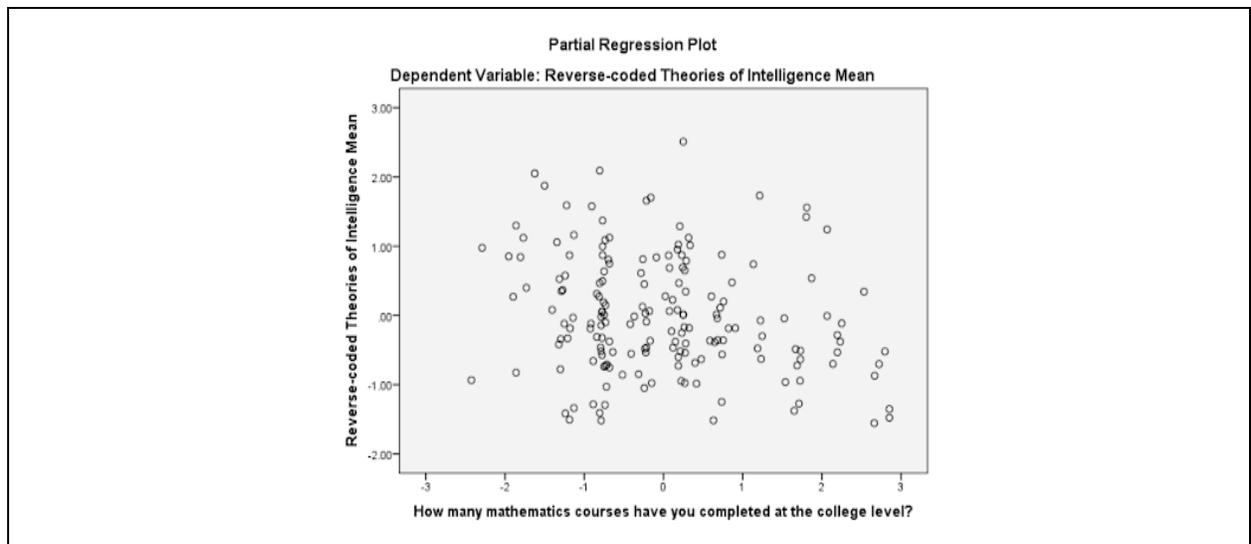


Table 4.29 Regression Analysis on Growth Mindset (TIS) in Mathematics with FDS Factor IV Achievement Frustration and Demographic Data of Preservice Teachers

### **Data Summary**

Statistical results from this study supported the purpose of this investigation into a preservice teacher’s level of frustration discomfort (FDS) with mathematics in relation to their theory of intelligence (TIS) in mathematics. Data shared in this chapter represented this multivariate correlational study that examined each of the four factors of frustration discomfort; discomfort intolerance, entitlement, emotional intolerance, and achievement frustration, in relation to the entity theory of intelligence (fixed mindset) and the incremental theory of intelligence (growth mindset). Analysis was also completed to see how various demographic data may have affected the preservice teachers’ beliefs towards frustration with mathematics and their mindset towards mathematics. Furthermore, the researcher included a multiple regression analysis to determine if any of the FDS Factors and/or demographic variables were predictors for growth mindset (TIS).

## **Chapter 5 - Conclusions and Implications**

### **Research Summary**

Mathematics education in the K-12 classroom is grounded on research-based standards and practices with the goal to create lifelong efficient users of mathematics. One pillar supporting K-12 mathematics is the widely adopted Common Core State Standards of Mathematics (CCSSM) that define the progression of content knowledge. Also supporting mathematics education are the 8 Mathematical Practices that describe what learning mathematics should look like, sound like, and feel like for students. Another pillar of support that has contributed to the success of mathematics education in the classroom are NCTM's Effective Mathematics Teaching Practices that guide teachers' instructional practices and assessments of the CCSSM and 8 Mathematical Practices. In addition to providing a foundation of mathematics education at the K-12 level, these interwoven mathematical systems have also been integrated into higher education for undergraduate students pursuing a degree in elementary or secondary education.

Although the CCSSM, 8 Mathematical Practices, and NCTM's Effective Mathematics Teaching Practices provide a framework for mathematics education in teacher preparation programs, the personal experiences each preservice teacher brings to the classroom should also be considered. For example, one of the Effective Mathematics Teaching Practices advises teachers to provide opportunities and support for students to engage in productive struggle as they grapple with mathematical ideas and relationships instead of simply seeking correct answers (NCTM 2014, p.48). Therefore teachers need to be educated on the visible and verbal signs of frustration in order to respond to students unable to practice productive struggle (Baker et al.,

2020). The literature also proposes that psychological factors and academic self-efficacy account for up to 14% (FDS accounting for 23% alone) of the variance in college students' grade point average, and that the variance continues to increase each year of college (Wilde, 2012). It is therefore apparent that further research was needed to investigate the psychological variables that can affect the learning of mathematics. Even more so, a closer look was needed to examine the unique beliefs, attitudes, and judgments towards mathematics each future teacher has that could potentially impact their understanding of mathematics and consequently their teaching of mathematics.

The purpose of this study was to examine preservice teachers' frustration discomfort with learning and doing mathematics in relation to their mathematical mindset. Survey data was collected from undergraduate students ( $n = 176$ ) that were majoring in elementary ( $n = 91$ ) or secondary ( $n = 85$ ) education of one Midwest university. In the spring of 2022, these preservice teachers were anonymously surveyed online using the Frustration Discomfort Scale (FDS), the Theories of Intelligence Scale (TIS), and several demographic items. Data analysis was conducted to identify patterns, relationships, and correlations between the FDS and TIS constructs, as well as preservice teachers' age, gender, degree, college year, type of instruction, and the number of completed collegiate math courses.

### **Conclusion of Findings**

#### ***Mathematics Courses and Growth Mindset***

Results from this study supported the existing literature claiming that the stronger the preservice teachers' mathematics content and pedagogical knowledge, the more it significantly influences students' achievement in mathematics and their mathematical disposition (Campbell et al., 2014; Clark et al., 2014). Although the data analysis in this study indicated that the more

math courses preservice teachers completed, the more of a growth mindset they had, further analysis of the demographic data clarified this relationship. The entire sample ( $n = 176$ ) in this study was mostly female, between 18 to 21 years in age, and receiving in-person instruction. However, the similar sample proportions of elementary (51.7%) and secondary (48.3%) majors allowed for comparable data analysis with other variables, like the number of math courses completed and degree of growth mindset.

The number of collegiate math courses completed in relation to a preservice teachers' degree of fixed or growth mindset had a negative correlation with both the entire sample  $r(174) = -.207, p < .01$  and the secondary education sample  $r(83) = -.306, p < .01$ . Thus, suggesting that the more math courses a preservice teacher completes at the college level, the less of a fixed mindset they have, i.e., more of a growth mindset they have. This negative correlation continued to appear in the regression analysis to see if each of the FDS Factors and/or the number of completed math courses was a predictor of growth mindset (Tables 4.27, 4.28, and 4.29). In fact, if each of the FDS Factors were held constant, then increasing the number of math courses completed by 1 unit produced a decrease in fixed mindset was apparent for all FDS Factors.

In an attempt to better understand why there was a significant correlation between these variables within the secondary education data and not the elementary education data, further analysis was conducted to reveal distinct differences within the number of completed collegiate math courses between each major. Over half (53%) of secondary education preservice teachers in this study had taken either only one collegiate math course (30.6%) or 5 or more collegiate math courses (22.4%), resulting in less than 50% that took 2, 3, or 4 math courses. This may be due to the requirement of secondary education majors to minor in a specific content area, like history or mathematics, and therefore required to take more or less college-level math courses. That being

the case, secondary education preservice teachers minoring in mathematics (or a closely related field, like STEM) could have completed more math courses at the college level, and hence had more of a growth mindset (low TIS score).

How does this compare to the sample of elementary education preservice teachers in this study? Although there was not a significant correlation between the number of collegiate math courses completed and growth mindset for elementary education preservice teachers (as there was in the secondary sample and the entire sample), the frequency of TIS responses agreeing with growth mindset revealed a pattern similar to that found in the secondary education sample. There was a 9.89% increase in TIS responses of “Strongly Disagreeing” or “Disagreeing” with fixed mindset statements (i.e., agreeing with growth mindset) in elementary preservice teachers that had completed 3 or more collegiate math courses (46%) compared to those that had indicated they had only completed 1 or 2 math courses (53%). Thus supporting the theory that the more math courses a preservice teacher takes, the more of a growth mindset they have, as suggested across the entire sample.

Further research is needed to determine if the reason the correlation was only significant in the secondary sample is because there was more disparity in the number of completed math courses of secondary preservice teachers, therefore resulting in a correlated disbursement of fixed versus growth mindset responses and in a stronger correlation. For example, 81% of elementary preservice teachers in this study had completed 2, 3, or 4 math courses at the college level, compared to only 47% of secondary preservice teachers having completed 2, 3, or 4 math courses. How does this variation in the number of completed math courses between the elementary and secondary samples affect the correlations with growth mindset?

Another variable needing more investigation is the type of math course. University math courses provided participants with a variety of math content, differing pace of instruction, and a range of academic rigor. It's possible that a preservice teacher may need to take one or more remedial math courses before they can take a math course that meets the minimum graduation requirement. This could result in a preservice teacher responding to the survey that they have taken many math courses, yet their academic ability in mathematics remains low. How would this affect the significant correlation between the number of completed math courses and growth mindset? A future study could clarify the relationship between these two variables, possibly by requiring participants to list which math courses they've taken and when they completed each course.

### ***Toleration of Discomfort and Growth Mindset***

Of the four FDS Factors, Factor I Discomfort Intolerance had the most significant correlation with individual TIS items and the TIS mean score. The data suggested that there is a positive relationship between the entity theory of the TIS (fixed mindset) and intolerance of discomfort (FDS Factor I). In other words, the more of a growth mindset a preservice teacher has towards mathematics, or the more they believe their mathematics intelligence is incremental (low TIS), the more they can tolerate feeling discomfort in mathematics (low FDS). Intolerance to discomfort (FDS Factor I) in mathematics appeared to account for a 3.9% variance in growth mindset, and when the number of completed collegiate math courses joined discomfort intolerance as predictors, there was a 2.5% increase of variance in growth mindset (Table 4.26). These analyses, including the significant positive correlation between these variables,  $r(174) = .199, p < .01$ , proposed an increase in discomfort intolerance will predict an increase in fixed

mindset. Variables that indicate they have a significant impact include: major, gender, year in college.

Considering the participants' demographics, there were more disparities between major and gender that may have influenced the correlations. Specifically, the correlation between FDS Factor I Discomfort Intolerance and TIS was only significant in the secondary education sample of preservice teachers,  $r(83) = .287, p < .01$ . For example, feelings of discomfort with difficult tasks that require a lot of hassle had the strongest correlation with a fixed mindset with secondary education students (Tables 4.12 and 4.13). When the gender of the secondary education sample was analyzed, significant correlations between discomfort intolerance and growth mindset only existed among females. This positive correlation actually increased in strength when males (32.9%) were removed from the secondary education sample. Looking closer, the data suggested that only females of secondary education had significant positive correlations between FSD Factor I and TIS. Questions remain as to why there wasn't a significant correlation with the elementary education sample between Factor I and TIS, since there was a larger percentage of females in the elementary sample (97.8%) compared to females in the secondary education sample (67.1%).

The researcher also analyzed the entire sample data by the preservice teachers' current year in college. According to the data, there was an increase in agreement responses to fixed mindset from juniors and seniors ( $n = 100$ ) compared to freshmen and sophomores ( $n = 76$ ). Thus suggesting that juniors and seniors had more of a fixed mindset compared to freshman and sophomores (Tables 4.16 and 4.17). Additional research on the degree of fixed and growth mindset of preservice teachers according to college year is needed to try to identify more patterns and themes of a mathematical mindset as students progress through college.

### ***Toleration of Criticism and Growth Mindset***

In an elitist, performance culture where mathematics is judged based on performance scores and is used as a sorting mechanism and indicator of giftedness, a growth mindset is needed to change mathematics to an open, learning subject (Boaler, 2016, p. 101). Several of the FDS Factor II Entitlement items, according to the data, had significant positive correlations with TIS Fixed Mindset items (see Appendix F) suggesting that the more preservice teachers feel entitled, the more of a fixed mindset they had. However, other patterns of relationships within the Entitlement Factor items weren't as clear. For example, the data displayed both positive correlations with age (*Q5 I can't tolerate criticism especially when I know I'm right*,  $r(174) = .150$ ,  $p < .05$ ) and negative correlations with preservice teachers' age (*Q1 I can't bear it if other people stand in the way of what I want*,  $r(174) = -.153$ ,  $p = .043$ ). Additional research is needed to justify these findings; if the older a preservice teacher is, the more they can't tolerate criticism, and if the younger a preservice teacher is the more they can't bear for others to stand in their way. Another surprising find was the correlation analysis in Table 4.20 that displayed a significant negative correlation between Factor II Entitlement and TIS of the elementary sample, yet there were positive correlations in the secondary sample (Table 4.21). Again, future studies are needed to investigate the difference between elementary and secondary preservice teachers that affected the direction of these relationships.

### ***Managing Emotions and Growth Mindset***

Several items of Factor III Emotional Intolerance had significant correlations in both the positive and negative directions dependent on the preservice teachers' major. For example, analysis of the elementary sample in Table 4.22 described a negative correlation with an increased belief in the Emotional Intolerance item, *Q7 I can't get on with my life, or be happy, if*

*things don't change*, resulting in a decrease in TIS item, *GMQ2 You can always substantially change how intelligent you are*. This presents the idea that the more an elementary preservice teacher believes they can't be happy unless things change (they can't tolerate emotions), the less of a fixed mindset they have (so they have a growth mindset). Another example of this negative relationship from Table 4.22 is between Entitlement item, *Q4 I can't stand situations where I might feel upset*, and the TIS item, *GMQ4 You can change even your basic intelligence level considerably*. Here, the correlation proposes that the more an elementary preservice teacher would avoid upsetting situations, the less of a fixed mindset they'd have (or more of a growth mindset). On the contrary, Table 4.23 displays positive correlations between Emotional Intolerance and TIS with the secondary preservice teachers. This appears to represent a relationship more typically theorized of a growth mindset in relation to emotional intolerance. For example, the Factor III Emotional Intolerance item, *Q1 I can't bear disturbing feelings*, had a positive correlation with several of the TIS items, meaning the more they can't tolerate disturbing feelings, the more of a fixed mindset they had.

### ***Achieving Full Potential and Growth Mindset***

Could having a growth mindset bring frustration when you can't achieve your full potential? The data for Factor IV Achievement Frustration indicated a negative correlation between frustration with achievements in mathematics and having a fixed mindset. The Achievement Frustration item, *Q3 I can't stand being prevented from achieving my full potential* was negatively correlated with the TIS mean score,  $r(174) = -.217, p < .01$ , as well as several other TIS items (Table 4.24). This implies that the more a preservice teacher feels frustrated by not achieving their full potential, the less of a fixed mindset they have. This would support the Theory of Intelligence by suggesting that students with a growth mindset strive to improve and

progress through mathematics education, whereas a student with a fixed mindset may not feel frustrated when not achieving their full potential.

### **Implications for Future Research**

The findings from this survey data reveal unique relationships between specific demographics, factors of frustration discomfort, and fixed and growth mindsets towards mathematics. Although the data didn't indicate that there was a statistically significant correlation between the overall FDS mean and TIS mean of the entire sample, there was a significant negative Pearson correlation between the FDS and TIS mean scores of the elementary education preservice teachers,  $r(89) = -.311$ ,  $p = .003$ . This data analysis suggests that the more of a growth mindset they have, the less tolerant of discomfort in mathematics they are. Although, the literature seems to portray dispositions such as grit and perseverance as those supportive of a growth mindset, which, in theory, would make a person more tolerant of discomfort in mathematics. Further investigation would be beneficial between these two constructs with an elementary educator sample.

Why did participants in this study tend to be more decisive when responding to the Fixed Mindset items of the TIS in comparison to the Growth Mindset items? Table 4.9 displayed the frequency of responses for each of the 6-point Likert scale options of the 4 Fixed Mindset items and the 4 Growth Mindset items. Additional studies using this instrument are needed to understand why preservice teachers preferred to respond to the Growth Mindset items towards the middle of the Likert scale ("Mostly Agree" and "Mostly Disagree"), yet responses to the Fixed Mindset items were more definitive ("Strongly Agree" and "Strongly Disagree"). Further investigation is needed to compare the fixed and mindset items, like the wording and tone, that may be affecting the participants' responses.

This study serves as the launching point for future research within these constructs for various research designs, sample populations, and demographics. It would be worthwhile to conduct a mixed methods study to measure frustration discomfort and mindsets towards mathematics using observations and interviews, in addition to the quantitative survey FDS and TIS instruments. Further data analysis could also be run to determine if any additional variables are predictors for frustration discomfort or growth mindset in mathematics. Regression analysis was conducted in this study to determine that overall, TIS was not a predictor of FDS. However, there was evidence from the regression analysis indicating that discomfort intolerance and the number of completed math courses were predictors to growth mindset.

It may also be beneficial to study the professional teaching population to compare FDS and TIS data to preservice teachers. This investigation would seek to find out if the sample's frustration discomfort and mindset changes from preservice teacher to professional teacher to veteran teacher. This could be a longitudinal study that measures participants' frustration discomfort and mindset towards mathematics over a long period of time, like as a freshman student to a senior preserve teacher, and then in years 1, 5, and 10 of their professional teaching career. It may also be telling to measure the FSD and TIS with professional teachers that do and do not have a graduate degree to see if there is any correlation. With a mixed methods research design or a study using a different demographic sample (like new and veteran teachers), there may also be additional demographic data that could yield a stronger regression analysis on frustration discomfort and growth mindset. Another example of additional demographic variables could be the number of and type of mathematics courses completed. The question in this survey that asked participants about the number of completed college courses may have been confusing when determining the quantity. Instead, participants could be surveyed for this

information by selecting which math courses they've completed from a list provided by the researcher. Participants could also be asked to share academic records, like GPA or ACT score, and when they took these math courses to see if there are any patterns and relationships with the FDS and TIS variables.

### **Implications for Teacher Preparation Programs**

Rather than content knowledge, efficacy beliefs were more prominent factors in standards-based teaching, therefore mathematics courses for preservice teachers may need to reevaluate the ratio of teaching dispositions and mathematics content within their curriculums (Ottmar et al., 2013). Revisions in teacher preparation programs' curricula may be needed to integrate topics like, social and emotional needs within mathematics education, to address preservice teachers' dispositions towards mathematics. If preservice teachers are able to have a mathematical mindset to critically reflect on their own knowledge and experiences prior to entering the teaching field, they may have a greater chance of continuing to grow their mindset through critical self-reflection (Cady et al., 2006). Instructors of elementary mathematics courses in teacher preparation programs should also emphasize learning goals instead of performance goals for the preservice teachers to positively impact preservice teachers' motivation, mathematics thinking, and mathematical conversations (Harkness, 2009). Future research would be beneficial on the impact of a growth mindset curriculum implementation within mathematics education courses.

Another area of future research that needs to be addressed is the increase in online-delivered higher education courses compared to in-person courses. How has this revolutionary adaptation to instruction impacted preservice teachers' growth mindset in mathematics? Are online courses able to assess learning to support a growth mindset or is standardized testing the

most prominent type of assessment? Additional research on the communication and assigned tasks in online mathematics courses of teacher preparation programs is needed to assess its effects on students' fixed and growth mindsets. For example, by providing instructional accommodations for online learners (just as a teacher would for in an in-person classroom) discussions, assignments, and assessments need to promote a growth mindset. This may require online courses to allow for more creative and unique ways to problem solve and opportunities to reason, justify, and reflect on mathematical thinking. It may be beneficial to study the discomfort intolerance and growth mindset towards mathematics with a larger "online" sample of students.

The data in this study suggested that the more math courses completed in college, the more of a growth mindset towards mathematics a preservice teacher has (although more research is needed to clarify the type of math course). It may be beneficial for teacher preparation programs to increase the number of required math courses before students begin the program as a junior. Another suggestion would be to increase the number of math courses preservice teachers take within the teacher preparation program. For example, an elementary education program typically includes only one math content course and one math methods course. However, the researcher is suggesting that preservice teachers' mindsets may change to a stronger degree of a growth mindset if they were required to take 3 or 4 math courses in a teacher preparation program. Additional time learning and practicing math content and math methods appears to produce a growth mindset towards mathematics. Perhaps even if students enter the elementary education program with a fixed mindset, they would have more opportunities to learn and grow as a mathematics student teacher and change their mindset if they took more math courses.

### **Closure of the Study**

Mathematics education is more than facts, formulas, and fractions. There are feelings of anxiety and triumph that mathematics causes for all students. However, these experiences are defining for a student when that student wishes to become a teacher. This study aimed to investigate the feelings of frustration and discomfort preservice teachers have towards mathematics in relation to their degree of a fixed or growth mindset. Although there was not a significant correlation between the FDS and TIS mean scores of the entire surveyed sample, there were several significant findings that indicated a future study is necessary. These unique patterns and relationships that this study revealed hint at areas of future research that should be considered, like what is the relationship between growth mindset and achievement frustration and is there causation between math courses completed and growth mindset. The field of mathematics education research should continue to study possible constructs, like frustration discomfort and mathematical mindset, in a continuous attempt to improve the curriculum and teaching practices for K-12, and therefore improve teacher preparation programs. A growth mindset in mathematics begins with the teacher as a student and evolves into students as teachers.

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## **Appendix A: Consent Form**

### Frustration Discomfort and Growth Mindsets of Preservice Teachers in Mathematics Informed Consent Form

You are invited to participate in a research study about the frustration discomfort and growth mindset of preservice teachers.

This study is being conducted by Ashley Udell as a requirement for the degree of Doctor of Philosophy in Curriculum and Instruction at Kansas State University.

Participation in this study is voluntary. If you choose to complete this anonymous online survey, you may also opt in to an optional drawing of three \$15 Starbucks gift cards. You have the option of doing so by providing your email address at the conclusion of the survey.

Participating in this study will benefit the field of mathematics education. Data gathered from this study will contribute to the improvement of teacher preparation programs and mathematics curriculum.

The electronic data will be collected anonymously through Kansas State University's online survey delivery system Qualtrics. Participants' names will not be collected in the survey nor included in the data, but instead identified by a number.

Please note: You must be 18 or older to participate in this study.

If you have any questions about this study, please contact the Principal Investigator, Dr. Sherri Martinie, at [martinie@ksu.edu](mailto:martinie@ksu.edu) or 785-532-8414.

By completing this survey, you are consenting to participate in this study.

\*Please print or save a copy of this form for your records. \*

## Appendix B: Frustration Discomfort Scale

The revised Frustration Discomfort Scale (FDS) below lists the items organized by factor. However, survey items will be mixed and not divided by factor when given to participants in this study. Once scores are analyzed, a low score will be associated with the belief being absent or as having a high tolerance for frustration, for example.

### Frustration Discomfort Scale (Harrington, 2005)

Directions: Listed below are a number of common thoughts and beliefs that people may have when they are distressed or frustrated. Please consider your experiences learning and practicing **mathematics** when you read each statement. Then decide how well this usually describes your own beliefs towards **mathematics** by using the following scale to record your answers:

(1)Absent (2)Mild (3)Moderate (4)Strong (5)Very Strong

#### FDS Factor I: Frustration Intolerance

- Q1 I can't stand doing things that involve a lot of hassle.
- Q5 I can't stand having to push myself at tasks.
- Q9 I can't stand having to persist at unpleasant tasks.
- Q11 I can't stand doing tasks that seem too difficult.
- Q15 I can't stand the hassle of having to do things right now.
- Q19 I need the easiest way around problems. I can't stand making a hard time of it.
- Q23 I can't stand doing tasks when I'm not in the mood.

#### FDS Factor II: Entitlement

- Q2 I can't bear it if other people stand in the way of what I want.
- Q6 I can't stand it if other people act against my wishes.
- Q10 I can't stand having to give in to other people's demands.
- Q12 I can't stand having to change when others are at fault.
- Q16 I can't tolerate criticism especially when I know I'm right.
- Q20 I can't tolerate being taken for granted.

Q24 I can't stand having to wait for things I would like now.

**FDS Factor III: Emotional Intolerance**

Q27 I can't bear disturbing feelings.

Q3 I can't bear to have certain thoughts.

Q7 I must be free of disturbing feelings as quickly as possible. I can't bear it if they continue.

Q13 I can't stand situations where I might feel upset.

Q17 I can't stand to lose control of my feelings.

Q21 I can't bear to feel that I am losing my mind.

Q25 I can't get on with my life, or be happy, if things don't change.

**FDS Factor IV: Achievement Frustration**

Q28 I can't tolerate any lapse in my self-discipline.

Q4 I can't stand feeling that I'm not on top of my work.

Q8 I can't stand doing a job if I'm unable to do it well.

Q14 I can't stand being prevented from achieving my full potential.

Q18 I can't bear the frustration of not achieving my goals.

Q22 I can't bear to move on from work I'm not fully satisfied with.

Q26 I can't tolerate lowering my standards even when it would be useful to do so.

## Appendix C: Theories of Intelligence Scale

The Theories of Intelligence Scale (TIS) below uses a 6-point Likert scale and contains four items associated with the entity theory describing beliefs that we have a fixed intelligence and four items associated with the incremental theory describing beliefs that our intelligence is malleable. When given, the items are mixed, but then the four responses intended for a fixed mindset are reverse coded for analytical purposes. This results in a low score associated with a growth mindset.

### Theories of Intelligence Scale (Dweck, 2000)

Directions: The following statements were designed to investigate thoughts about intelligence. Please consider your experiences learning and practicing **mathematics** when you read each statement. Then decide how much you agree or disagree with each statement considering your beliefs towards **mathematics** by using the following scale to record your answers:

(1)Strongly Disagree (2)Disagree (3)Mostly Disagree (4)Mostly Agree (5)Agree  
(6)Strongly Agree

1. You have a certain amount of intelligence, and you can't really do much to change it.
2. Your intelligence is something about you that you can't change very much.
3. \*No matter who you are, you can significantly change your intelligence level.
4. To be honest, you can't really change how intelligent you are.
5. \*You can always substantially change how intelligent you are.
6. You can learn new things, but you can't really change your basic intelligence.
7. \*No matter how much intelligence you have, you can always change it quite a bit.
8. \*You can change even your basic intelligence level considerably.

\*Growth Mindset items to be reverse-coded

## Appendix D: Frequency of Demographics

Table D1

*Summary of Participants' Demographic Data, by Age and Gender*

	<u>Male</u>	<u>Female</u>	<u>Total</u>	<u>Male</u>	<u>Female</u>	<u>Total</u>
18-19	0	25	25	8	27	*36
20-21	1	53	54	17	22	39
22-23	0	10	10	3	6	9
24-25	0	0	0	0	0	0
26-30	0	1	1	0	0	0
31-35	0	0	0	0	0	0
36+	1	0	1	0	1	1
Total	2	89	91	28	56	85

\*One secondary education participants' gender was undisclosed who was 18-19 years old

Table D2

*Summary of Participants' Demographic Data, by College Year and Gender*

	<u>Male</u>	<u>Female</u>	<u>Total</u>	<u>Male</u>	<u>Female</u>	<u>Total</u>
Freshman	0	11	11	5	16	*22
Sophomore	1	24	25	4	14	18
Junior	1	34	35	14	16	30
Senior	0	20	20	5	10	15
Total	2	89	91	28	56	85

\*One secondary education participants' gender was undisclosed who was a freshman

Table D3

*Summary of Participants' Demographic Data, by Collegiate Math Courses Completed and Gender*

	<u>Male</u>	<u>Female</u>	<u>Total</u>	<u>Male</u>	<u>Female</u>	<u>Total</u>
1	0	12	12	7	18	*26
2	0	28	28	9	20	29
3	1	38	39	3	5	8
4	1	6	7	1	2	3
5+	0	5	5	8	11	19
Total	2	89	91	28	56	85

\*One secondary education participants' gender was undisclosed who took one math course

## Appendix E: Frequency of FDS Factor I Discomfort Intolerance

Table E						
<i>Frequency of FDS Factor I Discomfort Intolerance</i>						
	Absent	Mild	Moderate	Strong	Very Strong	Mean
I can't stand doing things that involve a lot of hassle.	7	71	66	26	6	2.73
I can't stand having to push myself at tasks.	37	77	44	16	2	2.26
I can't stand having to persist at unpleasant tasks.	14	55	71	28	8	2.78
I can't stand doing tasks that seem too difficult.	30	82	38	24	2	2.35
I can't stand the hassle of having to do things right now.	27	66	61	13	9	2.49
I need the easiest way around problems. I can't stand making a hard time of it.	28	71	45	26	6	2.49
I can't stand doing tasks when I'm not in the mood.	9	42	50	56	19	3.19

**Appendix F: Significant Correlations of FDS, TIS, and Demographics by Major**

Table F1

*FDS Factor I Discomfort Intolerance Significant Correlations*

	FI Q1	FI Q3	FI Q4	FI Q5	FI Q6	FI Mean	FDS Mean	Math Courses
FM Q1				.238		.213		-.203
				.293				-.287
FM Q2								-.285
FM Q3							-.288	
FM Q4	.203		.208	.219		.257	-.352	-.210
			.301	.331		.316		
FM Mean	.205			.209		.225	-.307	-.200
								-.282
GM Q2			.280		-.307	.284		
GM Q3			.210			.305		-.318
			.322					
GM Mean			.280			.282		-.301
TIS Mean						.199		-.207
						.287		-.306
Math Courses	-.285	-.250		-.231		-.281	-.195	
	-.299	-.281		-.293		-.296		

Age		-0.350	.291
			.349

All, Elementary, and Secondary Samples, p,.01

Table F2  
*FDS Factor II Entitlement Significant Correlations*

	FII Q2	FII Q3	FII Q6	Math Courses
FM Q1				-.203
				-.287
FM Q2	.282			-.285
FM Q4		.204		-.210
		.305		
FM Mean				-.200
				-.282
GM Q3			-.283	-.318
GM Mean				-.301
TIS Mean				-.207
				-.306

All, Elementary, and Secondary Samples, p,.01

Table F3

*FDS Factor III Emotional Intolerance Significant Correlations*

	FIII Q2	FIII Q6	FIII Q7	FIII Mean	Math Courses
FM Q1	.289				-.203 -.287
FM Q2					-.285
FM Q4	.237 .302			.285	-.210
FM Mean	.203 .289			.284	-.200 -.282
GM Q2			-.288	-.290	
GM Q3					-.318
GM Mean					-.301
TIS Mean					-.207
Math Courses		-.211			

All, [Elementary](#), and [Secondary](#) Samples, p,.01

Table F4

*FDS Factor IV Achievement Frustration Significant Correlations*

FIV Q3	Math Courses
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FM Q3	-.271	
	-.336	
GM Q1	-.222	
	-.339	
GM Q3	-.230	
GM Mean	-.207	
TIS Mean	-.217	-.306
	-.284	

All, Elementary, and Secondary Samples, p,.01

Table F5  
*Participants' Demographic Significant Correlations*

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	College Year	Age
Math Courses	.406	.291
	.465	.349
	.376	
College Year		.651
		.536

All, Elementary, and Secondary Samples, p,.01

## Appendix G: Email to Students

Email message to students Monday, January 24, 2022:

Students,

This week I am conducting a research study on mathematical mindset with preservice teachers as participants. You are being requested to complete an anonymous online [survey](#) to examine the level of frustration intolerance and discomfort and the degree of growth and fixed mindset students have towards mathematics. Participants' responses are anonymous, yet the survey concludes with an optional drawing for one of three \$15 Starbucks gift cards if an email address is provided.

Thank you again for your support in this research study on preservice teachers' mathematical mindset and your contribution to the research field of education.

The Mathematical Mindset of Preservice Teachers Survey Link:

[https://kstate.qualtrics.com/jfe/form/SV\\_38fDyjTgYTXaYYu](https://kstate.qualtrics.com/jfe/form/SV_38fDyjTgYTXaYYu)

(Survey Expires 01/31/2022)

Questions can be sent to the researcher, Ashley Udell, at [audell@k-state.edu](mailto:audell@k-state.edu) or to Dr. Sherri Martinie at the College of Education at [martinie@ksu.edu](mailto:martinie@ksu.edu).

Thank you,  
Ashley Udell

Proposal Number: IRB-10980