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**Gender Differences in Academic Self-Concept, Perfectionism, and Math Performance  
among First-Year STEM and Non-STEM students**

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### **Abstract**

The primary goal of this research was to compare academic self-concepts and adaptive and maladaptive perfectionistic tendencies as they relate to differences in mathematics performance of first-year undergraduate students' gender and major (STEM or non-STEM). One hundred and ninety-nine first-year undergraduate students completed self-reported questionnaires including the Frost Multidimensions Perfectionism Scale, the academic self-concept scale of the Personal and Academic Self-Concept Scale (PASCI), and a math performance measure consisting of practice SAT questions. This study utilized correlational, multivariate analyses of variances (MANOVA), and multiple regression techniques. MANOVA results revealed a main effect of gender on all variables and a marginally significant effect of major on participants math performance. Correlational analysis examined the associations between the variables of interest. Results revealed significant expected associations between math performance and academic self-concept, and maladaptive perfectionism and academic self-concept. An unexpected finding was the association between parental influence on choosing a major and lower levels of academic self-concept. Hierarchical regression examined the effects of academic self-concept, adaptive perfectionism, and maladaptive perfectionism on math performance, controlling for gender and major. Results confirmed that gender and major were significant predictors of math performance. Academic self-concept was also a significant predictor of math performance. Finally, adaptive and maladaptive perfectionism were marginally significant predictors of math performance scores above and beyond all other variables. Overall, results indicate the importance of considering choice of major, academic self-concept, and perfectionism constructs in math performance.

### **Gender Differences in Academic Self-Concept, Perfectionism, and Math Performance among First-Year STEM and Non-STEM students**

The Science, Technology, Engineering and Mathematics (STEM) fields have notoriously suffered from disproportionate retention and attrition across academia and the work force (Dasgupta & Stout, 2014). In higher education, men hold more graduate degrees than women in STEM related fields, particularly at the doctoral level (National Science Foundation 2018, Figure 3-28). After obtaining a STEM related degree, young women are not as likely to continue their pursuit and participation in STEM work (Xu, 2008). Occupationally, women represent only 28% of the workforce in STEM fields, yet half of all jobs in the United States are held by women (National Science Foundation, 2018; Noonan, 2017). With the STEM field projected to increase by 8.8% within the next 5 years and non-STEM fields projected at a 5.5% increase, it is apparent that there is no shortage of employment opportunities for women in STEM (Jiang, 2021; SOCCPC, 2012). It is also important to note this discrepancy in STEM does not emanate from a lack of collegiate women. Despite women obtaining more bachelor's degrees than men overall, in STEM fields roughly 30% are awarded to women (Bloodhart et al., 2020; Noonan, 2017; National Science Foundation, 2015). The most disproportionately awarded degrees have been engineering and computer science, although within the last decade, women recipients of engineering degrees have increased by at least 16 % (Charlesworth & Banaji, 2019; Mann & DiPrete, 2013). On the contrary, the number of women pursuing computer science has declined steadily over the last 20 years (National Science Foundation, 2018). Physical sciences, and mathematics follow closely behind engineering, while agriculture, and biology exhibit near or

exhibit equal degree distributions between men and women (National Academies of Sciences, Engineering, and Medicine, 2020). Theorists have attempted to unravel the complexity of differences in undergraduate students' pursuit of major, with many concluding that it cannot be attributed to a single cause - as the breadth of research highlights a wide array of possibilities. These range from educational differences, such as course taking, extracurricular participation, and past academic achievement, to individual and cognitive differences, such as differences in personal ability beliefs, values, and motivations, as well as personal and parental expectations for success, socioeconomic status, perfectionism tendencies, and a multitude of other variables (Akar et al., 2018; Halpern et al., 2007; Maltese & Cooper, 2017; Pinguart & Ebeling, 2020; Stoeber & Rambow, 2007; Svoboda et al., 2016; Wang & Degol., 2013; Wille et al., 2020). This study will focus on group differences and associations between the core variables motivating to students' choice of major in conjunction with differences in perfectionism and personal academic ability beliefs, referred as academic self-concept in this study.

### **Factors Related to Choosing STEM and Non-STEM Majors**

#### ***Gender***

There is a substantial body of literature demonstrating the influence of gender to individuals' choice of majors, with men and women often choosing distinctly different paths (Denice, 2021; Alon & DiPrete, 2015; Morgan et al., 2013; Cech, 2013; Wang & Degol, 2013). Gender differences in the desire to take on caregiving responsibilities at home, as well as the perceived or real incompatibility of these responsibilities with STEM jobs, are often cited as reasons for the persistent gender gap in these fields (Weisgram & Diekman, 2017). Most of the arguments revolve around the central tenet that there will be significant gender differences in the

family-work orientation of young men and women, that this orientation will be strongly correlated with the completion of STEM majors, and that this correlation will account for a nontrivial portion of the gender disparity in STEM major completion (Weeden et al., 2021). Students have also reported concern that majoring in STEM fields will lead to occupations that are incompatible with family life. These biases discourage both men and women from pursuing science-related fields in higher education, especially in the areas of physics, engineering, and mathematics (Ganley et al., 2018; Wiswall & Zafar, 2018). While this line of research is still widely investigated, when assessed in older cohorts, variations in family and career orientation have had little influence on the gender gap in STEM (Mann & DiPrete, 2013, Perez-Felkner et al., 2012).

Many of the theoretical frameworks examining gender differences in STEM graduation rates assume that differences in career aspirations between the genders may be anticipated, at least in part, by differences in the antecedent competences, inclinations, or preferences (Weeden et al., 2021). One theory is that young women who have low self-perceptions of their mathematical and scientific abilities are less likely to go into these subjects as a job or as a university major. In a similar vein, it has been thought that students who don't possess the aptitude and background to succeed in STEM fields either don't have any interest in pursuing these fields at all or are actively discouraged from doing so. In most models, occupational goals are assumed to be an intervening variable in most models' inferred causal linkages between actual ability, self-perceptions of ability, family-work motivations, and STEM degrees. Taken together, these studies highlight the significant role of gender socialization in shaping students' academic decisions and frequently determine the extent to which they perceive certain majors as approachable or inaccessible (Quadlin, 2020).

### *Cognitive Math Ability*

College attendance and graduation rates are greater for women than for males in the United States, but women are less likely to pursue careers in STEM sectors and more likely to major in the humanities and social sciences (Weeden et al., 2021). Further, women in the United States have higher GPAs than men do, but they still score somewhat lower than men on math tests on average and have historically lacked among cohorts of high school graduates who have the best preparation in both science and math. Variations in earlier academic achievement—as evidenced by grades, math test scores, and enrollment in math and science courses in high school—are often cited as an explanation for gender differences in STEM achievements (Hyde et al., 2008). These effects are thought to be most salient within STEM programs as efforts to retain student participation in STEM are often thwarted by introductory level mathematics courses, which often serve to weed out those students with less confidence or ability (Mattern et al., 2015). It is important to note that one of the most often cited factors in STEM attrition is a deficiency in analytical and quantitative mathematical skills (Sithole et al., 2017). This may render those students who may be interested in STEM, yet display deficiencies in mathematical skills, to pursue fields unrelated to STEM. It has been speculated that these disparities render women less inclined to pursue and succeed in fields demanding strong mathematical backgrounds (Ellison & Swanson, 2010). This is particularly important to the future of women in STEM as the projected increase in STEM careers is about 8.8% in comparison to 3.7 for non-STEM related careers. Further, math heavy fields represent over 25% of the projected increase (Zilberman & Ice, 2021). Thus, understanding women's underrepresentation in STEM fields, particularly math heavy ones, is of particular importance to bolster women's representation as more employment opportunities arise in STEM fields.

When comparing STEM and non-STEM students' quantitative reasoning skills, Elrod & Park (2020) found that STEM majors demonstrated significantly elevated quantitative reasoning skills. Further, women scored significantly lower than men in quantitative reasoning skills. While research indicates that women get better math grades than men in class, men outperform women on mathematics-based standardized tests (Voyer & Voyer, 2014; Valla & Ceci, 2014). The slight advantage men have in mathematics exams has not been significant enough to explain differences in the STEM attrition and retention rates of men and women (Kane & Mertz, 2012; Hyde et al., 2008). According to Wang and Colleagues (2013) having a strong perception of mathematics ability and a weaker perception of verbal skills is most often associated with the choice of STEM career. This, most often referred to as academic self-concept, will be discussed in detail later in this study. It may be likely that the perception of academic ability is an underlying factor in differences between student outcomes. The potential contribution of academic self-concept is particularly evident in the fact that high mathematics ability does not necessarily positively influence STEM persistence. Students who are high achieving in mathematics may not persist in their undergraduate efforts due to lack of interest in the subject, or confidence in their ability to translate their earlier mathematics skills into collegiate STEM skills (Hewson, 2011; Sithole, 2017). The latter has negative implications for efforts to retain STEM students, as elevated levels of self-criticism following performance on a STEM-related task have been linked to the early decisions to withdrawal from competitive academic environments, independent of actual performance or ability (Rice et al., 2013). In fact, the loss of students who perform objectively high in STEM courses has been attributed to the potential onset of perfectionism tendencies, which later pose risk to retention efforts (Holland et al., 2019). This may be particularly problematic as recent research highlights the steady increase of



perfectionism across recent generations (Curran & Hill, 2019). As perfectionism has been thought to be implicated in both educational and occupational decisions, the current study focuses on the construct of perfectionism as a personality variable potentially influencing student outcomes. Understanding variable which may affect cognitive math performance are particularly important in the first two years of student's undergraduate experience. This because the first two years of a student's undergraduate experience have been identified as a critical timepoint in student retention in STEM programs such that student persistence in their STEM undergraduate endeavors is significantly influenced by their academic performance across their first two years (Griffith, 2010). Research on the exit rate of STEM students finds that about half of students who enter STEM programs switch their majors before completion, while others find that fewer than 40% of STEM students graduate with their initial STEM degree (PCAST, 2012; Chen, 2013). Further, 60% of those leave most often do so within their first two years (Chen et al., 2018).

Thus, the focal purpose of this study is to examine factors above gender and cognitive math performance which may be differentially impacting STEM and non-STEM students. The current study utilizes theory related to perfectionism, mathematics performance, and academic self-concept in first year STEM and non-STEM majors as well as explore any relationships between these constructs and personal interest, pay, and parents to participants choice of major. The next sections will examine previous theory and research on facets of the social cognitive career theory including perfectionism and academic self-concept as potential factors differentially influencing student's educational choices.

### **Social Cognitive Career Theory**

Looking past gender and cognitive differences, some of the most robust indicators of student's academic choices, persistence, and overall success have been related to cognitive ability, perceptions of domain specific ability, and general interests in the subject (Kaleva et al., 2019; Wang & Degol, 2013). Academic interests, choices, persistence behaviors, and future performance have all been hypothesized to be fostered and maintained by preexisting dispositions, such as personality characteristics and traits, which in turn shape the learning experiences that lead to perceptions of academic ability and academic performance-related outcomes (Rice et al., 2013). The Social Cognitive Career Theory (SCCT) posits that that individuals are more likely to develop interest in, pursue, and excel in endeavors in which they perceive themselves to be competent. This theory asserts that cognitive and experiential processes are instrumental in the development of career growth and attainment (Lent, 2013). The need-to-know what influences students' interest in and success in math and science, broadly and in respect to women and specific minority groups, has been a driving force in the development of a robust field of study on the social cognitive career theory (Lent et al., 2008). Personal performance successes, vicarious experiences, social reinforcement, and physiological and emotional states are thought to be the four basic sources of information that inform individuals' opinions about their own abilities. One's performance may be affected by factors such as the social models and reinforcing messages one encounters, as well as one's physiological condition and mental state when doing certain activities (Lent & Brown, 2006). Low perception of ability often results in perceived career barriers, those are individuals' perceptions about internal or external circumstances that can obstruct the advancement of their careers (Lent et al., 2000). The

perceived career barriers impact the decisions and behaviors and overall interest development of students, most notably women (Luzzo & McWhirter, 2001).

### ***Intrinsic Outcomes - Personal Interest***

As it relates to academic choices, personal interest is theorized to be a long-lasting inclination to focus on certain academic topics and activities, and it has been linked to tenacity, and increased motivation to learn (Ainley et al., 2002, Renninger, 2000). Personal interest in an academic major is often thought of as intrinsically rewarding, as it benefits the individual in the moment as well as in the future and is frequently cited as one of the more influential factors guiding students' decisions (Quadlin, 2020). According to the Social Cognitive Career Theory (SCCT), what motivates student interest in a certain educational or professional area is the student's general confidence in their capacity to succeed in that sector, irrespective of their objective skills in that subject (Lent & Brown, 2019). It has also been hypothesized that students' motivation to pursue their academic interests stems from preexisting inclinations, or mental schemata, that link the subjects of interest to pleasant memories and their own sense of what is important in life. Further, academic interest and academic achievement have been positively correlated in previous research, in that higher interest in an academic subject is related to higher scores in that subject (Marsh et al., 2005).

### ***Extrinsic Outcomes - Monetary Influence***

As it relates to the social cognitive career theory, the monetary influence people expect to receive is referred to as a material outcome expectation. These outcome expectations arise from individual's expectations regarding the results of their actions (Lent & Brown, 2006). While the

influence of personal interest to individual choice of college major is thought to be the primary driver of major choice, the potential economic payout of certain majors is another notable influence in students' decision to seek out certain majors (Mullen, 2013; Quadlin, 2020).

Students may be aware of wage disparities across majors and utilize them as a reference point when deciding their major (Davies & Guppy, 1997; Quadlin, 2017). Earning potential has been most strongly correlated with degrees in STEM, health or business fields, moderately in the realm of social sciences, and weakly associated with humanities and education (Kim et al., 2015). This monetary influence is considered extrinsically rewarding, such that upon finishing their degree they will experience monetary benefit (Ma, 2009).

### ***Social Outcomes- Parental Influence***

Another notable influence in students' decision to pursue their chosen major is often the influence of parents (Wang & Degol, 2013). In the social cognitive career theory, the influence of parents serves as a social outcome expectation (Lent & Brown, 2006). Student's may perceive certain benefits, or drawbacks, for pursuing career paths their parents push them towards. Further, beginning at a young age, parents relay to their children the achievement expectations they hold for them, and the things that they perceive their child can and cannot attain (Cohen, 1987). Parents can be an important factor undermining student achievement through excessive parental expectations, which can negatively influence academic achievement by causing excess stress; as the individual is preoccupied with meeting these expectations, they are likely less motivated to pursue their interests and experience skewed perceptions of their abilities (Jones, 2015; Dandy & Nettlebeck, 2002).

**Perfectionism**

Perfectionism has been connected to a variety of characteristics that may affect academic performance. Perfectionism influences the academic and overall adjustment of college students both positively and negatively (Rice et al., 2006). Differential effects on career uncertainty and goal persistence and completion have been associated with the adaptive and maladaptive dimensions of perfectionism, such that it hinders student's ability to graduate with a degree in their chosen major (Powers et al., 2012; Leong & Chervinko, 1996). In addition, although perfectionism has been associated to high intelligence and various pathways to academic success, it may also hinder more practical skills such as problem solving and metacognitive regulation (Bosetti & Pyryt, 2007). Some research finds that perfectionism in those with above average intelligence is thought of as a cognitive style connected to the pursuit of excellence in their performance across academic setting as well as endeavors in other domains (Sastre-Riba et al., 2019).

Perfectionism, defined generally as the desire to be precise and is comprised of various dimensions and subdimensions which encompass interpersonal, cognitive, and environmental influences (Cox et al., 2002). The multidimensionality of perfectionism, as it relates to interpersonal and intrapersonal differences, posits two overarching dimensions of perfectionism. The first being self-oriented perfectionism (SOP) in which individuals are inclined to strive for perfection though setting high standards in which they evaluate themselves (Hewitt & Flett, 1991). The second dimension, socially prescribed perfectionism (SPP), reflects an individual's belief that they must meet exceptionally high standards to earn the approval of important people in their life (Hewitt & Flett, 1991). These two dimensions can be further broken down into maladaptive and adaptive components which have differing implications, especially on academic

outcomes (Verner-Filion & Vallerand, 2016). Self-Oriented Perfectionism (SOP) is often considered the adaptive component of perfectionism (Lo & Abbott, 2013). As it relates to academics, it is often associated with elevated positive affect, academic achievement, and overall increased satisfaction with life (Frost et al., 1993; Cox et al., 2002; Ashby et al., 2012). Socially prescribed perfectionism (SPP) is considered the maladaptive component of perfectionism and has repeatedly predicted negative academic adjustment such as elevated negative affect and stress, anxiety, and decreased levels of academic achievement (Bieling et al., 2003; Flett et al., 2007; Bong et al., 2014; Ashby et al., 2012; Verner-Filion & Gaudreau, 2010). The current study addresses perfectionism's adaptive and maladaptive components as they relate to academic self-concept, math achievement, and STEM vs non-STEM status.

The Frost Multidimensional Perfectionism Scale (FMPS), a common theoretical framework for perfectionism, stresses high personal standards followed by excessively critical appraisals of one's own actions (Frost et al., 1990). Perfectionists, according to Frost (1990), put a high priority on meeting their parents' standards, which may lead them to place too much emphasis on order, organization, and neatness in their lives. The FMPS measures six dimensions: Concern over Mistakes, Organization, Personal Standards, Doubts about Actions, Parental Expectations and Parental Criticism. Within this framework, perfectionism can be measured through its adaptive and maladaptive components. The adaptive perfectionist encompasses the dimensions of personal standards and organization (Frost et al., 1990). The maladaptive perfectionist reflects elevated scores across the dimensions of Doubts about Actions, Parental Expectations and Criticism, and Concern over Mistakes. What differentiates adaptive perfectionists from maladaptive perfectionists is their capacity to acknowledge their limits in constantly attaining their high expectations (Gilman & Ashby, 2003).

Roughly a decade ago, the prevalence of perfectionism was alarmingly high in adolescents and younger children (Portesova & Urbanek, 2013). According to Curran and Hill (2019), the increase in the prevalence of perfectionism is in part due to meritocratic ideologies, which have created a culture in which everyone is expected to perfect themselves and their life by aiming to meet impossible achievement standards. This new society imposes an extra weight on parents: in addition to their personal obligation to achieve, they are now accountable for their children's accomplishments and failures. The self-esteem of parents then becomes contingent on their children's achievement outcomes, this leads to the growth of parental expectations for their children's achievement related outcomes.

### *Theories of Perfectionism*

Regarding the development of perfectionism, different models have been formulated to explain the possible pathways towards the development of perfectionism. Although the theories differ with respect to their processes and dynamics, they converge on the idea that developmental periods occurring from early childhood into adolescence are critical timepoints with parents playing a vital role (Stoeber & Childs, 2011; Nounopoulous et al., 2006; Damien et al., 2013; Maloney et al, 2014)

In the social expectations model, children's perfectionism results as a response to the contingent self-esteem linked with parental expectations and parental criticism (Flett & Hewitt, 2002). The contingency is most often conveyed to the child through achievement related outcomes, in which they only receive praise for near perfect achievement (Olsson et al., 2020). This perspective is rooted in the research of Missildine (1963), who hypothesized that perfectionists' upbringings were marked by constant negative reinforcement from their parents as

they continued to push for improvement, rather than provide encouragement or praise. Through this, children may believe their efforts are futile. This model has predicted longitudinal increases in the development of maladaptive perfectionism across adolescence (Damien et al., 2013).

The social learning model suggests that children acquire the perfectionist tendencies of their parents through directly observing, imitating, and emulating their parents' perfectionism through continuous exposure to their parents' perfectionism, which often leads children to idealize the perfection they perceive in their parents (Bandura & Walters, 1977). This model has received some empirical backing in high school and college populations, such that students identify the perfectionist behavior of their parents as central to their own behaviors (Speirs Neumeister et al., 2004; Speirs Neumeister et al., 2009).

It is interesting to note that parental levels of adaptive perfectionism have predicted adolescent levels of adaptive perfectionism, while parental maladaptive perfectionism as well as the perfectionist standards they hold for others have predicted adolescent levels of maladaptive perfectionism (Appleton et al., 2010). This reflects the idea that the pathways to each type of perfectionism may differ, such that maladaptive perfectionism develops through both social learning and social expectations while adaptive perfectionism develops through social learning (Damian et al., 2013).

Some research finds gender differences emerge in the development of perfectionism. Differences in overall perfectionism are documented as early as elementary school, with young girls being more likely to exhibit perfectionist tendencies (Bas, 2011). Related to the dimensions, elevated parental expectations and personal standards have been found in young girls, and elevated doubts about their performance in young boys (Livazović, & Kuzmanović, 2022).



Though, this pattern has mixed findings as it relates to the period of adolescence. In some studies, neither early nor late adolescents exhibit these gender differences (Rice et al., 2007; Curran & Hill, 2019). Other studies find boys and girls to demonstrate differences in their perfectionism scores during adolescence (Gavino et al., 2019). As individuals approach new developmental periods, such as the periods from adolescence to young adulthood, and young adulthood to adulthood, research finds mixed associations between age and perfectionism. Such that, age has been positively correlated with overall perfectionism as well as its specific dimensions (Butt, 2010). On the other hand, studies find no correlation between age and overall perfectionism and have demonstrated a positive relationship between age and the dimensions of perfectionism as they relate to domain specific outcomes such as academics (Stoeber & Stoeber, 2009; Schweitzer & Hamilton, 2002). Many studies using college samples indicate no overall gender differences in perfectionism, though when individual dimensions are assessed, women often score higher on the adaptive dimensions perfectionism while men score higher on the maladaptive dimensions of perfectionism (Reuther et al., 2013; Leone & Wade, 2017).

As it relates to academic achievement, Rice et al. (2013) investigated the relationship between perfectionism, self-efficacy and academic achievement among STEM college students. Their findings indicated that women in STEM fields may be more susceptible to maladaptive perfectionism. Moreover, adaptive perfectionists were favorably correlated with self-efficacy and STEM-specific GPAs, but their total GPAs were not substantially different. Maladaptive perfectionism has been associated with greater impulsivity thus resulting in poor performance, while adaptive perfectionists demonstrated slower and more thoughtful responses on a performance related gambling task (Karami Isheqlou, 2022). This is thought to be due to the heightened emotional response that accompanies maladaptive perfectionists when faced with

both positive and negative performance feedback, although, the impulsivity was greater after being presented with negative outcomes. On the other hand, adaptive perfectionists respond positively to favorable feedback and spend more time into accuracy over speed. Significant links between maladaptive perfectionism and anxiety related to learning and performing statistics have been demonstrated and suggest that students with low self-efficacy and minimal satisfaction with their academic performance are particularly at risk for the onset of anxiety while interpreting statistical results as well as decreased performance in math related courses (Comercho & Fortungo, 2013). When taken together, the negative perceptions students have of themselves, and their subject specific abilities may hinder actual performance independent of actual ability. Thus, the adaptive and maladaptive dimensions of perfectionism may be differentially associated with both actual performance and student's perceptions of their academic abilities. These subject-specific perceptions of ability form what is known as academic self-concept, discussed in the following section. Lo & Abbott (2019) highlight that the function and nature of the components of self-concept that support perfectionism should be explored. Taken together the results imply that perfectionism is not simply linked to only negative attributions, as suggested in the early research, but may also include a functional component that is reflected through the malleability of adapting their standards and expectations.

### **Academic Self-Concept**

The most widely accepted conceptualization of self-concept posits that a person's self-concept encompasses their perceptions of themselves which are shaped by their interactions with and interpretations of their surroundings (Shavelson et al., 1976). According to Shavelson and colleagues (1976) differing concepts of self might be crucial for understanding and forecasting

behavior. It is believed that a person's actions shape his or her self-perceptions, and vice versa. Structured, layered, hierarchical, stable, developing, evaluative, and distinct are all ways to define one's own sense of self (Marsh, 1986; Marsh; 1989; Marsh, 1990). Academic self-concept is a self-concept specific psychological construct representative of an individual's internal expectations in relation to differing academic domains as well as academic achievement settings (Flowers, 2013; Wigfield & Karpathian, 1991).

### *Theories of Academic Self-Concept*

Differing theories exist to explain the relationship between academic self-concept and academic achievement, but research centers on a few main theories. In the skills development paradigm, academic achievement is a predictor of academic self-concept, but academic self-concept has no bearing on academic achievement (Calsyn & Kenny, 1977). On the other hand, the self-enhancement model posits one path from academic self-concept to academic achievement, with academic self-concept being the most influential factor to academic achievement. In this model, there is not an effect of academic achievement on academic self-concept (Wu et al., 2021). The reciprocal effects model combines the two preceding models and proposes that early academic self-concept impacts later academic accomplishment, and early achievement lends itself to improved academic self-concept (Wu et al., 2021). According to the theory of reciprocal effects, students' positive perceptions of themselves in the classroom and their actual performance in school encourage and strengthen one another. The reciprocal impact model hypothesized that stronger academic self-concept would lead to better academic accomplishment, and vice versa (Marsh et al., 2002; Marsh et al., 2006). Students with inferior academic accomplishment, as argued by Liu (2009), will form negative academic beliefs and

confidence, leading to even worse academic self-concepts. Through the reciprocal effect model, academic achievement and academic self-concept are interrelated concepts, in that stronger self-concepts give rise to more effort and tenacity and therefore greater achievements (Marsh & Craven, 2006).

The final theoretical model of academic self-concept relevant to this study is the Internal/External (I/E) Frame of Reference Model of academic self-concept. As it relates to academia, internal or dimensional comparisons may lead to self-perceptions, in which successes in one school subject might serve as a frame of reference for another (Möller et al., 2009; Möller & Köller, 2001). Specifically, students' academic self-concepts are formed in the context of the I/E model by comparing their performance to internal and external sets of standards or reference points (Marsh, 1986). In this model, students with similar levels of academic accomplishment and ability can have vastly different conceptions of themselves based on their own frames of reference (Marsh & Scalas, 2011). It is rooted in preliminary research that points to a persistent non-significant correlation between verbal and mathematical self-concepts, which serves as the foundation for the argument.(Marsh, 1986). This model helps explain how students build their academic self-concepts by selecting the proper frames of reference on a cognitive level, specifically evaluating verbal and mathematical self-concepts, which serve as the cornerstone of academic self-concept (Marsh et al., 1988). This is because individuals categorize themselves as verbally or mathematically dominant, rarely feeling efficacious in both domains, which is often an inaccurate assessment of actual ability (Marsh, 2007). Proponents of this theory assert that students' academic self-concepts form based on how they evaluate their academic performance and achievement in comparison to their classmates and peers (Möller & Marsh, 2013). For example, students who do better on a standardized mathematics exam than their peers develop a

positive frame of reference regarding their perception of their over mathematics ability when compared to those around them. This external comparison is thought to be the primary frame of reference. On the other hand, internal comparisons occur when a student does better on the math portion of an exam as compared to the verbal portion or vice versa. The evaluation of their own academic performance and achievement across these domains leads to an increased negative perception of ability in the domain with the lower score. This sets the standards for students' internal frame of reference (Marsh, 1986). Moreover, the non-significant correlation between the two dimensions is thought to be due to the interaction of internal and external comparisons (Yeung et al., 2010). These internal and external comparisons have underpinning very similar to the internal and external pressures that accompany perfectionists as they strive to flawlessly meet their unrealistically high standards (Frost et al., 1990; Hewitt & Flett, 1991). Therefore, a primary goal of this study is to assess the contribution of the adaptive and maladaptive dimensions of perfectionism to the academic self-concept of first year STEM and non-STEM students.

### *Development of Academic Self-Concept*

During childhood, academic self-concept becomes established through a child's direct experiences in educational and familial settings, their self-assessment evaluations and observations, and differing suppositions others hold towards their behaviors and achievements (Luttenberger et. al, 2019). Specifically, students' academic self-concepts are formed via a process of social comparison, whereby they evaluate their own performance relative to that of their peers. High school, often known as adolescence, is most thought of as a transitional time between childhood and adulthood. It is marked by cognitive and emotional development, the

filtering of parental and society expectations, the competing demands of different roles, and the increasing complexity of interactions with both parents and peers (Byrne & Shavelson, 1986; Marsh et al, 2005).

The empirical research on the specific time periods in which gender differences develop in academic self-concept has produced inconsistent findings. Early studies suggest a gradual emergence of gender differences in academic self-concept, beginning towards the end of childhood into early adolescence and intensifying through late adolescence (Wigfield et al., 1997; Eccles, 1987). As children get older, the social comparison process in which academic self-concept is formed often renders declines in children's academic self-concepts (Eccles, 1987; Eccles, 1984). Longitudinal research on the academic self-concepts of students beginning in middle school and ending before high school graduation demonstrates a narrowing gap between boys and girls across time (Fredricks & Eccles, 2002). When comparing the academic self-concepts of gifted and average ability students, Preckel and Colleagues (2008) discovered gender differences in academic self-concept favored men significantly more in gifted students than in those with average ability. Furthermore, this changed across men of varying ability but did not explain differences in the academic self-concepts of women, as women of gifted and average intelligence exhibited consistently lower levels of academic self-concept independent of actual ability. This negative pattern has been postulated as a factor diminishing the likelihood of high ability women to pursue mathematics related majors (Eccles & Harold, 1991). Regarding academic self-concept in university students, women in STEM fields generally exhibit a more negative self-concept than men even when there are no differences in their academic achievements and grades (Jacobs et al., 2002; Frenzel et al., 2010). These disparities might be regarded in part as the effects of familial or educational socialization since, following elementary

school, the gender-based mathematics and self-concepts become increasingly prominent (Senler & Sungur, 2009).

### **Perfectionism and Academic Self-Concept**

In a similar fashion as the development of perfectionism, parental expectations precede the development of academic self-concept beliefs. Research on the influence of parents on academic self-concept has demonstrated that parents' beliefs or expectations about their child's mathematical ability have a greater influence on the child's academic self-concept than actual past performance, and that children's perceptions regarding their abilities are far more strongly influenced by their parents' beliefs than by their own past performance (Parsons et. al., 1982, Phillips, 1987). Further, findings of a meta-analysis examining the effect of communication on a child's academic self-concept found a positive correlation between the child's degree of comfort in communicating with their parents and their academic self-concept (Jeynes, 2007). Rice and Colleagues (2005) note the development of both adaptive and maladaptive perfectionism are influenced by the relationships children have with their parental influences. Studies using samples of middle school students indicate early familial differences between adaptive and maladaptive perfectionists, when compared to maladaptive perfectionists, students who classified as adaptive perfectionists reported receiving greater parental nurturing (DiPrima et al., 2011). Thus, in considering the role parents play in their children's subsequent academic choices, a child's perceptions of their parents' expectations for their academic success as well as their acknowledgement of criticism have the potential to contribute to the development of differing perfectionist tendencies which may be differentially impacting other factors.

As it relates directly to perfectionism, few studies have looked at the relationship between academic self-concept and perfectionism dimensions (Lo & Abbott, 2019). DeDonno (2018) explored the relationship between the adaptive and maladaptive dimensions of perfectionism, finding differences in their relation to academic self-concept. Students with high levels of doubt in their actions are more likely to display lower levels of academic self-concept. Further, individuals with higher personal standards were more inclined to have high levels of academic self-concept. Strong relationships between maladaptive perfectionism and the acceptance of self-defeating beliefs have been documented, indicating that people with high levels of maladaptive perfectionism may have a more vulnerable sense of identity (Lo & Abbott, 2019). According to Higgins' (1987) discrepancy theory, a smaller gap between one's actual self and one's ideal self/ought self may make adaptive perfectionists more realistic in their pursuit of success, whereas a larger gap between one's actual self and one's ideal self/ought self may cause maladaptive perfectionists to doubt their ability to meet their standards. In this, the "ideal self" refers to the views that one has about the qualities or attributes that they would like to have, while the "ought self" refers to the beliefs that one has about the characteristics or attributes that they feel it to be their obligation to have.

Therefore, taken together it is likely that the effects of academic self-concept and perfectionism differ between men and women as well as between STEM and non-STEM students as they relate to academic performance. These differences are likely rooted in early relationships with parents, in which maladaptive and adaptive perfectionist tendencies manifest as a result of varying experiences at various developmental time periods. As the first two years of a student's undergraduate endeavor are the most influential in their persistence, the influence



of adaptive and maladaptive perfectionist tendencies on the academic self-concept of students may be impacting their performance.

### **Current Study**

This research focused on examining patterns of associations between adaptive and maladaptive perfectionism, academic self-concept, and math performance among first-year undergraduate STEM and non-STEM majors.

#### *Research Question 1: Gender and Major Differences*

The first research question investigated whether math performance, academic self-concept, maladaptive perfectionism, and adaptive perfectionism varied by gender and major, and whether gender and major significantly interacted in relation to these variables. In line with prior research, mean level differences in math performance, and academic self-concept, gender differences were expected to emerge. Specifically, men are expected to display higher math scores on the standardized measure of math performance and indicate higher levels of academic self-concept (Watt, 2004; Liu & Wang, 2005; Hyde et al., 2008; Voyer & Voyer, 2014; Wang & Degol, 2017). Literature on the relationship between gender and adaptive and maladaptive perfectionism does not robustly indicate specific pervasive gender differences in overall perfectionism, with early research by both Frost & Steketee (1997) and Parker & Adkins (1995) finding no gender difference in perfectionism levels. Recent research points to small differences in the adaptive and maladaptive dimensions, with women more likely to display higher levels of both perfectionism dimensions. Thus, women were expected to display elevated levels of maladaptive perfectionism and adaptive perfectionism (Sand et al., 2021; Lenoë & Wade, 2017; Livazovic & Kuzmanovic, 2022). As they relate to differences between STEM and non-STEM

majors, consistent with the literature, students in STEM and non-STEM are expected to differ in their academic self-concepts and their math performance. STEM students often have higher levels of academic self-concept in comparison to their peers as well as elevated math performance (Betz et al., 2021; Thompson & Bolin, 2010). While women in STEM are more likely to experience maladaptive perfectionism, it is not likely that as a whole STEM and non-STEM students will differ in adaptive and maladaptive perfectionism (Lo & Abbott, 2019; Rice, 2013; Wang et al., 2013; Elrod & Park, 2020).

Therefore, the expected result for *hypothesis 1a* was that men and women would differ in their academic self-concept, math performance, adaptive and maladaptive perfectionism. Specifically, women were expected to score higher in both dimensions of perfectionism while men were expected to display higher scores on academic self-concept and math performance. For *hypothesis 1b*, STEM and non-STEM students were expected to differ on their academic self-concept and math performance scores. Specifically, STEM students were expected to score higher in math performance and academic self-concept. No differences were expected in the perfectionism levels of STEM and non-STEM students. Interaction effects between students' gender and major were being explored and for *hypothesis 1c*, it was expected that women STEM majors would display elevated levels of maladaptive perfectionism (Rice, 2013). This is in line with prior findings in which women in STEM are susceptible to maladaptive perfectionism.

### *Research Question 2: Variable Associations*

The second question explored any significant associations between academic self-concept, adaptive perfectionism, maladaptive perfectionism, math performance, the influence of

parents on participant's choice of major, the influence of personal interest on participants choice of major, the influence of future pay on their major, along with gender and major.

As it relates to prior findings, math performance was expected to significantly relate to academic self-concept, the influence of interest, gender, and major (Marsh et al., 2005; Marsh, 2007; Marsh & Craven, 2006; Valentine et al., 2004). While research regarding the relationship between perfectionism, academic self-concept, and math performance is not robust, the hypothesized results follow the pattern in which adaptive perfectionism relates to more favorable academic outcomes as well as increased levels of academic self-concept, and maladaptive perfectionism relates most often to decreased performance and lower levels of academic self-concept, these associations are expected to differ by gender and major (Rice, 2013; Comercho & Fortungo, 2013; Lo & Abbott, 2019; DeDonno, 2018; Karami Isheqlou, 2022). As it relates to the influence of parents, pay, and interest, in line with prior research, interest and pay were expected to be associated with major, and interest is expected to be associated with math performance (Quadlin, 2020). In line with the Social Cognitive Career Theory (SCCT), academic self-concept was expected to be related to the influence of interest in choosing a major (Lent & Brown, 2019).

Therefore, *Hypothesis 2a* expected math performance to significantly relate to academic self-concept, adaptive and maladaptive perfectionism, the influence of interest, gender, and major. *Hypothesis 2b*, expected academic self-concept to be associated with gender, major, adaptive and maladaptive perfectionism, and the influence of interest. *Hypothesis 2c*, the intrinsic influence of interest and the extrinsic influence of monetary gain are expected be associated with participants choice of major.

*Research Question 3: Math Performance Predictors*

The third research question investigated whether participant's math scores could be predicted by adaptive and maladaptive perfectionism after accounting for gender, major, and academic self-concept. In line with prior research in which gender predicts math achievement, it is expected to predict higher math performance in men (Hu & Hu, 2021; Priulla et al., 2021; Moè, 2020). With regard to major, previous literature indicates differences in the predictive ability of major (STEM vs non-STEM) on math performance, with most finding elevated math performance in STEM students (Sithole, 2017; Elrod, 2020).

For *hypothesis 3a*, participants gender and major were expected to predict their math performance. As it related to academic self-concept, prior literature finds it to be a robust predictor of academic performance (Ghazvini, 2011; Marsh et al., 2018). The expected result for *hypothesis 3b* is that participants academic self-concept would predict their math performance above and beyond gender and major. Regarding the expected predictive ability of perfectionism, prior literature does not find the independent effects of perfectionism significantly related to academic performance, though some research finds components of perfectionism to predict academic achievement through negative self-perceptions (Park et al., 2020). Thus, whether perfectionism predicts math performance above and beyond gender, major and academic self-concept will be explored.

## Methods

Two-hundred and one participant were recruited from a mid-sized southeastern university, consisting of 141 women ( $n = 70.1\%$ ) and 51 men ( $n = 24.4\%$ ) first-year students,

pursuing STEM or non-STEM degrees. In accordance with the ACT (2016) definition, majors were coded into a binary variable with the STEM majors including science, computer science, mathematics, medical and health, and engineering and technology. Data were excluded for 1 participant due to failure one failure to provide adequate informed consent.

The final sample included 199 undergraduate students. Of these participants, 141 identified as women ( $n = 70.1\%$ ), 51 identified as men ( $n = 25.4\%$ ), and 7 identified as other ( $n = 3.5\%$ ), with ages ranging from 18 – 26 years old ( $M = 18.48$ ,  $SD = 0.60$ ), and self-reported GPA ranging from 2.40 – 4.80 ( $M = 3.69$ ,  $SD = 0.40$ ). Further, the majority of the sample identified as White/Caucasian ( $n = 63.2\%$ ), with the secondary race/ethnicity being Hispanic or Latino ( $n = 19.5\%$ ) (see Table 1).

**Table 1**

*Demographic Characteristics of Participants by Group*

	Total Sample ( $n = 199$ )	STEM ( $n = 60$ )	Non-STEM ( $n = 54$ )
	$n$ (%)	$n$ (%)	$n$ (%)
<b>Gender</b>			
Woman	141 (70.1%)	38 (63.3%)	41 (75.9%)
Man	51 (25.4%)	18 (30.0%)	10 (18.5%)
Other	7 (3.5%)	4 (6.7%)	3 (5.6%)
<b>Race</b>			
White/Caucasian	127 (63.2%)	37 (61.7%)	35 (64.8%)
Black/African American	28 (13.9%)	7 (11.7%)	9 (16.7%)
Asian	25 (12.4%)	10 (16.7%)	3 (5.6%)
American Indian/Alaskan	4 (2.0%)	0 (0.0%)	2 (3.7%)

Other	15 (7.5%)	6 (10.0%)	5 (9.3%)
Ethnicity			
Hispanic or Latin	39 (19.5%)	10 (16.7%)	15 (46.3%)
Not Hispanic	160 (80.4%)	50 (83.3%)	39 (53.7%)
Age (in years)	18.53 ± 1.083	18.48 ± 0.596	18.57 ± 1.449
Highschool GPA	3.69 ± 0.395	3.69 ± 0.423	3.68 ± 0.363

*Note.* Counts and percentages are given for nominal variables. Means and standard deviations are given for continuous variables.

### Participant Parental Demographics

Participants were also asked to complete demographic questions regarding parental level of education and parental occupation. As represented in Table 2, over a quarter of the sample reported their mother's highest level of education being a 4-year college degree ( $n = 52$ , 29.9%), and their father's highest level of education being a 4-year college degree ( $n = 46$ , 26.4%). Further, more participants reported that their mothers' occupations were non-STEM related ( $n = 74$ , 36.8%), and the majority of their fathers' occupations were also non-STEM related ( $n = 67$ , 58.5%).

Of the participants identified as STEM majors, over a quarter of participants reported their mother's highest level of education as a 4-year college degree ( $n = 17$ , 28.3%), and their father's highest level of education as a 4-year college degree ( $n = 16$ , 26.7%). Further, these participants reported the majority of their mothers' occupations were in non-STEM related fields ( $n = 38$ , 64.4%), and the majority of their fathers occupations were also in a non-STEM related field ( $n = 34$ , 56.7%)

Regarding participants identified as non-STEM majors, over a quarter of participants reported their mothers' highest level of education as a 4-year college degree ( $n = 16$ , 29.6%).

Fathers' highest level of education was most often reported as a 4-year college degree ( $n = 18$ , 33.3%). Further, participants reported that the majority of their mothers' occupations were in non-STEM related fields ( $n = 36$ , 66.7%), and the majority of their fathers' occupations were also in non-STEM related fields ( $n = 33$ , 61.1%) (Table 2).

**Table 2***Demographic Characteristics of Parents by Participant Group*

	Total Sample ( $n = 199$ ) $n$ (%)	STEM ( $n = 60$ ) $n$ (%)	Non-STEM ( $n = 54$ ) $n$ (%)
<b>Mother's Schooling</b>			
Some Highschool	10 (5.7%)	5 (8.3%)	3 (5.6%)
Graduated Highschool	34 (19.5%)	11 (18.3%)	8 (14.8%)
Some college	27 (15.5%)	7 (11.7%)	13 (24.1%)
2-Year College	17 (9.8%)	6 (10%)	7 (13.0%)
4-Year college	52 (29.9%)	17 (28.3%)	16 (29.6%)
Postgraduate	30 (17.2%)	11 (18.3%)	6 (11.1%)
Unsure	4 (2.3%)	3 (5.0%)	1 (1.9%)
<b>Father's Schooling</b>			
Some Highschool	13 (7.5%)	8 (13.3%)	2 (3.7%)
Graduated HS	45 (25.9%)	13 (21.7%)	13 (24.1%)
Some college	23 (13.2%)	7 (11.7%)	11 (20.4%)
2-year college	10 (5.7%)	2 (3.3%)	2 (3.7%)
4-year college	46 (26.4%)	16 (26.7%)	18 (33.3%)
Postgrad	25 (14.4%)	9 (15.0%)	4 (7.4%)
Unsure	12 (6.9%)	5 (8.3%)	4 (7.4%)
<b>Mother's Occupation</b>			
STEM	23 (11.4%)	15 (25.4%)	8 (14.8%)
Non-STEM	74 (36.8%)	38 (64.4%)	36 (66.7%)

N/A	16 (8.0%)	6 (10.2%)	10 (18.5%)
Father's Occupation			
STEM	27 (23.7%)	15 (25.0%)	12 (22.2%)
Non-STEM	67 (58.5%)	34 (56.7%)	33 (61.1%)
N/A	20 (17.5%)	11 (18.3%)	9 (16.7%)

*Note.* Counts and percentages are given for nominal variables. Means and standard deviations are given for continuous variables.

### **Procedure**

The following procedures and materials were approved via the university's Internal Review Board (IRB) prior to survey distribution and data collection. Students were recruited through convenience sampling from introductory undergraduate courses at the University of North Florida. The office of Institutional Research assisted with recruitment and survey distribution by emailing 25% of the incoming freshman class at three points throughout the semester. Participants were incentivized with a \$5 gift card compensation upon completion of the study.

Prior to beginning this study, participants were required to complete an online informed consent form. Participants began the study by completing a series of demographic questions, followed by a 15-item mathematics performance measure. The rest of the study materials (personal satisfaction, perfectionism, and parent's satisfaction) were all displayed through block randomization to control for order effects and response biases. After completion of all study materials, participants were redirected to an external link and asked to fill in their email address to receive their incentive.



## Measures

### *Demographics*

Participants were given a series of demographic questions, including their major, age, race and ethnicity, gender, high school GPA, current course enrollment, and any factors influencing their choice of major. Factors included the value of parents, pay, and interest. Furthermore, participants were asked to complete their parents' demographic information, which included their parent's highest level of education and their parent's current occupation. Cumulative high school GPA was measured on a 4.00+ scale. To ensure accurate data analysis, participants' majors were coded as "1.00" = "STEM pursuing" and "2.00" = "non-STEM pursuing". In accordance with the ACT (2016) definition, majors were coded into a binary variable with the STEM majors including science, computer science, mathematics, medical and health, and engineering and technology.

### *Academic Self-Concept*

Participants completed the Personal and Academic Self-Concept Inventory (PASCI) (Fleming & Whalen, 1990; This sample,  $\alpha = .77$ ) The PASCI is a multidimensional measure with 9 subscales assessing the personal and academic facets of self-concept. Of the original nine subscales, this study used the following three subscales: the 5-item Academic Ability, the 5-item Mathematical ability, and the 5-item Verbal ability. Each of these 15 items were measured on a 7-point Likert scale from 1- *practically never* to 7- *very often*. 6 items were reversed scored, 3 from the academic ability subscale, 2 from the verbal ability subscale, and 1 from the math ability. Questions included: "*Do you think of yourself as good at mathematical problems?*" and "*Have you ever thought that you have a greater ability to read and absorb articles and textbooks*

*than most people?*” Research supports adequate internal validity and test-retest reliability of this questionnaire in undergraduate students (Fleming & Whalen, 1990).

### ***Perfectionism***

Participants also completed the Frost Multidimensional Perfectionism Scale (Frost et al., 1990,  $\alpha=.90$ ;  $\alpha = .91$  in this sample). The FMPS consists of 35-items originally across 6 subscales, including: 9-item Concern over Mistakes, 7-item Personal Standards, 5-item Parental Expectations, 3-item parental criticism, the 4-item Doubts about actions, and the 6-item Organization. Two subscales were derived to address the adaptive and maladaptive dimensions – maladaptive perfectionism (Doubts about Actions/Concerns over Mistakes, and Parental Expectations/Criticism;  $\alpha =.92$ ) and adaptive (Personal Standards and Organization;  $\alpha =.89$ ). Participants were asked to indicate the extent to which they agree or disagree with each statement presented on a 5-point Likert-scale from 1- *strong disagreement* to 5- *strong agreement*. Lastly, higher scores on each of these subscales indicate higher levels of perfectionistic thoughts and behaviors.

### ***Math Performance Measure***

To assess math performance, participants completed a basic mathematics test consisting of 15 questions from a free SAT practice test provided by the college board ( $\alpha = .75$  in this sample).

### **Table 3**

#### *Study Measure Descriptive Statistics*

Scale Measure	Mean ( <i>SD</i> )	Skewness	Kurtosis	Reliability ( $\alpha$ )	Range
1. Frost Multidimensional Perfectionism Scale	3.35 (.59)	0.59	-0.08	.914	1.82 – 4.67
2. Adaptive Perfectionism Subscales	3.18 (.65)	-0.56	-0.003	.885	1.73 – 4.91
3. Maladaptive Perfectionism Subscales	3.11 (.75)	0.11	-0.31	.920	1.19 – 4.71
4. Math Performance	7.82 (3.0)	0.17	-0.85	.753	2.00 – 14.0
5. Academic Self-Concept	3.86 (.57)	0.07	-0.09	.753	2.19 - 5.31

### Analysis Plan

The focus of the analyses was to examine group and individual differences in math performance score, academic self-concept, adaptive perfectionism, and maladaptive perfectionism, any associations between the variables of interest, and any predictor variables which may predict participants math performance.

The first analysis was conducted using multivariate ANOVA (MANOVA) techniques to test for gender and major differences across all variables of interest. The two independent variables gender (men and women) and major (STEM and non-STEM). The dependent variables consisted of math performance, academic self-concept, adaptive perfectionism, and maladaptive perfectionism. Pillai's trace statistic is utilized for interpretation based on Olson's (1976) recommendation that Pillai's trace be used for general use.

The second analysis was conducted using Pearson's-Product-Moment Correlation and Point-Biserial Correlations to assess any significant associations between the variables of interest. These included math performance, academic self-concept, adaptive perfectionism, and

maladaptive perfectionism, the influence of parents to the participants choice of major, the influence of pay to the participants choice of major, and the influence of interest to the participants choice of major. Gender was dummy coded for the correlational analysis and hierarchical regression as men = 1 and women and others = 0.

The third analysis utilized hierarchical regression techniques to determine how participants gender, major, academic self-concept, adaptive perfectionism, and maladaptive perfectionism contribute to their math performance scores. Gender was dummy coded and men were used as the reference group for comparison. This analysis utilized standardized versions of the dependent variables, as recommended for variables that are not all part of the same scale (Grice & Iwasaki, 2009). The raw scores were transformed into Z scores by combining the means and standard deviations to generate a new score that is described in the same unit across all scales (Andrade, 2021).

## **Results**

### **Statistical Assumptions**

Before conducting analyses, statistical assumptions of the data were assessed. By checking the statistical assumptions, estimates of effect sizes improve and the potential of obtaining Type I and Type II errors are minimized. The skewness and kurtosis values were utilized to assess data normality. There were no issues for these values regarding math performance, Perfectionism Subscales, and Academic Self-Concept variables (Table 3). Outliers were assessed using boxplots. Regarding the academic self-concept scale, there were two outliers at the lower end for women and for STEM students, and two at the upper end for non-STEM students. Regarding maladaptive perfectionism, there was one outlier on the lower end for men. Finally, on adaptive perfectionism there was one outlier on the lower end for men and for STEM

students. These outliers were not considered extreme values. An alpha of .05 was used for all statistical tests.

Next, the assumptions for Pearson's Product Moment correlational analyses were assessed. The assumption of level of measurement was met, as all variables included are continuous and measured at interval or ratio levels. Skewness values for all variables were in between -1 and 1, and kurtosis values for all variables were between -2 and 2 indicating that the variables are normally distributed. Thus, the assumption that all data are of normal distribution is met. Scatterplots were used to assess linearity and indicated a linear relationship between the variables.

The assumptions for Multivariate Analysis of Variances (MANOVA) were assessed. The assumption of continuous dependent variables was met, as well as the assumption of categorical independent variables. To address the assumption of homogeneity of variances Box's M test of equality ( $p = .845$ ) confirmed that the assumption of homogeneity of variance has been met. Therefore, the statistical assumptions were met, thus allowing for the data to produce accurate conclusions. Assumption of the absence of multicollinearity was met, as any dependent variables that are correlated are low.

The assumptions for hierarchical regression were met. The absence of multicollinearity was apparent, as the independent variables included do not exhibit a correlation greater than or equal to 0.7, thus minimizing error (Tabachnick & Fidell, 1996). The variables displayed linear relationships with independent observations. Residual plots were examined to address the assumptions of normality, and homoscedasticity. There were no issues in the data regarding these assumptions. Further, the sample size is in line with the recommended size of 91 participants for a regression analysis using five independent variables (Cohen, 1992). Though,

the presence of outliers is important to note as regression analyses are particularly sensitive to outliers (Pallant, 2005).

### **Multivariate Analysis of Variances (MANOVA)**

To test the hypotheses related to Research Question 1, a MANOVA was conducted.

In support of hypothesis 1a, the expected overall main effect of gender was significant,  $F(4, 103) = 4.40, p = .003, \eta_p^2 = .15$ . To examine which dependent variables contribute to the main effects, Univariate ANOVAs were examined. Analysis indicated that gender had a significant to marginally significant main effect on all dependent variables: academic self-concept  $F(1, 106) = 9.34, p = .003, \eta_p^2 = .08$ , adaptive perfectionism  $F(1, 106) = 3.46, p = .065, \eta_p^2 = .03$ , maladaptive perfectionism  $F(1, 106) = 4.91, p = .029, \eta_p^2 = .04$ , and math performance  $F(1, 106) = 5.42, p = .022, \eta_p^2 = .05$ . Mean differences between genders are presented in Table 4. In comparison to women, men scored higher on math performance ( $M = 9.03, SE = 0.57; M = 7.51, SE = .31$ ) and academic self-concept ( $M = 4.25, SE = 0.13; M = 3.79, SE = 0.07$ ). Women scored higher of measures of adaptive perfectionism ( $M = 3.80, SD = 0.07; M = 3.51, SE = 0.13$ ) and maladaptive perfectionism ( $M = 3.17, SE = 0.08, M = 2.78, SE = 0.15$ ). Results indicate that women are experiencing elevated levels of perfectionism. Further, men are associated with higher math scores as well as higher levels of academic self-concept.

In support of hypothesis 1b, the multivariate test of differences between majors was significant,  $F(4, 103) = 2.58, p = .04, \eta_p^2 = .09$ . To examine which dependent variables contribute to the main effects, Univariate ANOVAs were examined. Analysis indicated that major only had a significant main effect on total exam score  $F(1, 106) = 7.24, p = .008, \eta_p^2 = .002$ . In contrast to hypothesis 1b, academic self-concept was not significantly different between majors  $F(1, 99) = 0.11, p = .744, \eta_p^2 = .001$ . Mean differences are presented in Table 5. The

only significant mean difference was demonstrated between STEM and non-STEM students on the total math exam score. STEM students scored significantly higher than non-STEM students ( $M = 9.15$ ,  $SE = .41$ ;  $M = 7.40$ ,  $SE = .503$ ). Contrary to hypothesis 1c, there were no interaction effects between gender and major  $F(4,103) = .231$ ,  $p = .92$ ,  $\eta_p^2 = .009$ ).

**Table 4**

*Means and Standard Deviations for Gender*

	Men	Women
	<i>M(SE)</i>	<i>M(SE)</i>
Academic Self-Concept	4.25(.13)	3.79(.71)
Adaptive Perfectionism	3.51(.13)	3.80(.07)
Maladaptive Perfectionism	2.78(.15)	3.17(.08)
Math Performance	9.03(.57)	7.51(.31)

**Table 5**

*Means and Standard Deviations for Major*

	STEM	Non-STEM
	<i>M(SE)</i>	<i>M(SE)</i>
Academic Self-Concept	4.09(.95)	3.96(.11)
Adaptive Perfectionism	2.92(.11)	3.02(.13)
Maladaptive Perfectionism	3.74(.09)	3.57(.11)
Math Performance	9.15(.41)	7.40(.50)

### Correlational Analysis

To test the hypotheses related to research question 2, a Pearson's Product Moment correlational analysis was conducted. The results are presented in Table 6. The results partially support the expected pattern for hypothesis 2a. Math scores were expected to be significantly related to academic self-concept, interest, gender, and major. Partially in line with the expected pattern, results indicated that math performance was positively associated with academic self-concept, the intrinsic influence of interest in choice of major, and unexpectedly with the extrinsic influence of monetary gain in choosing a major. Thus, higher levels of math performance were related to elevated academic self-concept and being intrinsically rewarded by interest in their major as well as extrinsically motivated by the future monetary gain of their major. Math performance was associated with major, such that STEM majors are associated with higher levels of math performance. In contrast to the expected effect, math performance was not associated with gender.

The results partially supported hypothesis 2b. Academic self-concept was expected to be associated with gender, major, adaptive and maladaptive perfectionism. Results revealed a significant relationship between academic self-concept and maladaptive perfectionism as well as gender. Participants with lower levels of academic self-concept reported higher levels of maladaptive perfectionism. Participants with elevated academic self-concepts were associated with men. In contrast, academic self-concept did not significantly relate to adaptive perfectionism and participant's major. The intrinsic influence of interest was unrelated to academic self-concept. An unexpected marginally significant negative relationship arose between academic self-concept and the influence of parents on participant's choice of major.



Participants with higher self-concepts were less likely to report their parents as influential to their choice of major.

The results partially supported hypothesis 2c. The influence of interest in participants choice of major was expected to be related to participants choice of major. Results revealed the influence of interest was unrelated to participants choice of major. The extrinsic monetary influence was associated with STEM majors, and unexpectedly also associated with the social influence of parents in choosing a major. Participants who indicated their personal interest as influential to their choice of major also indicated the potential payout of their major as influential to their decision, this is also associated with STEM majors. Further, participants with lower levels of academic self-concept are associated with more social influence from their parents in choosing their major.

**Table 6**

*Bivariate and Point-Biserial Correlations between Study Variables*

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. Math Performance	-	.31**	-.09	-.01	.29**	.25**	.11	.08	-.32**
2. Academic Self-Concept	-	-	.10	-.29**	.05	.02	-.25**	-.16	.29**
3. Adaptive Perfectionism	-	-	-	.28**	.05	.07	.11	-.17	-.07
4. Maladaptive Perfectionism	-	-	-	-	.01	-.05	.17	-.21*	.09
5. Extrinsic Influence	-	-	-	-	-	.31*	.25*	-.03	-.28*

6. Intrinsic Influence	-	-	-	-	-	-	.07	-.11	.02
7. Social Influence	-	-	-	-	-	-	-	-.17*	-.01
8. Gender	-	-	-	-	-	-	-	-	-.13
9. Major <sup>b</sup>	-	-	-	-	-	-	-	-	-

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

<sup>a</sup> Dummy coded, men are the reference group: 1 = men, 0 = women and others

<sup>b</sup> STEM = 1, non-STEM = 2

### Hierarchical Regression

To address research question three, a hierarchical regression was performed to investigate the ability of academic self-concept and the adaptive and maladaptive dimensions of perfectionism to predict math exam scores, after controlling for gender and major. Results are presented in Table 7. Hypothesis 3a expected gender and major to predict their math performance.

The hierarchical regression revealed that at Step 1, gender and major both contributed significantly to the regression model,  $F(2, 107) = 9.74, p < .001, R^2 = .15$  and accounted for 15% of the variation in math performance. Gender was a positive predictor of math performance, indicating that a 1-unit increase from women men is associated with higher math performance ( $b = .32, SE = .14, p = .02$ ). Major was a negative predictor of math performance, indicating that a 1-unit decrease from non-STEM to STEM is associated with higher math performance ( $b = -.42, SE = .12, p < .001$ ).

At Step 2, adding academic self-concept to the model explains an additional 5% of the

variation in math performance  $F(3, 106) = 8.82, p < .001, R^2 = .20$ . Major emerged again as a negative predictor of math performance, ( $b = -.38, SE = .120, p = .002$ ). Academic self-concept was a positive predictor of math performance, such that math performance is elevated for every unit increase in academic self-concept ( $b = .15, SE = .06, p = .01$ ). Gender was no longer a significant predictor in this model, suggesting that academic self-concept accounts for the variance explained by gender alone ( $b = .22, SE = .14, p = .11$ ).

At Step 3, adding adaptive and maladaptive perfectionism explained an additional 4.2% of the variance in math performance  $F(5,104)=6.64, p <.001, R^2=.24$ . With all variables included in the model, major ( $b = -.41, SE= .12, p <.001$ ), academic self-concept ( $b =.20, SD = .06, p = .002$ ), and maladaptive perfectionism ( $b =.13, SE= .06, p = .04$ ) were significant predictors of math performance. Both gender ( $b = .21, SE = .14, p =.14$ ) and adaptive perfectionism ( $b = -.11, SE = .06, p =.07$ ) were not significant predictors of math performance. Overall, the most important predictors of math performance were participants major, academic self-concept, and maladaptive perfectionism.

**Table 7***Hierarchical Regression Model of Math Performance*

	<i>B</i>	<i>SE</i>	$\beta$	<i>R</i>	<i>R</i> <sup>2</sup>	$\Delta R^2$
Step 1: Demographics				.39*	.15*	.14*
Gender <sup>a</sup>	.32	.14	.21*			
Major	-.42	.12	-.31**			
Step 2: Academic Self Concept				.45**	.20**	.05**
Gender <sup>a</sup>	.23	.14	.14			
Major	-.38	.12	-.28**			

Academic Self Concept	.15	.06	.22**			
Step 3: Perfectionism				.49	.24	.20
Gender <sup>a</sup>	.21	.14	.13			
Major	.41	.12	-.30***			
Academic Self- Concept	.20	.06	.30**			
Adaptive Perfectionism	-.11	.06	-.16			
Maladaptive Perfectionism	.13	.06	.19*			

Note. \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$

<sup>a</sup> Dummy coded, men are the reference group: 1 = men, 0 = women and others

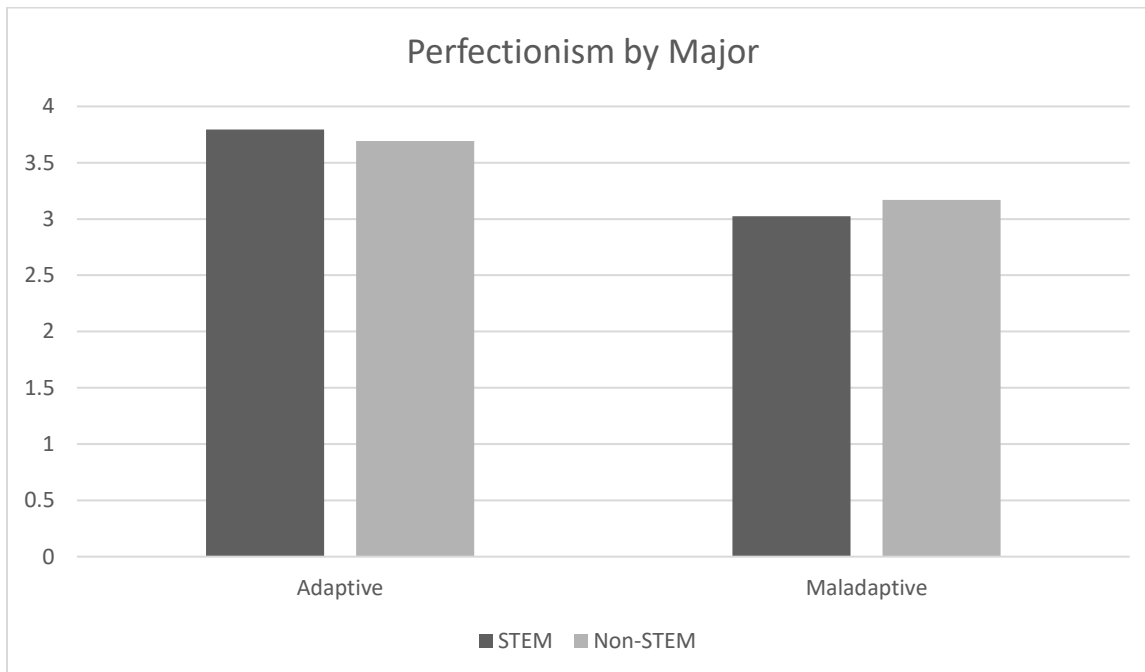
### Repeated Measures ANOVA

Repeated measures 2 x 2 ANOVA was conducted to assess whether there was a statistically significant difference between the two dimensions of perfectionism for gender (men and women) and major (STEM and non-STEM). Results are presented graphically below in Figures 1 through 3. There was a significant multivariate within-subjects main effect for perfectionism  $F(1, 110) = 46.19, p < .001, \eta_p^2 = .29$ . There were no significant interaction effect for gender  $F(1,110) = .15, p = .69, \eta_p^2 = .01$  or major  $F(1,110) = 1.44, p = .23, \eta_p^2 = .01$ . There was no significant interaction between both gender and major  $F(1,110) = .002, p = .97, \eta_p^2 = .00$ . There was a multivariate between-subjects main effect for gender  $F(1,110) = 6.65, p = .01, \eta_p^2 = .05$ . Women were more perfectionistic than men overall ( $M = 3.49, SE = .06; M = 3.16, SE = .11$ ). STEM students were higher in adaptive perfectionism than maladaptive perfectionism ( $M = 3.74, SE = .09; M = 2.96, SE = .10$ ). Non-STEM students were also higher in adaptive perfectionism than maladaptive perfectionism ( $M = 3.58, SE = .11; M = 3.03, SE = .13$ ). STEM

students reported higher levels of adaptive perfectionism than non-STEM students ( $M = 3.74$ ,  $SE = .09$ ;  $M = 3.58$ ,  $SE = .11$ ). Non-STEM students reported higher levels of maladaptive perfectionism than STEM students ( $M = 3.03$ ,  $SE = .13$ ;  $M = 2.9$ ,  $SE = .11$ ). STEM women reported higher levels of adaptive perfectionism in comparison to maladaptive ( $M = 3.86$ ,  $SE = .10$ ;  $M = 3.11$ ,  $SE = .11$ ). Non-STEM women reported higher levels of adaptive perfectionism as opposed to maladaptive ( $M = 3.75$ ,  $SE = .09$ ;  $M = 3.24$ ,  $SE = .11$ ). STEM men reported higher levels of adaptive perfectionism than maladaptive ( $M = 3.62$ ,  $SE = .15$ ;  $M = 2.80$ ,  $SE = .18$ ). Non-STEM men reported higher levels of adaptive perfectionism than maladaptive ( $M = 3.41$ ,  $SE = .21$ ;  $M = 2.82$ ,  $SE = .24$ ).

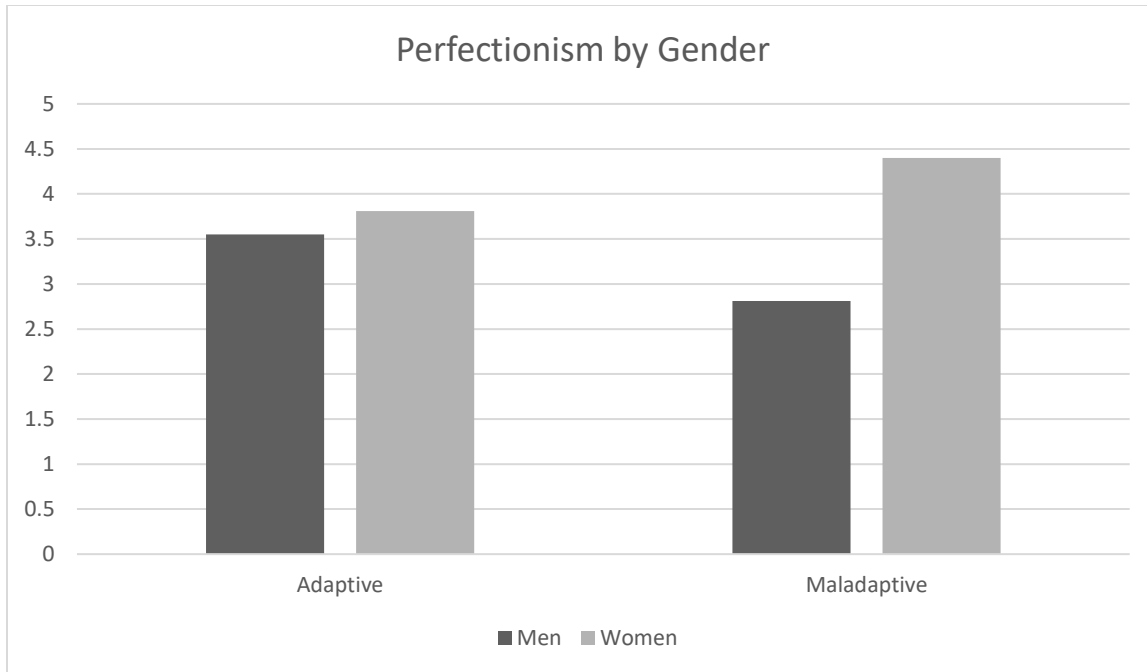
**Figure 1**

*Perfectionism by STEM and non-STEM Status*



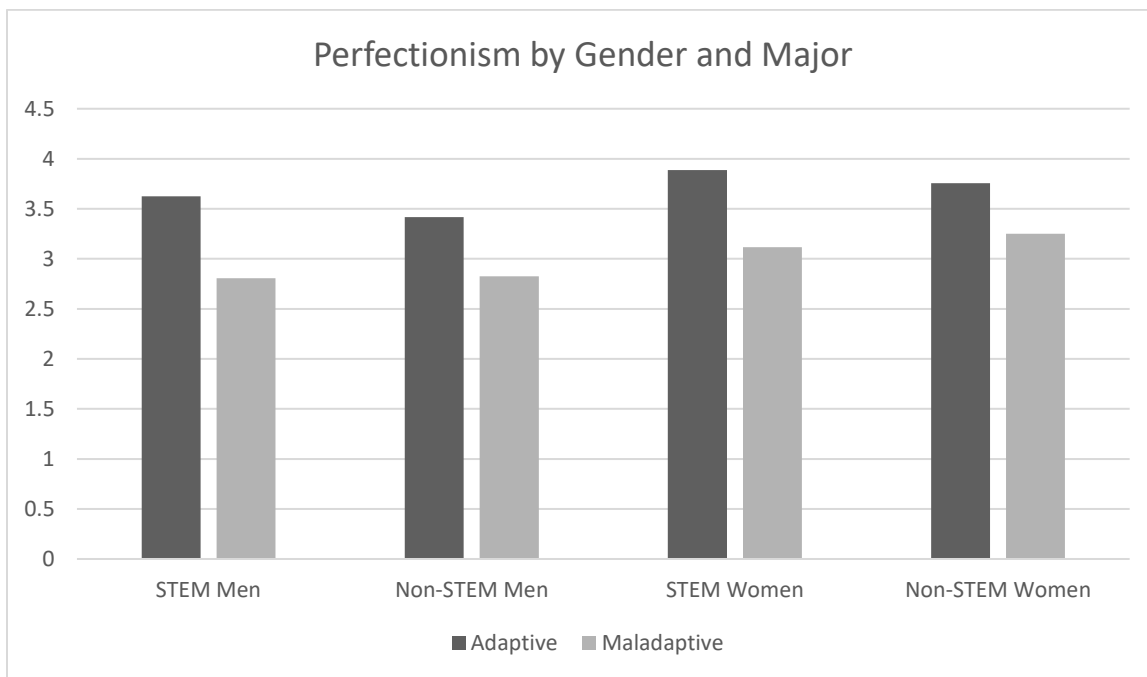
**Figure 2**

*Perfectionism by Gender Identification*



**Figure 3**

*Perfectionism by Gender and Major Identification*



### Discussion

This study's primary research goal was to assess differences in individual personality characteristics and cognitive math ability between STEM and non-STEM majors and how they relate to gender differences. The first research question investigated group differences between men and women along with STEM and non-STEM majors on measures of academic self-concept, maladaptive perfectionism, adaptive perfectionism, and math performance. Hypothesis 1a expected men and women to differ in their academic self-concept, math performance, adaptive and maladaptive perfectionism. The pattern of results partially supported the expected effect. Men demonstrated elevated math performance and academic self-concept, while women demonstrated higher levels of maladaptive and adaptive perfectionism. For men, it seems that these results align with previous literature in which academic self-concept has been linked to elevated academic performance through an elevated perception of academic ability (Marsh et al., 1988; Cokley, 2000; DeDonno & Fagan, 2013). These results do not indicate an elevated ability per se, as women often demonstrate elevated math grades in their mathematics courses compared to men (Goetz et al., 2008). The lower academic self-concept of women has been demonstrated in research on first year students, with women reporting elevated negative perceptions of their academic abilities (Ackerman et al., 2013). The finding that women demonstrate elevated levels of both dimensions of perfectionism is likely related to the academic context in which the study took place (Rice, 2013). While many studies do not find large, gendered differences in perfectionism, studies examining STEM specific gender differences find women more susceptible to maladaptive perfectionism (Rice et al., 2012). This seems to be reflected in the current results, as the main effect of gender on adaptive perfectionism was marginally significant, the main effect of gender on maladaptive perfectionism was significant

indicating greater levels of maladaptive perfectionism in women. The prevalence of elevated levels of both dimensions of perfectionism along with lower levels of academic self-concept shed light on a potential baseline understanding of gender differences in variable related to achievement early in the university setting and may hold some explanatory weight when studied longitudinally. Hypothesis 1b expected STEM and non-STEM majors to differ in their levels of academic self-concept and math performance. In support, results revealed differences between STEM and non-STEM student math performance, with STEM students scoring higher than non-STEM students. Contrary to the expected result, STEM and non-STEM students did not significantly differ in their levels of academic self-concept. Although not significant, STEM students did demonstrate higher academic self-concept levels than non-STEM students. Prior research finds a small correlation between academic self-concept and STEM status, though this result varied when controlling for differing motivational profiles (Van Soom & Donche, 2014). Hypothesis 1c expected an interaction effect, such that STEM women were anticipated to score higher in maladaptive perfectionism. Contrary to the expected result, no interaction effects emerged between gender and major. The small sample size may have decreased the statistical ability to detect interaction effects.

The second research question addressed associations between the study variables. The pattern of results partially support the expected results. In line with the expected results in hypothesis 2a, math performance was significantly related to academic self-concept, the intrinsic influence of interest in choosing a major, and major. Specifically, STEM students were associated with elevated math performance. Unexpectedly, it was also related to the extrinsic influence of monetary gain. In contrast, math performance was unrelated to gender and either dimension of perfectionism. The positive relationship between student's math exam scores and



academic self-concept falls in line with prior research (DeDonno, 2013; Cokley, 2000). The strong relationship between academic self-concept and men has been speculated to stem from the notion that parents are more prone to credit innate talent over deliberate practice for their sons' ability in math (Marsh, 1986; Eccles et al., 1994). The finding that academic self-concept correlated with participants math performance adds to prior research findings that both academic grades and standardized test scores are correlated with academic self-concept (Marsh et al., 2005). Though, academic grades are likely stronger in effect magnitude. In partial support of hypothesis 2b, academic self-concept was negatively associated with maladaptive perfectionism and gender. Specifically, higher levels of maladaptive perfectionism are associated with lower academic self-concept and lower academic self-concept is associated with identifying as a woman. Further, these results corroborate the findings of previous work displaying significant associations between gender and academic self-concept (Fleming & Whalen, 1990). Specifically, demonstrating the importance of raising the low academic self-concept of women. Further, in line with the Social Cognitive Career Theory, the low academic self-concept of women in the current study may reflect the inability for women to develop interest in subjects they do not feel confident in (Lent & Brown, 2006). The relationship between dimensions maladaptive perfectionism and academic self-concept has been documented in prior research and it is likely that the perfectionist dimension of self-doubt is the driving force behind the influence of perfectionism on academic self-concept (Dedonno, 2018). Further, it is likely that the component of shame or inadequacy maintains the relationship between maladaptive perfectionism and lower levels of self-concept (Lo & Abbott, 2019). The finding that maladaptive perfectionism did not relate to participants math performance aligns with the findings that maladaptive perfectionists don't necessarily have decreased ability, but rather they hold a negative perception of

themselves. Adaptive perfectionism was not significantly associated with academic self-concept or math exam. The non-significant finding of adaptive perfectionism with math performance and academic self-concept does not align with previous findings that adaptive perfectionism is related to higher academic achievement and maladaptive perfectionism is associated with lower academic success (Livazović, & Kuzmanović, 2022). Further, it adds to the debate in which the dimensions of “adaptive perfectionism” are more related to “perfectionist strivings” over being a more functional adaptive component of perfectionism (Smith et al., 2019). It may be that adaptive perfectionist tendencies prevent against a negative perception of one’s academic ability, but do not serve to enhance an individual’s perception of their ability. Hypothesis 2c expected the intrinsic influence of interest in choosing a major and the extrinsic influence of monetary gain to be associated with participants choice of major. The influence of interest in choosing a major was unrelated to participant’s major, though the extrinsic influence of monetary gain was associated with STEM majors. Further, this was also associated with the social influence of parents in choosing a major. Unexpectedly, the social influence of parents in choosing a major was related to academic self-concept and gender. Specifically, women and individuals with low self-concept reported being more influenced by their parents in choosing their major. This finding serves as a response to the question posed by Beier & Rittmayer (2009), in which they call for researchers to explore if the influence of parents on individuals’ academic choices differed between men and women. Gender differences were found for the influence of parents to participants choice of major with men being less likely to be influence by their parents than women. This influence, along with the low levels of self-concept and high levels of maladaptive perfectionism may reflect the idea that the influence of parents may be negatively affecting the way individuals perceive themselves and the subsequent academic choices they make. The

finding that math performance was related to the influence of interest is promising, though the influence of interest was not related to any gender. STEM specific men have been associated with higher levels of academic interest and larger sample sizes may allow closer analysis of STEM specific gender differences in interest (Beier & Rittmayer, 2009).

The third research question investigated the ability of academic self-concept, adaptive, and maladaptive perfectionism to predict math exam scores while exploring the effects of gender and major. This study found that math exam scores were more related to academic self-concept than to gender. Though, women were associated with lower academic self-concept. It is important to note the relationship between academic self-concept, as literature regarding academic persistence finds academic self-concept predicts college persistence (Guay et al., 2004). Thus, these results may reflect that the lower academic self-concepts in combination with elevated maladaptive perfectionist tendencies are afflicting women at an elevated rate in their first year, which has future implications in retention and attrition. Maladaptive perfectionism significantly predicted math performance, whereas adaptive perfectionism only served as a marginal predictor. The finding that academic self-concept predicted academic achievement negates the skills development model proposed to explain the relationship between achievement and academic self-concept, specifically academic self-concept was able to predict achievement (Calsyn & Kenny, 1977). The results to lend themselves to support for the self-enhancement model, in which academic self-concept is the most influential factor to academic achievement (Wu et al., 2021). They also reflect the notion of the reciprocal effect models in which academic self-concept and achievement seem to mutually reinforce one another, though to align with this model longitudinal research is warranted (Wigfield & Eccles, 2000; Marsh et al., 2002, Steinmayr et al., 2018; Sewasew & Schroeders, 2019).

Taken together, it is apparent that academic self-concept and perfectionism are both present across first year undergraduate students. The overall pattern of results suggest that the combination of verbal and math self-concept as measured by the PASCI as overall academic self-concept is significantly relate to standardized math achievement above and beyond the dimensions of perfectionism. The maladaptive component of perfectionism was negatively associated with academic self-concept, suggesting maladaptive perfectionist tendencies are most prominently affecting academic self-concept, leading to lower achievement through perception of inadequacy. This study also finds the pattern of low levels of academic self-concept, higher levels of maladaptive perfectionism, and lower math scores to be most salient in women and those who identify as “other” while the more positive pattern of high achievement and positive academic self-concept associating with men. It may be likely that maladaptive perfectionist dimensions serve as an internal or external reference for which women base their self-concept. Further, the influence of parents on participants choice of major was negatively related to academic self-concept, as positively associated with women. This suggests that women are more susceptible to the influence of their parents, and this influence may be reflected in their heightened levels of maladaptive perfectionism and more negative perceptions of ability

### *Limitations*

The current study poses both strengths and limitations with respect to the interpretations of its results. The nature of the self-reported data may have implications to both its validity and reliability (Gregorich, 2006). Convenience sampling was used to recruit participants from a single, mid-sized institution in the southeast, which may limit the generalizability of the results (Heckman, 2010). Additionally, the demographic and overall group characteristics were skewed

within the sample. Specifically, white men and women were overrepresented. The monetary reward participants received likely influenced those who chose to participate in the study. This study was limited by its budget as well as its time constraints. The math exam used in the study reflected knowledge participants may have already studied prior to taking the SAT, thus a mathematics exam reflecting new material may provide different insight into achievement. The sample was too small to detect effects between both gender and major. Thus, looking at gender and major separately.

### ***Future Directions***

Future research should address the low academic self-concept and higher perfectionist tendencies of women as they relate to differences between majors. include first year math grades to compare standardized measures of math performance to course marks, as men are thought to have more advantage in standardize measures of performance, women are more likely to display higher course grades. That is, while men often outperform women, women often achieve higher marks overall (Voyer & Voyer, 2014; Wang & Degol, 2017). While this study did not find significant differences between majors, except for total math score, studies with greater sample sizes may reveal differences not found in the current study. Further, longitudinal methods should be employed to assess the temporal relationships between academic self-concept, perfectionism tendencies, and academic achievement (Marsh, 2006). It has been hypothesized that high-stakes school grades, as opposed to standardized examinations with no relevant academic outcome, will magnify the impact of academic self-concept on academic achievement (Marsh et al., 2005). Therefore, a measure of high-stakes school grades should be considered for future research. Understanding differences in the influence of parents to the formation of academic self-concept

at different time points in an individual's educational pursuit may help tease apart the time points in which the negative effects begin to trickle into academic choice and persistence. Future research would benefit from a larger sample size addressing these differences between gender and major, such as STEM women vs non-STEM women. As this study used a mathematics focus, generalizability of results should be assessed through the lens of other academic domains (Marsh et al., 2005).

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