ROLE OF GRIT AND OTHER FACTORS IN MITIGATING MATH ANXIETY IN COLLEGE MATH STUDENTS

Lori Ogden
West Virginia University
Lori.Ogden@mail.wvu.edu

Marjorie Darrah
West Virginia University
Marjorie.Darrah@mail.wvu.edu

Monica Leppma
West Virginia University
Monica.Leppma@mail.wvu.edu

Math anxiety refers to feelings people get when facing computational challenges. The fear of failure often causes people to avoid activities, like taking challenging mathematics courses or choosing majors that require mathematics. Grit describes how people persist or persevere in the wake of failure. This article looks at factors that contribute to a person having grit and the interaction of grit and math anxiety. Students (N = 258) enrolled in college math classes at a large university completed a set of surveys that indicated their levels of self-compassion, mindfulness, self-efficacy, math anxiety, and grit. The analyses of the data found that grit predicted math anxiety, and that self-compassion, mindfulness, and self-efficacy predicted grit. The results of this study suggest that promoting factors that help students develop grit can in turn affect their math anxiety and thus their persistence in mathematics courses and STEM majors.

Keywords: grit, math anxiety, self-efficacy, mindfulness, self-compassion

Many countries do not produce enough science, technology, engineering, and mathematics STEM majors to keep up with the demand for STEM workers (Langdon et al., 2011; Peri et al., 2014; van den Hurk et al., 2019). It is important to understand what contributes to STEM avoidance and lack of success in STEM majors. Since all STEM majors must take and pass mathematics courses for their major, one factor to STEM retention is success in mathematics. Although mathematics education is quite different from country to country, the pervasiveness of the effects of math anxiety on performance stands out in many parts of the world (Foley et al., 2017). Foley et al. (2017) point out how math anxiety must be considered when trying to increase mathematics achievement, which is important for STEM success.

Researchers have been examining ways to address math anxiety through non-academic interventions (Beilock & Maloney, 2015; Brunyé et al., 2013). Factors such as grit, mindfulness, self-compassion, and self-efficacy have established associations with anxiety, well-being, resilience, and academic achievement (Jarukasemthawee et al., 2021; Neff et al., 2005; Neff & Germer, 2013; Tubbs et al., 2019). However, research is needed to better understand the correlates of grit, particularly in relation to math anxiety. Therefore, our first aim was to assess the validity of grit as a predictor of math anxiety. Our second aim was to determine whether self-efficacy, self-compassion, and mindfulness were associated with grit. Our research questions were as follows:

1. How does grit affect math anxiety?
2. What roles do self-efficacy, self-compassion, and mindfulness have in predicting grit?

Background

What is Grit? Angela Duckworth has been credited with identifying grit as a trait that should be studied within an academic setting. She and her colleagues attempted to answer the question, "Why do some individuals accomplish more than others of equal intelligence?" (Duckworth et al., 2007, p. 1087). They define grit as persistence or perseverance in the wake of failure. In other words, students with grit see academic success as a purpose worth pursuing. Academic success may entail

Lamberg, T., & Moss, D. (2023). *Proceedings of the forty-fifth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol. 2). University of Nevada, Reno.

a long and sometimes bumpy road, but gritty students do not give up easily (Duckworth, et.al., 2007). Grit is explained as a two-dimensional concept that includes *consistency of interest* and *perseverance of effort* (Duckworth, et. al., 2007; Duckworth & Quinn, 2009). Six individual studies that focused on grit as a predictor of academic success concluded that level of education influenced grit, grit intensified with age, undergraduate students with higher levels of grit earned higher GPAs, and grit predicted retention better than self-control among cadets during their first summer at West Point (Duckworth, 2007)

Some researchers have found stronger relationships between student success and the perseverance of effort component of grit than with consistency of interest (Bowman, et. al., 2015; Cross, 2014; Hodge et. al., 2016). A study of Australian university students revealed that first-generation college students had higher levels of grit, specifically in perseverance of effort, and that effort predicted student productivity and student engagement (Hodge et al., 2016). Meta-analytic synthesis of grit literature conducted by Crede and Tynan (2017) further discussed the lower-order facets of grit; perseverance and consistency and agreed that perseverance of effort played a larger role in student achievement than did consistency of interest. Furthermore, they argued that perseverance should be considered a distinct construct apart from grit. Another meta-analysis by Lam and Zhou (2019) also supported this notion. In addition, they pointed to the need for additional research focused on which grit facets affect academic learning outcomes and suggested teachers identify and foster strategies that promote grit through both sustained effort and the development of academic interest. They questioned whether grit is something that can be taught and invited researchers to further explore this notion.

How is Grit Related to Math Anxiety? Sheila Tobias (1976) coined the phrase "mathematics anxiety." This first article discussed the dread, powerlessness, paralysis, and mental disorder that occur in people with this condition. Most students have the cognitive ability to carry out a mathematical task successfully, but their fear and anxiety regarding math get in the way (Tobias, 1991). Cognitive researchers have established an important relationship between negative emotions, such as anxiety, and academic performance. Wang et al. (2015) uncovered an intriguing relationship between math anxiety and math performance in motivated individuals; high and low levels of anxiety both had a negative relationship with performance and moderate levels of math anxiety had a positive association with effective performance.

Math anxiety not only affects performance in math but also affects motivation and interest in the subject (Beilock et al., 2015). Lack of success in math courses frequently affects students' persistence in college and may even affect their motivation or interest in pursuing STEM-related degrees. Since math anxiety is associated with poorer performance in math (Henslee & Klein, 2017) and math anxiety may cause capable students to avoid math classes, this can affect the number of students preparing for much-needed STEM-related occupations (Beilock et al., 2015).

Researchers are beginning to demonstrate that personality factors influence the development of math anxiety (Beilock et al., 2015; Brunyé et al., 2013). Some agree that to reduce math anxiety it is important to foster a student's strength in facing obstacles (Mammarella et al., 2018; Ramirez et al., 2018). A positive response to setbacks (Ramirez et al., 2018) and higher levels of resilience (Mammarella et al., 2018) are beneficial to alleviate math anxiety. Holtby (2018) claims there is a lack of evidence about how grit relates to math anxiety but found a significant negative correlation between grit and math anxiety. In that study, students who exhibited greater dedication to the pursuit of long-term goals reported feeling less anxiety in relation to their mathematical work.

How is Grit Related to Self-Efficacy? In Bandura's Social Cognitive Theory, self-efficacy is defined as "how well one can execute courses of action required to deal with prospective

situations" (Bandura, 1982). Bandura's theory also implies connections between self-efficacy, cognitive functioning and achievement, claiming that if a person believes they can perform well then they will view a difficult task as something they can achieve, rather than something they must avoid (Bandura 1993, Bandura 1996). Self-efficacy has also been related to motivation and positive attitudes in mathematics (Czocher, Melhuish et al., 2020). Honicke and Broadbent (2016) suggest that people with higher self-efficacy possess skills and attitudes that support achievement and success, for example, they found a correlation between self-efficacy and self-regulatory learning strategies. Self-efficacy has also been shown to influence the effort students put toward learning and their ability to persist, thus having an effect on their achievement (Mohammadyari, 2012). Alhadabi & Karpinski (2020) found that people who had more grit and high self-efficacy had high expectations for themselves and commonly set mastery goals for themselves. Those researchers found that the grit dimensions of consistency of interest and perseverance of effort are positively related to self-efficacy.

How is Grit Related to Self-Compassion? Self-compassion consists of three components: the ability to be kind to oneself regardless of circumstances, the acceptance of imperfection as an inevitable aspect of the human condition, and the mindful awareness of thoughts and feelings (Neff, 2003). Self-compassion's association with grit has yet to be explored in STEM education. According to our search of the literature, only sports psychology research has started to examine the relationship between self-compassion and grit to improve athletes' wellbeing and performance. Doorley et al. (2022) suggested that because self-compassion promotes healthy responses to stressful events, it seems to have features similar to grit.

Research has shown that self-compassion is associated with positive psychological functioning. For example, Neff et al. (2007) established a positive correlation between self-compassion and optimism, personal initiative, and curiosity and exploration. Moreover, higher levels of self-compassion are associated with decreased levels of difficulties in aspects of emotion regulation in college students, such as goal-directed behavior, impulse control, and emotional responses (Meyer & Leppma, 2019). Neff and Germer (2013) also demonstrated a negative relationship between self-compassion and psychological distress (e.g., depression, anxiety, and stress). Self-compassion also has a negative relationship with math anxiety in college students (Leppma & Darrah, 2022).

How is Grit Related to Mindfulness? Mindfulness is defined as the intentional, nonjudgmental awareness of the present moment (Kabat-Zinn, 2003). Mindfulness was shown to be positively related to improved emotion regulation (Meyer & Leppma, 2019) and inversely related to depression, anxiety, and anxiety symptom severity (Tubbs et al., 2019) in college students. Raphiphatthana et al. (2018) theorized that because mindfulness is associated with improved coping abilities, it may promote the ability to persevere and work through obstacles to reach a long-term goal, which is the definition of grit (Duckworth et al., 2007). Although mindfulness seems to be an antecedent to grit, very little research exists exploring the relationship between mindfulness and grit. We found only three studies to date. The first is the study by Jarukasemthawee et al. (2021) mentioned above. In the second, Raphiphatthana et al. (2019) compared associations between mindfulness and grit for Western and non-Western university students. Their findings indicated that mindfulness was associated with grit in both cultures; however, there was a stronger association in Western university students. In the final study, 343 undergraduates completed an online survey, and 74 of those participants completed the survey again 4.5 months later to assess a potential longitudinal relationship between mindfulness and grit (Raphiphatthana et al., 2018). Results indicated that mindfulness predicted an increase in grit, which was maintained over time. The authors concluded that mindful individuals tend to be

grittier. They suggested that non-judgmental awareness of the present moment may facilitate sustained interest in long-term goals.

Methods

Participants included 258 students, 68 students were enrolled in College Algebra with co-requisite and 190 were enrolled in the course without co-requisite. Of the students that reported, 233 were in a STEM major, the others were in various fields. Not all respondents completed every scale of the survey. For the analysis of each scale, we used all respondents who completed that scale. Student placement into College Algebra courses (co-requisite or non-co-requisite) is based on their SAT/ACT Math scores or how they performed on a Math Placement Exam (ALEKS). The co-requisite course focused on prerequisite skills including operations on real numbers and simplifying algebraic expressions, and also metacognitive skills such as mindfulness, coping with math and test anxiety, and self-compassion.

The research took place at a large public research university upon institutional review board approval. The participants in the project were a convenience sample of students who were enrolled in college algebra in the fall semester of 2020. The university offers college algebra and college algebra with a co-requisite support course for students with lower entrance scores. Students in both versions of the courses were asked to participate in the research study. All 494 students enrolled in the course were sent a survey near the 3rd week of the semester through email and offered five bonus points for completing it. The response rate for the survey was 52.2% (258/494). The following instruments were used to collect the responses:

- The Abbreviated Mathematics Anxiety Rating Scale (AMARS; Alexander & Martray, 1989),
- Grit-S (Duckworth & Quinn, 2009),
- Self-Efficacy for Learning and Performance Subscale (SELPS) from the Motivated Strategies for Learning Questionnaire (MSLQ) for College Students (Pintrich & De Groot, 1990),
- Five Facet Mindfulness Questionnaire (FFMQ; Baer et al, 2006), and
- Self-Compassion Scale-Short Form (SCS-SF; Raes et al., 2011).

Results

Data Analyses/Power Analyses

Power analyses were calculated and it was determined that the minimum sample size for multiple regression with a medium effect size, alpha level of .05, power of .90, and three predictors was 99. Our total sample size was much higher at 258. Simple linear regression was used to analyze research question 1. For research question 2, we used hierarchical multiple regression. The order of variables entered into the hierarchical multiple regression was based on empirical support (Pallant, 2020). In block 1, we entered self-efficacy due to its strong support regarding math engagement and achievement in the literature (Samuel & Warner, 2019). We entered self-compassion in block 2. Our data demonstrated a higher correlation between self-compassion and grit than mindfulness and grit. In addition, research indicates that self-compassion is frequently a mediator between mindfulness and other variables (Neff, 2016). Thus, we entered mindfulness in block 3. (See Table 1 for correlations).

Table 1: Correlations for Study Variables

	Variable	1	2	3	4
1	Grit	--	.383*	.394*	.356*
2	Self-Efficacy	.383*	--	.338*	.278*
3	Self-Compassion	.394*	.338*	--	.549*
4	Mindfulness	.356*	.278*	.559*	--

*p < .001

Research Question 1: Does grit have an impact on math anxiety?

Linear regression was used to evaluate the ability of grit to predict levels of math anxiety. A scatterplot indicated a linear relationship between the variables and homoscedasticity and normality of the residuals was detected. The model was significant. Math anxiety = 112.35 + (-1.72). F (1, 234) = 46.69, p < .001. Grit was negatively related to math anxiety and accounted for 17% of the variance. (See Table 2).

Table 2: Math Anxiety Simple Linear Regression

Grit	B	95% CI for B		SE B	ß	R2	ΔR2
Model						.172	.169
Constant	112.35***	99.77	124.92	6.38			
Grit	-1.72***	-2.21	-1.24	.25	-.415***		

*p < .05. **p < .01. ***p < .001.

Note: Model = Enter method in SPSS Statistics; B = unstandardized regression coefficient; CI = confidence interval; LL = lower limit; UL = upper limit, SE B = standard error of the coefficient; ß = standardized coefficient; R2 = coefficient determination; ΔR2 = adjusted R2.

Research Question 2: Do Self-Compassion, Mindfulness, and Self-Efficacy predict Grit?

Hierarchical multiple regression was used to better understand grit and assess the ability of self-efficacy, self-compassion, and mindfulness to predict levels of grit. To ensure no violations of assumptions of normality, linearity, multicollinearity, and homoscedasticity, preliminary analyses were conducted. In Step 1, self-efficacy was entered, and it explained 14.7% of the variance in grit. In Step 2, self-compassion was entered, and it explained 22.6% of the variance. In Step 3, mindfulness was entered. The variance explained by this model was 24.4%, F(3, 230) = 24.46, p < .001. (See Table 3).

Table 3: Hierarchical Regression Final Model

Grit	B	95% CI for B		SE B	β	R2	ΔR2
Model		LL	UL			.244	.234
Constant	12.62***	9.53	15.71	1.57			
Self-Efficacy	.13***	.07	.19	.03	.27***		
Self-Compassion	.13**	.04	.21	.04	.21**		
Mindfulness	.03*	.01	.06	.01	.17*		

*p < .05. **p < .01, ***p < .001.

Note: Model = Enter method in SPSS Statistics; *B* = unstandardized regression coefficient; CI = confidence interval; *LL* = lower limit; *UL* = upper limit, SE B = standard error of the coefficient; β = standardized coefficient; R^s = coefficient determination; ΔR^2 = adjusted R^s.

Discussion

This study seeks to establish relationships among self-compassion, mindfulness, self-efficacy, math anxiety, and grit. This article attempts to bring understanding to the correlates of grit and its role in math anxiety. The idea is to ultimately test interventions that may have beneficial effects on the variables. In this article we consider data collected three weeks into the semester shortly before the first exam and before any intervention was implemented.

Findings from the present study indicate an inverse relationship between grit and math anxiety in college students. This result aligns with Holtby's (2018) similar findings in an investigation of grit, coping, and math anxiety in elementary school students. In a study of 56 students enrolled in Grades 4, 5, and 6, Holtby found a significant negative correlation between grit and math anxiety. Although further research is needed, these findings taken together with the present study's findings suggest that understanding and increasing correlates of grit may be helpful in fostering resilience and perseverance in students by reducing math anxiety.

Findings also support our hypothesis that as self-compassion, mindfulness, and self-efficacy are higher this will predict higher levels of grit. The analysis of this student data corresponds to the conclusions in Alhadabi and Karpinski (2020) who found that grit dimensions (G-CI and G-PE) correlate positively with self-efficacy in university students (N = 258). Our results further align with Jarukasemthawee et al. (2021), who found statistically significant positive relationships between grit and self-compassion and grit and mindfulness in 320 Thai national athletes. Contrary to our findings, however, their findings suggested a direct relationship between mindfulness and grit but an indirect relationship between self-compassion and grit, mediated by self-regulation. A possible explanation for this is the different context and population. In two studies examining grit specifically in undergraduate university students, researchers found that increased mindfulness predicted increased grit (Raphiphatthana et al., 2018; Raphiphatthana et al.), which correspond with our findings. Our study is novel in that it also found that self-compassion was a predictor of grit in college math students. Based on our findings, students who have higher levels of self-efficacy, mindfulness, and self-compassion tend to be grittier.

Conclusions

Most math educators do not suffer from math anxiety and in turn may have trouble relating to students who do. Furthermore, those who teach mathematics courses may not know how to advise students who are searching for ways to mitigate their anxiety. Research suggests that non-cognitive factors, such as math anxiety, can hinder students' abilities in math (Henslee & Klein, 2017). Our findings suggest that implementing interventions aimed to increase self-efficacy, mindfulness, and self-compassion can increase grit in students. However, we realize that math instructors must understand this connection and more importantly how to intervene through the introduction of specific practices that include mindfulness and self-compassion. Since instructors establish classroom norms, the success of these types of interventions is tied to instructor buy-in and training. Professional development for those who are teaching entry-level math courses is critical to the success of interventions designed to affect a student's mindset.

This study provides empirical support for grit as a predictor of math anxiety. Our findings also provide insight into correlates of grit. Self-efficacy, mindfulness, and self-compassion all predicted

grit. Understanding and addressing these factors can provide educators with helpful direction in developing grit in students and reducing math anxiety that impedes the progress of many students. As a next step after finding these connections, we have begun to develop interventions that we believe will help to reduce math anxiety. The interventions are in the form of online modules students work through either for homework or in class that contain a short description of the topic, video, and open-ended questions for reflection. These modules are on topics including grit, math anxiety, mindfulness, self-compassion, and growth mindset. We are in the process of testing them with students to determine their effectiveness at reducing math anxiety and increasing student persistence and performance. Future research will explore mechanisms, interventions, and effectiveness in a broader population.

References

Alexander, L., & Martray, C. (1989). The development of an abbreviated version of the Mathematics Anxiety Rating Scale. Measurement and Evaluation in Counseling and Development, 22(3), 143-150. https://doi.org/10.1080/07481756.1989.12022923

Alhadabi, A., & Karpinski, A. C. (2020) Grit, self-efficacy, achievement orientation goals, and academic performance in University students, International Journal of Adolescence and Youth, 25(1), 519-535, https://doi.org/10.1080/02673843.2019.1679202

Baer, R. A., Smith, G. T., Hopkins, J., Krietemeyer, J., & Toney, L. (2006). Using self-report assessment methods to explore facets of mindfulness. Assessment, 13(1), 27-45. https://doi.org/10.1177/1073191105283504

Bandura, Albert (1982). Self-efficacy mechanisms in human agency. American Psychologist, 37 (2): 122–147. https://doi.org/10.1037/0003-066X.37.2.122.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. Educational psychologist, 28(2), 117-148.

Bandura, A. (1996). Failures in self-regulation: Energy depletion or selective disengagement?. Psychological Inquiry, 7(1), 20-24.

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. Policy Insights from the Behavioral and Brain Sciences, 2(1), 4-12.

Bowman, N. A., Hill, P. L., Denson, N., & Bronkema, R. (2015). Keep on truckin'or stay the course? Exploring grit dimensions as differential predictors of educational achievement, satisfaction, and intentions. Social Psychological and Personality Science, 6(6), 639-645.

Brunyé, T. T., Mahoney, C. R., Giles, G. E., Rapp, D. N., Taylor, H. A., & Kanarek, R. B. (2013). Learning to relax: Evaluating four brief interventions for overcoming the negative emotions accompanying math anxiety. Learning and Individual Differences, 27, 1-7. https://doi.org/10.1016/j.lindif.2013.06.008

Credé, M., Tynan, M. C., & Harms, P. D. (2017). Much ado about grit: A meta-analytic synthesis of the grit literature. Journal of Personality and social Psychology, 113(3), 492.

Cross, T. M. (2014). The gritty: grit and non-traditional doctoral student success. Journal of Educators Online, 11(3), n3.

Czocher, J. A., Melhuish, K., & Kandasamy, S. S. (2020). Building mathematics self-efficacy of STEM undergraduates through mathematical modelling. International Journal of Mathematical Education in Science and Technology, 51(6), 807-834.

Doorley, J. D., Kashdan, T. B., Weppner, C. H., & Glass, C. R. (2022). The effects of self-compassion on daily emotion regulation and performance rebound among college athletes: Comparisons with confidence, grit, and hope. Psychology of Sport & Exercise, 58, 1-11. https://doi.org/10.1016/j.psychsport.2021.102081

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: perseverance and passion for long-term goals. Journal of personality and social psychology, 92(6), 1087.

Duckworth, A. L., & Quinn, P. D. (2009). Development and validation of the Short Grit Scale (GRIT–S). Journal of personality assessment, 91(2), 166-174.

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The Math Anxiety-Performance Link: A Global Phenomenon. Current Directions in Psychological Science, 26(1), 52–58. https://doi.org/10.1177/0963721416672463

Henslee, A., & Klein, B. (2017). Using brief guided imagery to reduce math anxiety and improve math performance: A pilot study. Journal of STEM Education, 18(4).

Hodge, B., Wright, B., & Bennett, P. (2018). The role of grit in determining engagement and academic outcomes for university students. Research in Higher Education, 59(4), 448-460.
Holtby, N. M. (2018). Grit, Coping, and Math Anxiety: Examining the Pathways Through Which Devotion to Long-Term Goals May Promote Student Well-Being (Doctoral dissertation).
Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. Educational Research Review, 17, 63-84.
Jarukasemthawee, S., Pisitsungkagarn, K., O'Brien, W., Manley, H., & Pattanamontri, C. (2021). Relationships between mindfulness, self-compassion, and grit among Thai national athletes: The mediating role of self-regulation. International Journal of Sport and Exercise Psychology. https://doi.org/10.1080/1612197X.2021.2010230
Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: past, present, and future. Clinical Psychology: Science and Practice, 10(2), 144-156. https://doi.org/10.1093/clipsy/bpg016
Lam, K. K. L., & Zhou, M. (2019). Examining the relationship between grit and academic achievement within K-12 and higher education: A systematic review. Psychology in the Schools, 56(10), 1654-1686.
Langdon, D., McKittrick, G., Beede, D., Khan, B., & Doms, M. (2001). STEM: Good jobs now and for the future. ESA Issue Brief# 03-11. US Department of Commerce.
Leppma, M., & Darrah, M. (2022). Self-efficacy, mindfulness, and self-compassion as predictors of math anxiety in undergraduate students. International Journal of Mathematical Education in Science and Technology, 1-16.
Mammarella, I. C., Donolato, E., Caviola, S., & Giofrè, D. (2018). Anxiety profiles and protective factors: A latent profile analysis in children. Personality and Individual Differences, 124, 201-208.
Meyer, L. P., & Leppma, M. (2019). The role of mindfulness, self-compassion, and emotion regulation in eating disorder symptoms among college students. Journal of College Counseling, 22, 211-224.
Mohammadyari, G. (2012). Comparative study of relationship between general perceived self-efficacy and test anxiety with academic achievement of male and female students. Procedia-Social and Behavioral Sciences, 69, 2119-2123.
Neff, K. (2003). Self-compassion: An alternative conceptualization of a healthy attitude toward oneself. Self and identity, 2(2), 85-101. https://doi.org/10.1080/15298860309032
Neff, K. (2016). The self-compassion scale is a valid and theoretically coherent measure of self-compassion. Mindfulness, 7, 264-274. https://doi.org/10.1007/s12671-015-0479-3
Neff, K., & Germer, C. (2013). A pilot study and randomized control trial of the Mindful Self-Compassion program. Journal of Clinical Psychology, 69(1), 28-44. DOI: 10.1002/jclp.21923
Neff, K. D., Hsieh, Y. P., & Dejitterat, K. (2005). Self-compassion, achievement goals, and coping with academic failure. Self and Identity, 4(3), 263-287. https://doi.org/10.1080/13576500444000317
Neff, K. D., Rude, S. S., & Kirkpatrick, K. L. (2007). An examination of self-compassion in relation to positive psychological functioning and personality traits. Journal of research in personality, 41(4), 908-916.
Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS. Routledge.
Peri, G., Shih, K. Y., & Sparber, C. (2014). Foreign STEM workers and native wages and employment in US cities (No. w20093). National Bureau of Economic Research.
Peterson, C. H., Casillas, A., & Robbins, S. B. (2006). The student readiness inventory and the big five: Examining social desirability and college academic performance. Personality and Individual Differences, 41(4), 663-673. https://doi.org/10.1016/j.paid.2006.03.006
Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. Journal of Educational Psychology, 82(1), 33. https://doi.org/10.1037/0022-0663.82.1.33
Raes, F., Pommier, E., Neff, K. D., & Van Gucht, D. (2011). Construction and factorial validation of a short form of the self-compassion scale. Clinical Psychology & Psychotherapy, 18(3), 250-255. https://doi.org/10.1002/cpp.702
Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. Educational Psychologist, 53(3), 145-164.
Raphiphatthana, B., Jose, P. E., & Chobthamkit, P. (2019). The association between mindfulness and grit: An east vs. west cross-cultural comparison. Mindfulness, 10, 146-158. https://doi.org/10.1007/s12671-018-0961-9
Raphiphatthana, B., Jose, P., & Salmon, K. (2018). Does dispositional mindfulness predict the development of grit? Journal of Individual Differences, 39(2), 76-87. https://doi.org/10.1027/1614-0001/a000252
Samuel, T. S., & Warner, J. (2019) I can math! Reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students. Community College Journal of Research and Practice. https://doi.org/10.1080/10668926.2019.1666063
Tobias, S. (1976). Math anxiety: Why is a smart girl like you counting on your fingers. Ms, 5(1), 56-59.

Tobias, S. (1991). Math mental health: Going beyond math anxiety. College Teaching, 39(3), 91-93.
Tubbs, J. D., Savage, J. E., Adkins, A. E., Amstadter, A. B., & Dick, D. M. (2019). Mindfulness moderates the relation between trauma and anxiety symptoms in college students. Journal of American College Health, 67(3), 235-245. https://doi.org/10.1080/07448481.2018.1477782
van den Hurk, A., Meelissen, M. & van Langen, A. (2019) Interventions in education to prevent STEM pipeline leakage. International Journal of Science Education, 41:2, 150-164, https://doi.org/10.1080/09500693.2018.1540897
Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y. & Petrill,
S. A. (2015). Is math anxiety always bad for math learning? The role of math motivation. Psychological science, 26(12), 1863-1876.