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Tiffany L. S. Tovey
University of North Carolina at Greensboro, tlsmi32@uncg.edu

Stephanie Kelly
North Carolina A&T State University, sekelly@ncat.edu

Wiley Brown
North Carolina A&T, wsbrown@ncat.edu

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Tiffany L. S. Tovey
Educational Research Methodology Department
University of North Carolina at Greensboro

Stephanie E. Kelly
Business Information Systems & Analytics
North Carolina A&T

Wiley S. Brown
Business Information Systems & Analytics
North Carolina A&T

Corresponding Author: Tiffany L. S. Tovey, tlsmi32@uncg.edu

ABSTRACT

The importance of quantitative literacy in business education cannot be overstated. A barrier to enhancing quantitative skills for many business majors is their math anxiety, an angst some individuals experience when working with numbers. This study explored the relationship between math anxiety, locus of control, and impostor phenomenon in business students. 220 business students (undergraduate and graduate) from a two moderately sized southeastern universities in the United States participated in an online survey that assessed these three phenomena. A linear regression was run to understand the relationships among the variables. The results indicated that more than one fifth of math anxiety was accounted for by students' belief in the influence of their success and their fear of being outed as incapable. As locus of control becomes more external, math anxiety increases, and as feelings of impostor syndrome increase, so too do feelings of math anxiety. Implications of this study, including tips for recognizing and overcoming locus of control and impostor phenomenon issues are highlighted, areas for future research in business education are outlined, and limitations to the study are addressed.

Keywords: math anxiety, locus of control, impostor phenomenon

Quantitative literacy is a skill all future professionals must be equipped with (Kelly & Tovey, 2022). The ability to interpret and communicate data is a requirement permeating all fields of industry (Pan et al., 2018). It is the responsibility of business educators to create a future workforce that can withstand the exponential reliance on data and interpreting data using analytics in everyday business functions (Kelly & Tovey, 2022). According to Cardenas-Navia and Fitzgerald (2015), "data-analytics-enabled individuals with discipline-specific expertise who can turn data into understanding will be increasingly critical to the ability of government, businesses, and nonprofits to implement data-driven decision making" (p. 28). Graduates entering the workforce today need to have at least a basic understanding of mathematics and statistics in order to be effective business professionals; however, a major area of concern for

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business educators and industry is the lack of quantitative skills seen in new business majors (Cardenas-Navia & Fitzgerald, 2015; Cronin & Carroll, 2015; Pan et al., 2018; Singh et al., 2017).

Math anxiety is a barrier to students' success in quantitative reasoning courses (Kelly et al., 2015). When students have to devote their working memory resources to managing their anxiety symptoms, they have less working memory to focus on the quantitative reasoning task at hand (Morsanyi et al., 2014; Shaikh, 2013). This lack of working memory resources means that students who are perfectly capable of doing well at math struggle to perform well as their anxiety symptoms occupy their cognitive resources.

To avoid these stresses, students often avoid quantitative courses when they lack confidence in their ability to perform well in class (c.f., Singh et al., 2017). For business, this means that students with high math anxiety are likely to avoid classes such as data analytics, economics, accounting, finance, and statistics, which refine their quantitative reasoning skills in connection to business problems. As such, students that aspire to a career in business are likely to be less prepared for the demands of the modern workforce than students with low math anxiety who are not driven to avoid such training as a method of managing their anxiety.

Math anxiety, locus of control, and impostor phenomenon have been studied mostly separately in the literature. According to Sightler and Gravely Wilson (2001), it appears that those who believe that activities or events in their lives are externally caused (external locus of control) have higher feelings of fraudulence in their successes. In addition, low self-confidence has been identified as a definitional component of math anxiety (Rubinstein et al., 2015), a trait highly attached to impostor phenomenon-related feelings (e.g., Hoang, 2015; Langford & Clance, 1993).

No research has focused specifically on the relationships between locus of control, impostor phenomenon, and math anxiety together. The purpose of the current research is to add to the body of literature on these topics through understanding how impostor phenomenon and locus of control contribute to experiences of math anxiety among business majors.

Math Anxiety

Numbers are important in everyday life (Choi et al., 2020). Unfortunately, a fairly common occurrence when dealing with numbers is math anxiety, the angst that comes from working with numbers. Math anxious individuals tend to avoid quantitative courses and have negative views about math (Ashcraft, 2002), which influences both their educational and career choices. Math anxiety is often described as the feeling of tension, fear, or otherwise apprehension that comes along with the prospect of working with numbers, often interfering with math performance (e.g., Choi et al., 2020; John et al., 2020; Kelly et al., 2015; Rubinstein et al., 2015). Symptoms of math anxiety include physiological symptoms, like increased heart rate, as well as psychological symptoms, such as the inability to concentrate, feelings of helplessness, and shame.

Math anxiety can be mild or severe and can also occur in both formal (e.g., classroom) and informal (e.g., checkbook balancing) quantitative reasoning settings (Ashcraft, 2002; John et al., 2020). In quantitative reasoning courses, math anxiety has been found to be negatively related to students'

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feelings of perceived immediacy with their instructors, and those who are low in self-efficacy beliefs and high in math anxiety are less likely to participate in the classroom (Johnson & Kelly, 2020; Kelly et al., 2015).

According to Perry (2004), "math anxiety stems primarily from students' fears of failure and feeling of inadequacy" (p. 321). Some scholars have even included low self-confidence as a definitional component of math anxiety (e.g., Rubinstein et al., 2015). Choi et al. (2020) recently found math anxiety to be a predictor of both performance on math problems (objective numeracy) and perceived math ability (subjective numeracy). In short, much of students' ability to perform quantitative reasoning tasks is predicted by their belief about their skill at working with numbers (Necka et al., 2015).

Impostor Phenomenon

Sometimes, beliefs about one's abilities contradict the skill level that others observe. To be an impostor is to be posing as someone inauthentically. The impostor phenomenon, the internal feeling of being incompetent, a sense of fraudulence, and self-doubt in one's abilities and accomplishments, has been a popular topic of investigation in recent decades (Hoang, 2015; Langford & Clance, 1993; Leary et al., 2000; Mak et al., 2019). Those experiencing impostor phenomenon believe that their successes could be attributed to luck or other external factors, rather than their own personal abilities, and have difficulty internalizing accomplishments. According to the literature, individuals with impostor phenomenon feel that others see them as more competent than they see themselves and that they will be "found out" (Hoang, 2015; Leary et al., 2000).

Impostor phenomenon is related to anxiety, depression, introversion, needing to look smart to others, and unsupportive family relationships (Langford & Clance, 1993). Schubert and Bowker (2017) examined impostor phenomenon longitudinally in relation to self-esteem and found a negative relationship between self-esteem and impostor phenomenon, but a positive relationship between impostor phenomenon and self-esteem instability. In other words, those with low self-esteem and unstable self-esteem are more susceptible to impostor phenomenon than those who have a stable high self-esteem. As noted by Schubert and Bowker (2017), individuals in such conditions are predisposed to critical self-doubt, and in situations of personal achievement, may have feelings of impostor phenomenon.

Similarly, Cokley et al. (2018) looked at the mediating effect of self-esteem on perfectionism and impostor phenomenon and found that self-esteem partially mediated the relationship between the two variables. Interestingly, when looking at perfectionism via Slaney et al.'s (2001) measure, the subscale "discrepancy," which measures the discrepancy between standards set for oneself and actual goal achievement (i.e., maladaptive perfectionism), discrepancy had a positive direct and indirect effect on impostor phenomenon through self-esteem. The relationship between maladaptive perfectionism and impostor phenomenon was further explained by Pannhausen et al. (2020), who found that components of perfectionism, such as doubts about one's own performances, fear of failure, and high standards contribute to impostor phenomenon in high performers. Those with maladaptive perfectionism tendencies tend to be high in impostor phenomenon.

Locus of Control

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Locus of control refers to individuals' perceptions of the extent to which they have control over the outcomes of activities and events in their lives (Bodill & Roberts, 2013). Specifically, those with an internal locus of control attribute outcomes to their own effort and behavior, where those with an external locus of control attribute outcomes to luck or other external and situational factors. Recently, Bodill and Roberts (2013) found that the more strongly one believes that intelligence is unchanging (fixed mindset) is positively associated with external locus of control and negatively associated with how many hours per week a student will study. Similarly, Arslan and Akin (2014) examined the relationship between metacognition, the capacity of an individual to be critically aware of their own thought processes, and locus of control, and found that as metacognitive awareness increases, external locus of control decreases and internal locus of control increases. Those who are higher in metacognitive awareness are more likely to attribute the outcomes of events to internal factors.

Locus of control beliefs impact stress, anxiety, and performance. de Carvahlo et al. (2009) found a relationship between life stress and locus of control in students, such that greater external loci were associated with greater stress. Nordstrom and Segrist (2009) reported that students who apply to graduate school have a higher internal locus of control, and that locus of control was the largest predictor of the likelihood of going to graduate school. In addition, Carden et al. (2004) found that students with an internal locus of control were lower in academic procrastination and debilitating test anxiety, while higher in academic achievement as compared to those with an external locus of control. Finally, Curtis and Trice (2013) found that locus of control was related to grade point average, number of absences, sense of academic entitlement, procrastination, anxiety, and depression.

A 2001 study by Sightler and Gravely Wilson is the only investigation that brings locus of control and impostor phenomenon together in the research literature. Sightler and Gravely Wilson (2001) examined multiple correlates of impostor phenomenon among graduate entrepreneurs, including stress, work impact on family life, locus of control, and tolerance for ambiguity. They found that higher impostor phenomenon scores were related to a more external locus of control.

Given the impact of locus of control and impostor beliefs about abilities, this study seeks to understand how these variables interact with math anxiety. Therefore, the following research questions are proposed:

> **RQ1:** Is math anxiety related to impostor phenomenon and locus of control among business majors?
> **RQ2:** If so, how much variance in business majors' math anxiety is accounted for by their locus of control and impostor phenomenon?

Method

Participants

In total, 220 business students participated in this study. All attended one of two moderate size universities in the Southeastern U.S. that offered bachelors and masters degrees in business. Participants' majors broke down as follows: 52 management, 33 business information

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technology/systems, 27 accounting, 26 economics, 21 business education, 23 marketing, 23 supply chain management, 9 business analytics, and 6 finance. Among participants 34 were first-year, 39 were second-year (sophomores), 66 were third-year (juniors), 59 were fourth-year (seniors), and 22 were masters students. Participant sex broke down as follows: 87 males and 133 females. The average age of participants was 22.38 (*SD* = 4.49) years old.

Procedure

Upon institutional review board approval, the researchers emailed personal contacts who were business instructors and professors at two separate universities in the southeastern U.S., requesting that they share a link to an online questionnaire with their students. This method of solicitation resulted in 144 completed questionnaires. An additional 80 participants were recruited through link sharing in Qualtrics to eligible participants who were business majors at a university in the U.S. This link directed students to an informed consent document so students who chose to enter the questionnaire had to first acknowledge their consent. Completion of the questionnaire required approximately 10 minutes.

Instrumentation

Before utilizing any of the measures to address the research questions, each was subjected to confirmatory factor analysis (CFA) to check the hypothesized factor structure against the observed factor structure. Items that showed a statistically significant amount of residual error were removed before research question testing. Problematic items were removed one at a time, prioritizing items that yielded statistically significant residual error on the greatest number of items. Measures were respecified after each removal. The fit statistics for the original and modified measures can be found in Table 1. The descriptive statistics for the utilized measures can be found in Table 2.

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Table 1
Fit Statistics

		GFI	CFI	RMSEA	SRMR
Original	Math Anxiety	.99	1.00	.00	.01
	Locus of Control	.69	.65	.44	.04
	Impostor Syndrome	.89	.93	.17	.04
Modified	Locus of Control	.92	.93	.10	.05
	Impostor Syndrome	.95	.98	.11	.02

Table 2
Descriptive Statistics

	Range	Mean	*SD*	Skewness	Kurtosis	α
Math Anxiety	1.00-7.00	3.45	1.69	.24	-.83	.92
Locus of Control	1.67-7.00	4.38	1.12	-.21	-.23	.86
Impostor Syndrome	1.00-7.00	2.55	1.51	.80	-.17	.94

Math Anxiety. Math anxiety was measured through Kelly et al.'s (2015) measure. The measure is composed of six Likert-type items with a 7-point response ranging from *Low Anxiety* to *High Anxiety.* Kelly et al. (2015) report that the measure has excellent content validity. No items indicated statistically significant residual error during CFA, and therefore none were removed.

Impostor Phenomenon. Impostor phenomenon was assessed through Leary et al.'s (2000) assessment. The measure is composed of seven Likert-type items with a 7-point response scale ranging from *Not at all characteristic of me* to *Extremely characteristic of me.* One item yielded a statistically significant amount of residual error and was removed from the measurement model.

Locus of Control. Locus of control was assessed through Craig et al.'s (1984) assessment. The authors report that the measure has good predictive and concurrent validity. The measure has 17 Likert-type items with 7-point response scales ranging from *Disagree Strongly* to *Agree Strongly*. Through the CFA process, eight items were removed. No evidence could be found to indicate that this measure has ever been subjected to CFA previously. Given that, it is unsurprising that a large number of items needed to be removed, as scholars simply did not have the statistical tools to calibrate social science measures in the 1980's that are available today (Croucher & Kelly, 2019). Higher scores on this scale indicate a more internal locus of control.

Results

As one last check of the data before running analyses, data were tested for moderation across demographic characteristics of sex, class rank, and major. No statistically significant differences were found across any group of participants for any of the three variables. Specifically, an independent samples t-tests found no statistically significant differences by gender across imposter syndrome [*t*(221)

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= -.20, p =.84], math anxiety [t(221) = .88, p =.38], or locus of control [t(221) = .42, p =.68]. There was also no statistically significant difference across class rank for impostor syndrome [F(4, 219) = .52, p = .72], math anxiety [F(4, 219) = .73, p = .57], or locus of control [F(4, 219) = .74, p = .56]. Finally, there was no statistically significant difference across majors for imposter syndrome [F(8, 215) = 1.02, p = .42], math anxiety [F(8, 215) = 1.34, p = .23], or locus of control [F(8, 215) = 1.66, p = .11]. Therefore, the hypotheses can be tested treating the data as a cohesive group.

To address the research questions, first Pearson correlations were run. The correlation matrix can be seen in Table 3. Math anxiety was moderately negatively related to locus of control, which means that the more internal a students' locus of control, the less math anxiety they had. Math anxiety had a moderate positive correlation with impostor syndrome, meaning that the more a student was prone to feeling like an impostor, the more math anxiety they were likely to have.

To better observe the amount of variance in math anxiety accounted for by locus of control and impostor syndrome simultaneously, a linear regression was run. Both impostor phenomenon [β = .35 (p < .001)] and locus of control [β = -.21 (p = .003)] were statistically significantly related to math anxiety. As shown with the correlations, the higher a student's math anxiety, the higher their impostor phenomenon and the more external their locus of control. The regression showed that combined, impostor syndrome and locus of control accounted for 24% of the variance in students' math anxiety (r^2 = .24). As such, these student characteristics account for almost a quarter of all variance in a business major's anxiety from working with numbers.

Table 3
Correlation Matrix

	1	2
1. Math Anxiety		
2. Locus of Control	-.40*	
3. Impostor Syndrome	.46*	-.54*

*p < .001

Discussion

Findings from this study suggest that roughly a fourth of math anxiety is accounted for by business majors' belief in their success being external (i.e., locus of control) and their fear of being outed as incapable (i.e., impostor phenomenon). The more external locus of control students reported, the higher their math anxiety. Likewise, the more impostor phenomenon, the higher the math anxiety. Given that high quantitative reasoning is a necessity for future business professionals (Cardenas-Navia & Fitzgerald, 2015; Kelly & Tovey, 2022), math anxiety is critical for students to recognize and manage, otherwise it prevents them from being successful in their chosen major and later in their chosen career.

Business instructors have a key role to play in recognizing both impostor phenomenon and locus of control in their students, as well as in helping them to overcome their confidence and self-efficacy issues. This will help students to not only succeed in their quantitative reasoning courses, but also equip

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them to become better and more capable business professionals. The following sections share strategies for spotting both locus of control and impostor phenomenon in students, as well as strategies for helping students to combat these forces.

Recognizing Locus of Control and Impostor Phenomenon Issues

It is important to know the signs of impostor phenomenon and locus of control so that instructors can assist their students in overcoming these issues. One way that business faculty can identify when students need assistance internalizing their locus of control is by examining their communication style. Martin et al. (1999) explain that there are five motives that can drive a student to communicate with their professor:

- Relational: Seeking to build an interpersonal relationship with the instructor that will last after the class is over.
- Functional: Needing assistance to be successful in the course.
- Participatory: Informing the professor that they are involved with the class and material.
- Sycophantic: Currying favor with the professor through flattery.
- Excuse-making: Providing reasons that work is either incomplete or completed poorly.

Students who regularly engage in obvious sycophantic or excuse-making motives of communication are likely to have an external locus of control (Kelly, 2013; Myers et al., 2002). Because students with an external locus of control believe that the professor ultimately has more control over their grade than their own efforts, they are likely to engage in sycophantic or excuse-making communication to endear themselves to the professor or create sympathy in hopes of influencing the professor's decision about their grade.

Similarly, students will also display impostor phenomenon through their communication. Individuals who suffer from impostor phenomenon will diminish their accomplishments and state that they believe others are more capable (Barr-Walker et al., 2019), show verbal and nonverbal signs of high trait anxiety (Sakulku & Alexander, 2011), compare themselves to their classmates, or have irrational feelings of unpreparedness in their studies (Hoang, 2015). As such, students will disclose their own external locus of control and impostor phenomenon struggles to their professor if the professor is paying attention to the indirect messages that signal these conditions.

Helping Students Internalize their Locus of Control and Decrease their Impostor Phenomenon

Instructors are responsible for the development and reinforcement of behaviors associated with academic success (e.g., Nordstrom & Segrist, 2009). Thus, business educators need to provide space and opportunities for healthy dialogue among students and faculty for understanding how these phenomena influence their work (e.g., Hoang, 2015), and to promote behaviors that can help to overcome external locus of control and impostor feelings. Some suggested behaviors for overcoming impostor phenomenon ideations as well as increasing internal locus of control include:

- **Promote Reflection and Self-Awareness:** Help students to think about themselves, their own interests, and their own performance and engagement with math through intentional reflective activities. The process of intentional reflection on oneself in context (through journaling or any other mode) is called reflective practice (e.g., Bolton & Delderfield, 2018), and this technique can help

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students find the cause of their self-doubts.

- **Facilitate positive self-talk**: Help students reframe self-talk to be self-affirming and not self-deprecating (Prentiss, 2021). For example, if a student says, "I'm not good with numbers," correct them by saying, "You don't think you're good with numbers, but we both know you're smart."
- **Enhance self-efficacy**: Break big tasks into smaller parts, providing feedback along the way to help students see that they *can* tackle the job one step at a time (Margolis & McCabe, 2006).
- **Celebrate successes**: Provide opportunities for celebration of accomplishments and taking space to correctly attribute those accomplishments to personal hard work and effort (Margolis & McCabe, 2006).
- **Create space for sharing with others**: Debunking these negative feelings through the creation of spaces for dialogue and authentic communication around similar experiences students (and even instructors!) have (Prentiss, 2021). Recognizing that people should not feel alone with their feelings is key to overcoming struggles associated with self-doubt and anxiety.

Instructors can provide students with the language to talk about their perceived control and impostor feelings and facilitate intentional efforts to overcome the traps of not feeling responsible for their performance or not feeling like they are "good" at working with numbers.

Limitations

This study was limited in a few ways. First, though theoretical rationale exists for the assumption that locus of control and impostor phenomenon affect student anxieties (c.f., Arslan et al., 2009; Sakulku & Alexander, 2011), this study is based upon cross-sectional data and cannot truly ascertain that math anxiety is affected by the other variables in the study, only that they are related. Second, this study was based on a convenience sample, weighted toward upperclassmen and females. Future research should strive for a probability sample.

Future Research

This study serves as the foundation for several avenues in business education research. First, in terms of practical intervention studies, business education researchers should explore the influence of the above-highlighted classroom strategies on students' perceptions of their locus of control and feelings of being an impostor, especially as these relate to course outcomes and workforce preparation. While prior research indicates that these interventions should be effective, it is important to test these assumptions and work to refine the practices.

Second, there is a need to better understand the influential causes of math anxiety, impostor phenomenon, and locus of control. It is possible that locus of control and impostor syndrome both cause math anxiety. Else, it is possible that each of these variables are caused by other influences such as stereotype threat, confidence, perceived/actual competence, or self-efficacy. Understanding the root cause of math anxiety is key for finding corrective interventions (Kelly et al., 2015).

Finally, future research in business education needs to test the reliability of these findings. It is important to understand if these findings are replicated among students in different university types, degree majors, and cultures. It is also important to see if the measurement noise seen here is replicated

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among varied samples to help guide researchers in their refinement of the measurement tools (Croucher & Kelly, 2019).

Conclusion

The purpose of this study was to explore the relationship between math anxiety, locus of control, and impostor phenomenon among business majors. In order to create a workforce ready for the 21st century, that can handle the massive amounts of information and data analytics in everyday life, business educators need to provide students with tools for success aimed at decreasing impostor feelings and increasing internal locus of control. Students need to feel capable and responsible for their quantitative reasoning skills, and instructors can help to facilitate behaviors geared toward success. Dialogue, reflection, and education around topics of impostor phenomenon and locus of control as well as behaviors for increased self-efficacy and task management can help business education students to be successful in their 21st century business education.

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