



EXPLORING THE EFFECT OF COLORING MANDALAS ON STUDENTS' MATH ANXIETY IN BUSINESS STATISTICS COURSES

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Abstract. *Purpose* – the purpose of this article is to review a quasi-experiment study examining whether business students' math anxiety is reduced after participating in mandala coloring activities.

Research methodology – the research methodology integrated quantitative methods including independent t-tests and ANOVAs in a non-random convenient sample of 106 undergraduate students in 2018 in Texas, United States.

Findings – results from the one-way ANOVA and t-test analyses revealed that anxiety levels differed across groups, such that after coloring a pre-drawn mandala, math anxiety was significantly reduced in comparison to the control (doodling) group. Paired sample t tests also demonstrated that when comparing the anxiety levels at the baseline and post-treatment, math anxiety was reduced after performing both the pre-drawn and free-coloring mandala activities. Additionally, an independent sample t-test and a two-by-two factorial ANOVA demonstrated that males experienced a significant reduction in their math anxiety than the females did after performing the mandala coloring activity.

Research limitations – the study used a convenient sample, self-reported items, and a math anxiety measurement. Also, the findings found short-term evidence of math anxiety.

Practical implications – the findings of this study suggest that business statistics instructors who integrate a mandala coloring activity in anxiety-provoking undertakings may help to reduce their students' math anxiety.

Originality/Value – This study is the first to investigate mandala coloring to reduce math anxiety in business students. Unlike previous studies that focus on anxiety in general, this study examines the benefit of mandala coloring on students' math anxiety.

Keywords: business statistics, math anxiety, mandala art therapy, college students.

JEL Classification: CO2.

Introduction

According to the National Association of Colleges and Employers (NACE) (2016) employers in today's job market continue to expect business alumni to possess problem-solving skills and statistical analytical skills. As such, employers expect employees to apply statistics and

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data analysis as part of their jobs as business professionals (Phillip & Schultz, 1994). To fulfill this expectation, accredited colleges of business across the United States integrate business statistics as part of their curriculum to develop students' critical thinking, analytical, and problem solving skills (Palocsay & Markham, 2014). However, often times, students perceive business statistics courses to be irrelevant to their majors and careers, and as a result, avoid applying statistics and data analysis in their everyday jobs upon graduation (Philip & Schultz, 1994; Swanson, Meinert, & Swanson, 1994). Students' performance in business statistics courses is low in comparison to other business courses such as business communication because the course appears to be too difficult, unpleasing, and intimidating (Swanson, Meinert, & Swanson, 1994). Undergraduate students often experience math anxiety in business statistics courses, which impact their overall performance in the course (Zanakis & Valenzi, 1997). Cruise and colleagues (1985) define math anxiety as the "feelings of anxiety encountered when taking a statistics course or doing statistical analyses, that [includes] gathering, processing, and interpreting data." Math anxiety occurs when individuals experience fear when thinking or doing mathematical activities and applications in academic contexts (Ashcraft, 2002). For example, math anxiety can be induced when calculating and solving mathematical problems, and when manipulating numbers (Luttenberg, Wimmer, & Paechter, 2018). Math anxiety continues to be prevalent in four-year institutions with 25% of university students reporting experiencing high levels of math anxiety (Yeager, 2012). As such, business statistics instructors face challenges in coping with their students' math anxiety toward business statistics courses, which negatively impacts the learning process.

Several research studies have examined math anxiety in statistics courses in higher education. Correlational studies have found an inverse link between statistical test anxiety and students' GPA and performance in statistics courses (Benson, 1989; Zeidner, 1991). Additionally, math anxiety has been shown to be inversely correlated to statistical test anxiety (Sime, Ansoorge, Olson, Parker, & Lukin, 1987). Also, a study by Zanakis and Valenzi (1997) found that high math anxiety was linked to poor grades in statistics courses. Students' negative attitudes and math anxiety toward business statistics courses also impact their overall final course grade, for instance, students with high math anxiety earn lower grades (Lalonde & Gardner, 1993). To add, students' anxiety toward math experiences in business statistics courses result in poor confidence and low motivation to participate in the course (K. D. Hopkins, B. R. Hopkins, & Glass, 1996). Students who suffer from math anxiety also tend to procrastinate adopting effective learning activities (e.g., studying for exams, reading), which could make them successful in statistics courses (Onwuegbuzie, 2004). Thus, math anxiety has been shown to have negative learning outcomes in students enrolled in statistics courses.

To reduce individuals' anxiety, an innovative art therapy approach has been implemented using *mandalas* in the fields of psychology, art education, counselling, nursing, and the medical field. A mandala is a sacred circle with various designs derived from Tibetan Buddhism to promote "psychological healing and integration" in individuals (p. 149). In psychology, Carl Jung used the act of drawing a mandala to calm and heal patients that have dealt with trauma or traumatic incidents (Jung, 1973). Jung's (1973) mandala approach is supported by the psychoanalytic theory, which states that engaging in a creative process by drawing and/or coloring a symmetrical mandala induces positive cognitive and emotional

benefits because of its ability to calm the “inner chaos” of individuals’ emotional states. Studies have shown that mandala drawing and coloring has led to reduced anxiety in a variety of contexts in individuals that have faced dissociative disorders (Cox & Cohen, 2000), ADHD (Smitherman-Brown & Church, 1996), dementia (Couch, 1997), and post-traumatic stress disorder (PTSD) (Henderson, Rosen, & Mascaro, 2007).

In higher education contexts, several experiments have been conducted to determine mandalas’ calming effect on university students. For instance, Curry and Kasser (2005) examined the effectiveness of mandala coloring, plaid coloring, and free-form/unstructured coloring on undergraduate psychology students, and found that both mandala and plaid-design coloring significantly reduced the anxiety of the students because engaging in an art therapy activity (i.e., structured coloring of a complex and symmetrical geometric pattern) may induce a meditative state. After this study, Small (2006) extended Curry and Kasser’s work by implementing the concept of spirituality by having participants engage in a brief synopsis of a religious ritual across different religions (i.e., Buddhism, Hinduism) along with the mandala coloring activity among other conditions (mandala coloring, plaid-design coloring, and free-coloring/unstructured condition), and found that both traditional mandala coloring and spiritual ritual mandala coloring reduced students’ anxiety. Additionally, Kersten and van der Venet (2010) performed a single-subject experiment by inducing students’ anxiety using a brief writing exercise, and then having students color a pre-drawn or structured mandala to reduce their anxiety. In a replication of these previous studies, van der Venet and Serice (2012) compared 50 undergraduate and graduate psychology students that colored the pre-drawn or structured mandala and colored a plaid design, and found that college student participants that colored the pre-drawn mandala reported reducing their anxiety. Another study also found that coloring pre-drawn mandalas reduced undergraduate students’ state and trait anxiety levels (Sandmire, Gorham, Rankin, & Grimm, 2012). Additionally, a total of 93 counseling students enrolled in graduate school reported significantly reducing their situational anxiety levels after completing a mandala coloring activity, suggesting that engaging in the creative process may play a role in anxiety reduction (Duong, Stargell, & Mauk, 2018).

In nursing, medical, and psychology health education, studies have found that mandala coloring may enhance students’ mental states and positive psychological attributes. For example, Mahar, Iwasiw, and Evans (2012) examined first-year undergraduate nursing students who completed a mandala coloring activity, and students reported learning to be more reflective of their inner emotions, and indicated positive mood improvement and self-awareness. Another study found that medical students benefited psychologically and emotionally from the mandala coloring process by being able to navigate difficult emotions such as fear and being able to manage stress more effectively through achieving a state of mindfulness and awareness (Potash, Yun Chen, & Yan Tsang, 2016). Another medical study by Powell, Alcorn, and Lindsay (2017) found that coloring a structured mandala was more effective at reducing university students’ stress levels than traditional coloring. More recently, Chen, Liu, Chiou, and Lin (2019) examined the role of mindfulness and flow during the mandala coloring process among 76 university students, who were split into two conditions, high-skill and low-skill in teamwork, and students performed three mandala conditions (i.e., structured mandala, freeform/unstructured mandala, and cooperative mandala) in sequence form, and

found that the mandala activities did not enhance students' mindfulness, but it did improve their flow state. The study also found that the low-skilled group struggled with the free-form mandala activity, but they greatly benefited from engaging in teamwork as they worked together in a cooperative mandala (Chen et al., 2019). To date; however, no study has examined whether coloring mandalas has an effect on students' math anxiety levels in business statistics courses. Thus, the purpose of this study is to investigate whether math anxiety is reduced by engaging in an art therapy activity such as free coloring an unstructured mandala or coloring a pre-drawn (structured) mandala.

1. Literature review

1.1. Mandala art therapy and anxiety reduction

Mandalas have been used as an art therapy tool to help individuals reduce their own anxieties. Carl Jung (1973) used drawing mandalas or "sacred circles" as a healing, calming behavior among his patients who suffered from traumatic events. After this discovery, art psychotherapists have been adopting mandala art therapy to calm and reduce anxiety of individuals with several psychological conditions including ADHD, depression, and schizophrenia (Cox & Cohen, 2000; Smitherman-Brown & Church, 1996). In 2005, Curry and Kasser examined the effect of mandala drawing in reducing individuals' anxiety levels using mandala-drawing and plaid-form drawing intervention activities, and found that mandala drawing reduced individuals' anxieties. Another experimental study found that anxiety and trauma levels were reduced by drawing and coloring a mandala in comparison to random drawing on a blank sheet of paper (control condition) (Henderson, Rosen, & Mascaro, 2007). Follow up replication studies also confirmed that coloring pre-drawn mandalas reduced individuals' anxiety (Kersten & van der Venet, 2010; van der Venet & Serice, 2012). Moreover, Sandmire, Gorham, Rankin, and Grim (2012) performed a similar mandala intervention study, but using undergraduate university students a week prior to final examinations. The study found a significant decrease in both state and trait anxiety levels in the free-form coloring mandala group (Sandmire et al., 2012).

Other mindfulness studies have examined mandala coloring and its impact on anxiety with additional mindfulness tasks. For instance, Mantzios and Giannou (2018) examined whether a mindfulness guided mandala coloring activity would have an effect on anxiety, and found that college students reduced their anxiety after coloring a structured mandala as a guide instructed them about the coloring process, but it did not enhance their mindfulness state given the distraction of having an instructional guide. Also, Cross and Brown (2019) found that coloring a structured mandala, free-drawing, and engaging in a focused breathing exercise significantly improved students' mindfulness and positive affect, and they also reduced participants' anxiety levels.

Additionally, studies have found a link between mandala coloring and the reduction of test anxiety. First, Carsley, Heath, and Fajnerova (2015) found that the mandala pre-drawn coloring intervention reduced elementary students' test anxiety in comparison to the free doodling control condition. Next, Carsley and Heath (2019) assessed the pre-posttest scores

of university students' test anxiety and state mindfulness, and found that after performing the pre-drawn (structured) mandala coloring activity, it decreased university students' test anxiety, and increased their state mindfulness. Additionally, Burton and Baxter (2019) found that when comparing coloring a mandala for 20 minutes to visiting with other participants (control group), occupational therapy students in the coloring group significantly reduced their test anxiety in comparison to the control group.

Most recently, researchers have been investigating the physiological effects of mandalas on anxiety. For example, Muthard and Gilbertson (2016) examined the physiological effects (e.g., blood pressure, pulse) of mandala coloring paired with a breathing exercise on undergraduate students' negative affect, state anxiety, and psychological stress, and results showed that both negative affect and state anxiety were significantly reduced in the pre-drawn mandala-coloring experimental group in contrast to the control group, which sat quietly for seven minutes. Additionally, Lee (2018) conducted an experimental study using physiological measures (e.g., pulse rate) comparing the effects of freely coloring a mandala, coloring a mandala with present colors, free drawing a mandala within a preset circle, and coloring a rectangular grid with preset colors. Results from the physiological data showed that the three mandala conditions were more effective at anxiety reduction in comparison to coloring the rectangular figure due to the "centering effect," or the mindfulness state that occurs when coloring within a circle (Lee, 2018). As demonstrated by prior research, there is clear evidence that mandala coloring may reduce individuals' anxiety levels.

While researchers have conducted intervention studies to reduce math anxiety in university students, no previous research has examined the effect of mandala coloring on math anxiety in university-level business students in business statistics courses. Previously, research findings have found that math anxiety reduction strategies such as expressive writing (Park, Ramirez, & Beilock, 2014), visualization (Henslee & Klein, 2017), positive thinking (Arem, 2009), and relaxation (Husni, 2007) have been effective at reducing math anxiety in university students. The literature; however, has not addressed whether coloring mandalas is an effective strategy to reduce math anxiety. To address this gap in the literature, this study will replicate the experimental methodology of previous studies (e.g., Curry & Kasser, 2005; Sandmire et al., 2012) by examining the effects of a) coloring a pre-drawn mandala, b) coloring a free-form mandala using a blank circle, and c) free doodling on a white sheet of paper (control condition) on math anxiety. As such, the following hypothesis will be examined.

H1: Students participating in the pre-drawn and coloring mandala conditions will reduce their math anxiety to a higher extent than those in the control condition.

1.2. Mandala art therapy, sex, and anxiety reduction

For the past three decades, the literature has been controversial in regards to sex differences in math anxiety among university students. Early cross-sectional studies confirmed that female students exhibited more anxiety about statistics courses than the male students did (Benson, 1989; Zeidner & Safir, 1989). Later studies also found that females experienced higher levels of anxiety regarding the mathematical components of statistics courses in comparison to males (Bradley & Wygant, 1998; Hembree, 1990; Onwuegbuzie, 1995, 1998; Roysse

& Rompf, 1992; Zeidner, 1991; Pèrez-Tyteca, Castro Martínez, Rico Romero, & Castro Martínez, 2011; Alacam, 2018). However, a handful of studies have found no sex differences in anxiety levels in statistics courses (Baloglu, 2001, 2003; Howard & Warnick, 2016). As such, while both males and females experience math anxiety, there is some evidence that females experience anxiety toward math to a higher extent.

Interestingly, studies that state sex differences, report specific differences in math anxiety in statistics courses, such as calculating with statistical formulas and solving problems with numbers (Hembree, 1990). Cognitive-based studies have found that one explanation for the sex differences in math anxiety in statistics courses is due to a cognitive difference in spatial processing ability, which involves mental rotation abilities in working with numbers or non-linguistic symbols (Gardner, 1983; Maloney, Waechter, Risko, & Fugelsang, 2012; Sokolowski, Hawes, & Lyons, 2019). Another study surveyed university students about their math anxiety regarding specific mathematics activities such as adding, subtracting, multiplying, and working with arithmetic equations, and found that males had lower math anxiety than did the females; yet reported more positive attitudes toward solving mathematical problems than the females did (Rubinsten, Bialik, & Solar, 2012). Additionally, other studies that found evidence of math anxiety sex differences indicated that the reason might be that females are more likely to self-report anxiety in comparison to males (Ashcraft & Faust, 1994; Zettle & Houghton, 1998; Bieg, Goetz, Wolter, & Hall, 2015). A more recent study by Fullerton and Umphrey (2016) found that female university students majoring in advertising were more aversive and anxious toward statistics and mathematics in comparison to males, in part because of self-perceived gender stereotypes about the mathematical problem-solving process. Also, females might also be likely to suffer from the stereotype threat effect that suggests that females are socialized to believe that females are not “good at math,” and as a result, suffer from math anxiety and poor math performance (Pèrez-Garín, Bustillos, & Molero, 2017).

While multiple studies have documented sex differences across statistics courses in areas of psychology, sociology, education, and mathematics, there is a need to examine sex differences of undergraduate business students in business statistics courses. To date, only two studies have examined gender differences in math anxiety in business students. Currie (2014) found that female undergraduate business students exhibited higher math anxiety levels in comparison to male business students. More recently, Alacam (2018) examined undergraduate students by major (including business), and found that female business students exhibited higher math anxiety levels and higher emotional negativity toward mathematics in comparison to male business students. Despite this initial evidence across undergraduate studies, math anxiety continues to be understudied in the area of business statistics education. As a result, this study seeks to examine sex differences among business students enrolled in business statistics courses after participating in a mandala coloring activity including coloring a pre-drawn mandala and a free-coloring a mandala. It is expected that business students' math anxiety will be reduced after the mandala coloring activity; however, given prior research, it is expected that even after the mandala coloring activity, sex differences in math anxiety in business statistics courses will remain. As such, the following hypothesis is posed.

H2: Women will report higher math anxiety levels than the men do after participating in a mandala coloring activity.

2. Method

2.1. Mandala art therapy and anxiety reduction

Participants of this quasi-experimental study were a nonrandom convenient sample consisting of 106 (64 men, 42 women) undergraduate students enrolled in Statistics for Business and Economics, an entry-level business statistics course at a medium-sized university in the U.S. Southwest. Participants' age ranged between 18 to 45 years of age ($M = 21.03$, $SD = 0.49$). The ethnic identification of the participants included 56.6% Caucasian, 32.1% Hispanic, 4.7% African-American, 3.8% Asian-American, and 2.8% Other. The academic majors of participants included 18.9% accounting, 1.9% economics, 22.6% finance, 10.4% computer information systems, 17.9% management, 12.3% marketing, 9.4% general business, and 6.6% other. Of the participants 31.1% indicated being first generation students.

Upon institutional review board approval, participants were recruited with the permission of three Business Statistics for Business and Economics courses. Instructors provided a small portion of extra credit to the students whom agreed to participate in the study. Students from these three courses were surveyed and placed into three, non-random groups: Control ($n = 40$), Pre-Drawn Mandala ($n = 35$), and Free-Coloring Mandala ($n = 31$). Each group participated in a writing assignment, which served to induce math anxiety in students.

2.2. Procedures

This study employed similar procedures implemented by the research protocol of previous researchers including Curry and Kasser (2005) and van der Venet (2012). This quasi-experiment was designed to measure students' math anxiety during the baseline (Time 1), then an anxious mood about mathematics was induced using a writing exercise. After the exercise, students were measured for math anxiety (Time 2). Afterwards, participants participated in a coloring activity depending on their treatment group (control, coloring mandala) and their math anxiety was measured after the coloring activity (Time 3).

After securing institutional review board approval, instructors who were currently teaching Statistics for Business and Economics were contacted from the college of business via email. Once instructors' approval was obtained, the researcher administered the paper-based questionnaire in their face-to-face classrooms at the end of their class session. The interested participants were asked to sign an informed consent form. Then, students completed a 30-minute six-part questionnaire. First, participants completed their demographic information in three minutes. Second, participants completed the math anxiety questionnaire for another four minutes. Third, participants participating a four minute free writing exercise that enabled students to write about a time they felt high levels of math anxiety at school. Participants were encouraged to elaborate on their feelings about the experience. Fourth, participants completed the math anxiety questionnaire once again for another four minutes. Fifth, depending on the treatment group, participants were told to engage in a 15-minute coloring activity using a sheet of paper using coloring pencils. In the control condition, participants were told to doodle anything they wanted on the blank sheet of paper. In the pre-drawn mandala condition, participants were told to color the pre-drawn (structured)

mandala that included a complex, symmetrical geometric pattern using colored pencils (See Figure 1). In the free-coloring (unstructured) mandala condition, participants were told to create their own mandala by coloring within a blank and black circle using colored pencils (See Figure 2). Sixth, participants completed the math anxiety assessment for four minutes after the completion of the coloring activity. The conceptual process of the mandala approach along with its connection to university students' anxiety levels is illustrated in Figure 3. Also, a small amount of extra credit was provided to the participants by their instructors in exchange for participating in the study.

2.3. Instrumentation

The Math Anxiety Rating Scale-Revised (MARS-R) developed by Hopko (2003) was used to measure students' math anxiety in business statistics courses. This 12-item scale has been revised and validated amongst other anxiety-related instruments such as the Learning Math Anxiety (LMA) and Math Evaluation Anxiety (MEA) Scales (Hopko, 2003). Sample items include, "having to use the tables in the back of a math book," "being told how to interpret probability statements," and "reading and interpreting graphs or charts." Participants assess



Figure 1. Pre-drawn structured mandala design (Retrieved from www.colormandala.com)



Figure 2. Free-coloured unstructured mandala (student coloured on a blank circle)

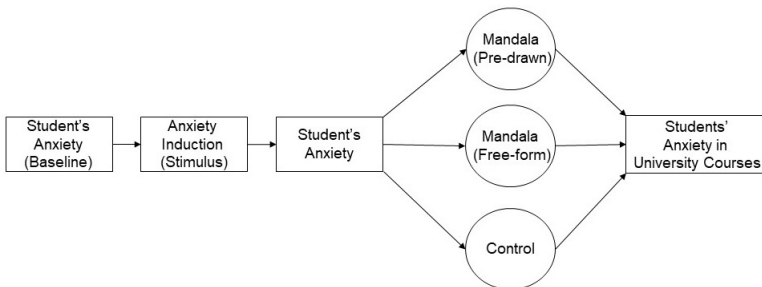


Figure 3. Conceptualization of the mandala approach on students' anxiety in university courses

each statement using a scale between 0 (*No Anxiety*) to 4 (*High Anxiety*). This assessment was used for the baseline, pre-, and posttest measures. The alpha reliability of the baseline test was .82, the pre-test was .85, and the post-test was .85.

To induce participants' anxiety after the baseline assessment of the MARS-R, a 4-minute writing exercise developed by Curry and Kasser (2005) was adopted to stimulate students' anxiety prior to the control and experimental conditions. Participants wrote about a previous negative math experience they had encountered in the past.

3. Results

Independent t-tests identified no baseline differences of math anxiety between the pre-drawn mandala ($t = 1.97, p = 0.05$) and the free-colored mandala ($t = 1.94, p = .06$) conditions. The descriptive results between baseline, math anxiety manipulation, and condition based on math anxiety levels are displayed in Table 1. A paired sample t test comparing the baseline (Time 1) with the anxiety induction (Time 2) was conducted to determine if the induction as effective. Results indicated that math anxiety increased after the written induction activity, $t(102) = 25.99, p < .001$. A one-way ANOVA also confirmed that the anxiety levels after the anxiety induction at Time 2 did not differ, $F(2, 104) = 2.61, p = 0.08$, which demonstrated the effectiveness of the math anxiety induction across treatments. Previous research has implemented a similar 4-minute written anxiety induction approach, and in this study, the stimuli was shown to be an effective method to induce university students' math anxiety (Curry & Kasser, 2005; van der Venet & Serice, 2012).

After the written induction activity, a one-way ANOVA revealed that anxiety levels differed across groups, $F(2, 104) = 3.01, p < 0.05$. To test the hypothesis, t tests were conducted to determine the math anxiety level post-treatment differences across the treatments. The pre-drawn (structured) group had a greater reduction of math anxiety ($M = 1.50, SD = 0.76$) than the (doodling) control group ($M = 1.95, SD = 0.67$), $t(102) = 2.18, p < .01$. As such, coloring a structured mandala was more effective at reducing math anxiety than doodling on a white sheet of paper with a mean decrease of 0.45. This finding is consistent with previous analytical findings supporting the theoretical assumption that coloring a structured mandala is an effective mindfulness approach to reduce university students' anxiety in comparison to doodling (control condition) (Curry & Kasser, 2005; van der Venet & Serice, 2012; Carsley & Heath, 2018). However, in the study no significant differences were found in math anxiety levels when comparing the pre-drawn (structured) group and the coloring of the mandala

Table 1. Descriptives of math anxiety levels at T1, T2, and T3, and changes from T3 to T2

Group	n	T1		T2		T3		T3 -T2	
		M	SD	M	SD	M	SD	M	SD
Pre-Drawn Mandala	35	1.67	0.71	1.74	0.69	1.59	0.75	-0.15	0.06
Free Color Mandala	31	1.65	0.79	1.7	0.74	1.58	0.83	-0.12	0.09
Control Group	40	1.99	0.69	2.01	0.68	1.95	0.67	-0.06	0.01

group, $t(102) = -.062, p = .47$. Interestingly, this finding is inconsistent with a previous study by Carsley, Heath, and Fajnerova (2015) suggesting that pre-drawn (structured) mandalas are more effective than free-coloured (unstructured) mandalas. Yet, van der Vennet and Serice (2012) suggested that the centering effect occurs as long as participants are coloring within a circle, whether structured or unstructured. Results of this study also showed that free coloring (unstructured) mandala group participants ($M = 1.58, SD = 0.82$) reduced their math anxiety more than the (doodling) control group ($M = 1.95, SD = 0.67$), $t(102) = 25.99, p < .001$. Participants that completed the unstructured mandala activity by free-coloring within circle reduced their math anxiety with a mean decrease of 0.37 than those who doodled on a sheet of paper. This finding is supported by the previous literature that has found that using an unstructured mandala, or coloring within a black circle, is more effective than the control condition (e.g., doodling) (Sandmire, Gorham, Rankin, & Grimm, 2012). Being able to color within a circle has been shown to produce a meditative or mindfulness state because students are able to express themselves through self-created symbols and shapes within the context of a circle (Sandmire, Gorham, Rankin, & Grim, 2012; Carsley & Heath, 2019).

Paired sample t tests were used to compare the anxiety levels between the baseline (Time 1) and post-treatment (Time 3) across the groups. Results demonstrated that the free-coloring of the (unstructured) mandala group reduced participants' math anxiety when comparing the baseline ($M = 1.65, SD = 0.79$) with the anxiety levels after performing the mandala coloring activity ($M = 1.58, SD = 0.82$), $t(30) = 10.65, p < .001$. Additionally, participants reduced their math anxiety when comparing the baseline results ($M = 1.66, SD = 0.71$) with the math anxiety after performing the pre-drawn (structured) mandala coloring activity ($M = 1.60, SD = 0.75$), $t(34) = 13.43, p < .001$. However, when comparing the baseline math anxiety levels with the control (doodling) activity, participants' math anxiety levels were not statistically significant, $t(34) = 11.99, p = 0.54$. These findings are consistent with previous scholarship that has compared baseline and post-mandala intervention anxiety levels, and found that performing a coloring mandala activity (structured or unstructured) reduced students' anxiety levels given its ability to trigger a meditative or healing state that can calm anxious feelings (Carsley & Heath, 2019; Lee, 2018; Noor, Saleem, Azmat, & Arouj, 2017; van der Vennet & Serice, 2012). Previous research suggests that the process of coloring a mandala (structured or unstructured) itself is a healing process that enables individuals to better manage negative emotions through creativity, visualization, and flow (Green, Drewes, & Kominski, 2013; Potash, Yun Chen, & Yan Tsang, 2016).

To determine if there were sex differences in math anxiety levels after the treatments (e.g., coloring mandala), an independent samples t -test was conducted. Results showed that males ($M = 1.61, SD = 0.74$) reduced their math anxiety to a higher extent than did females ($M = 1.90, SD = 0.75$), $t(104) = 1.91, p < .05$. This finding suggests that when comparing individuals by sex performing a mandala activity (structured or unstructured) may be more applicable to the reduction of males' math anxiety, and this is illustrated in Figure 4. This finding is consistent to the t -test performed by Carsley and Heath (2018), who also found that males reduced their anxiety more so than the women did, in part because males' motor skills may have helped them perform better in the mandala coloring activities.

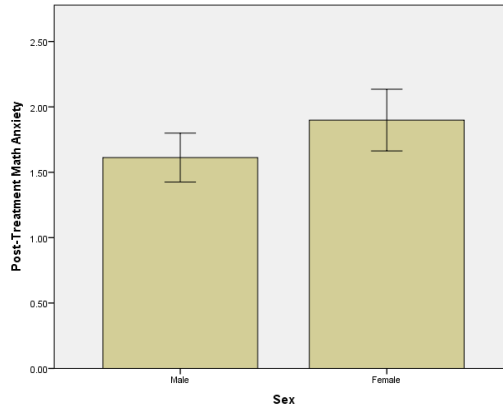


Figure 4. Post-treatment math anxiety mean comparisons by sex with 95% confidence intervals

Additionally, a two-by-two factorial ANOVA was used to explore the effect of sex and activity type (e.g., coloring vs. not coloring) on participants' pre- to post-activity change in math anxiety levels. There was no significant interaction between sex and activity type on math anxiety levels, $F(3, 106) = 4.13, p = 0.52$. However, a main effects analysis revealed that sex contributed to the variation in the pre- to post-activity change in math anxiety. Additionally, a main effect analysis revealed that participating in an activity type contributed to the variation in the pre- to post-activity change in math anxiety (See Table 2). The interaction finding of this study is inconsistent to Carsley and colleagues' (2015) study that found an interaction effect between gender and condition, such that in the free coloring mandala condition male decreased anxiety more in comparison to females. However, in the analysis of Sandmire et al. (2012), they found a similar main effect for activity type; however, in their study they did not find interaction effects between sex and activity, nor a main effect for sex. Also, in the analytical results of Carsley, Heath, and Fajnerova (2015) they did not find a main effect for gender or activity, nor an interaction effect between sex and condition.

Table 2. 2X2 ANOVA for pre- to post-activity change in math anxiety

Source	SS	df	MS	F	p
Sex (Female/Male)	3.25	1	3.25	6.12	0.02
Activity (Coloring/No Coloring)	4.51	1	4.51	8.48	0.01
Sex X Activity	0.22	1	0.22	0.41	0.52
Error	54.23	102	0.53		

4. Discussion

The purpose of this study was to examine the effectiveness of mandala coloring on reducing business students' math anxiety levels, after participating in a math anxiety written exercise in business statistics courses. Results of this study supported the hypothesis that coloring a

pre-drawn or structured mandala with complex, symmetrical geometric patterns and free coloring an unstructured mandala circle for fifteen minutes reduced participants' math anxiety (post-treatment) in comparison to the doodling. The findings of this study replicated Curry and Kasser's (2015) findings, which also reduced participants' anxiety in comparison to doodling on a blank sheet of paper. Previously, Sandmire and colleagues (2012) demonstrated that coloring structured mandalas reduce anxiety in college students, and this study's findings extends this research by providing initial evidence that coloring mandalas may reduce math anxiety in business undergraduate students. Previous studies have confirmed that coloring mandalas calms individuals' anxieties due to its therapeutic and meditative nature (Henderson, Rosen, & Mascaro; 2007; Sandmire et al., 2012). Mandala art activities are effective because they enable individuals to express their inner conflicting emotions and psychological trauma through the expression of symbols, which are often difficult to disclose about with other people, which supports Jung's psychoanalytic theory (Henderson, Rosen, & Mascaro, 2007; Jung, 1973). To add, several studies suggest that coloring mandalas enhance the state of mindfulness; thereby supporting the mindfulness approach, which enables individuals to pay attention and focus on the present moment, which is beneficial in cognitive-based tasks educational contexts (Carsley, Heath, & Fajnerova, 2015; Chen et al., 2019; Potash, Yun Chen, & Yan Tsang, 2016). As such, the findings of this study suggest that coloring mandalas has a short-term effect on students' math anxiety levels; however, additional research needs to continue to examine mandalas' effects on business students.

Additionally, this study provided support of sex differences on the math anxiety levels after performing a mandala coloring activity. In particular, males reduced their math anxiety to a greater extent than did the females after coloring a free-form and pre-drawn mandala than females did. This finding is consistent with Carsley, Heath, and Fajnerova (2015) who found sex differences in anxiety levels among elementary children pre-to-post treatment (e.g., coloring a mandala). Moreover, the math anxiety literature has documented sex differences in university students taking statistics courses (Currie, 2014; Maloney et al., 2012). One reason males might benefit more from coloring mandalas may be due to their ability to become attentive during the coloring process and their ability to achieve a meditative-like state, which helped them reduce their math anxiety levels (Curry & Kasser, 2005). Also, males are more likely to make more coloring mistakes (e.g., coloring outside of the lines); however, they do not judge themselves during the art-creating activity; whereas females are more cautious about making coloring mistakes, which might have contributed to their anxiety levels (Curry & Kasser, 2005). To add, females might have suffered from the stereotype threat effect, which may have impacted their ability to reduce their math anxiety (Pérez-Garín et al., 2017). Because females are socialized to be nurturing and are stereotyped to struggle with mathematics, reducing females' math anxiety might be more difficult in comparison to reducing males' math anxiety (Pérez-Garín et al., 2017).

5. Limitations and future research

The findings of this study need to be interpreted cautiously given the study's limitations. Firstly, this study used a convenient sample of undergraduate business students in statistics

courses, which do not make the findings generalizable to other undergraduate students or courses. It is important to examine whether mandalas' effect on math anxiety applies to other math-based courses in the curriculum of business schools such as finance, accounting, and economics, and other STEM-based schools such as science, technology, engineering and mathematics. Additionally, this study only included the students' anxiety perceptions, and not the instructors' anxiety perceptions. While few studies have examined the effectiveness of coloring mandala activities in the reduction of teachers' stress and anxiety, among their long-lasting teaching experience, mandalas might be beneficial for educators as well (Vitolo, 2018). Future research can begin to implement mandala activities to investigate their effect on teachers' anxiety as well, and among seasoned educators. Secondly, this study's sample was an American or Western region sample, and the findings need to be interpreted with caution because the findings cannot be directly generalized to the educational contexts of other developing countries around the world. Future studies may conduct a cross-cultural analysis to determine whether the findings of this study can be replicated in other developing countries.

Thirdly, this study only self-reported items to examine math anxiety, which might be affected by the social desirability bias, in particular, to avoid confessing inner anxiety about math. Future research may integrate physiological measures such as blood pressure and pulse, to determine whether individuals were physiologically anxious about mathematics in business statistics courses. Fourthly, this study only found initial evidence of the short-term effect on math anxiety. Future researchers may adopt longitudinal designs at different periods within the semester to determine if performing mandala art activities maintain their effect on math anxiety over time. Fifthly, this study was limited in measures, while the only measure of interest in the study was math anxiety, future studies may conduct a mandala intervention along with other similar anxiety constructs such as statistics anxiety, computer anxiety, and test anxiety. Sixthly, researchers may examine whether there are differences in performance by test grades or course grade in business statistics courses by examining pre-to-post anxiety levels.

6. Practical implications

Several implications can be drawn from the findings of this study. To start, business statistics educators may implement a mandala coloring activity in their business statistics or math-based courses to reduce students' math anxiety levels in their students. For instance, instructors may implement the activity before a test or a quiz to reduce their anxieties about the math problem-solving process. Instructors can also include mandala participation assignments within their syllabus. However, implementing the mandala activity at the curriculum-level may be more challenging given the rigid educational curricula of different college and department standards. For instance, business and engineering colleges that are accredited via AACSB and/or ABET might not be able to adapt mandala activities across the curriculum without proper assessment, and without having the mandala activity being linked to a specific course learning objective. Besides, the applicability of the mandala activity has been shown to be most useful to the age threshold of university students between 18 to 59 years of age (Van der Venet & Serice, 2012), and studies have documented the mean age range

of participants to be between 18.8 to 34.2 years of age (Henderson, Rosen, & Mascaro, 2007; Van der Venet & Serice, 2012). As such, the mandala activity is beneficial to university-aged students within those age thresholds.

Moreover, given that sex differences were found in math reduction in the treatment groups, business educators need to recognize the alleviating effect it may have on males in comparison to females. Because females struggle with math anxiety in business courses, educators may need to be mindful of these sex differences in their courses. Furthermore, even though math anxiety continues to be prevalent in business statistics courses, not enough applications are being offered to help students manage their anxiety. Finally, by exploring anxiety-reduction activities such as mandala coloring, students may be better equipped to manage their anxiety, and this may help them overcome perceived cognitive and performance challenges.

Conclusions

Because the prevalence of math anxiety continues to be high in undergraduate students (Yeager, 2012; Zanakis & Valenzi, 1997), adopting a short intervention may help students cope with their anxieties in business statistics courses. The findings of this study provide initial support that introducing an art therapy intervention such as a mandala coloring activity may yield positive benefits such as math anxiety reduction in business students. Instructors of face-to-face business statistics courses may consider adopting an art therapy activity within their course, or prior to anxiety-inducing course activities such as quizzes or exams to help students manage their math anxiety. Given that math anxiety has been shown to be correlated to negative course outcomes such as low motivation and confidence, poor course grades, and a low GPA (K. D. Hopkins, B. R. Hopkins, & Glass, 1996; Lalonde & Gardner, 1992; Zeidner, 1991), additional research needs to examine whether reducing math anxiety with mandala activities prevent negative course performance outcomes. Also, future research is needed to explore factors that might explain why sex differences occurred in this study despite participating in a mandala coloring activity. Business instructors need to be aware of the potential perceived differences in math anxiety among their students, even after a short art therapy intervention. Moreover, the findings of this study warrant future research examinations that investigate whether mandala coloring influences business students' math anxiety and course performance levels.

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