Mathematics Anxiety and Math Instructional Time in Preservice Elementary School Teachers

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Abstract

Math anxiety is a common problem that has numerous adverse impacts, including the avoidance of math-related tasks, classes, and careers. Past studies have shown that teachers with math anxiety may spend less time engaged in math instruction in their classrooms. Reduced instructional time can result in students lagging behind their peers in math skills acquisition. The present study examines the impact of a brief expressive writing intervention on three preservice elementary school teachers with math anxiety. Expressive writing interventions have been successfully used to reduce a wide variety of negative symptoms and also to improve math performance. Through the use of a multiple-baseline, multiple-probe, single-case research design study, the current researchers examined the impacts of three 10-min expressive writing interventions on two variables: levels of math anxiety (as measured by the FS-ANX subscale of the Fennema-Sherman Mathematics Anxiety Scale) and the number of minutes engaged in math instruction. Though results for math anxiety were somewhat encouraging, results for teacher instructional time were mixed. Implications and recommendations for future research are discussed.

Keywords: math anxiety, instructional time, pre-service teachers, elementary school, math instruction

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Mathematics Anxiety and Math Instructional Time in Preservice Teachers

Math anxiety is a widespread phenomenon that can severely restrict people's lives. Individuals who experience math anxiety often avoid advanced math classes and math-related careers. As a result, math anxiety's negative impact extends far beyond individuals; it also robs our nation and world of future contributors to solutions for STEM-related social, medical, and economic problems. For many people, math anxiety begins to develop during their elementary school years. Many schoolteachers themselves are math anxious and can unintentionally pass it on to their students. Interestingly, elementary school teachers have higher math anxiety rates than other teachers.

Recent research has provided tremendous insights related to the practice of teaching and the process of learning. Much more is now known about how knowledge acquisition and retention are impacted by both cognitive and affective factors. Some of these factors include working memory, stereotype threat, past trauma, and self-efficacy beliefs. One phenomenon influenced by all of these elements is the potentially debilitating experience of math anxiety. This equal-opportunity problem can be detrimental to children and adults alike, making teachers as susceptible as their students to its negative impacts. Given this, it is essential to look for potential differences in math instruction provided by teachers with varying degrees of math anxiety.

A review of the literature shows six research areas that are key to understanding the basis for the current study: (a) math anxiety negatively impacts people's lives and career options; (b) many people with math anxiety are actually quite math capable but avoid math classes and related careers after erroneously assuming they are just bad at math; (c) preservice teachers have high rates of math anxiety; (d) teacher math instructional time can impact student academic performance and other outcomes; (e) there is a lack of current research that explores the relationship between preservice teachers' levels of math anxiety and the time they spend on classroom math instruction; and (f) expressive writing interventions show promise for reducing the impacts of math anxiety. After the literature on

the aforementioned points is reviewed, the research questions for the current study will be presented.

A number of researchers have examined the negative impacts math anxiety may have on career choice. The National Council of Teachers of Mathematics (2000) noted that “those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures” (p. 5). Unfortunately, people who are math anxious avoid college majors and careers that rely heavily on math skills (Ashcraft, 2002; Ashcraft & Moore, 2009; Kytälä & Björn, 2010). The impact of math anxiety on career choice also has consequences beyond the individual; as Hembree (1990) notes: “These suggestions have national import; when otherwise capable students avoid the study of mathematics, their options regarding careers are reduced, eroding the country’s resource base in science and technology” (p. 34). This impact is unfortunate, especially given the lack of a direct connection between math anxiety and actual math ability (Ramirez, Gunderson, Levine, & Beilock, 2013).

Many people with math anxiety are actually quite math capable. A recent study found that math anxiety and math performance were not significantly related after controlling for perceived math competence (Erturan & Jansen, 2015). Other studies found that the association between math anxiety and math achievement was not universal and that math anxiety’s impact on working memory can cause temporary retrieval interference during problem solving (Ramirez, Gunderson, Levine, & Beilock, 2013; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2015). Based on these and related studies (Barrouillet & Lépine, 2005; Beilock & DeCaro, 2007; Ma & Xu, 2004), it is reasonable to hypothesize that many people with math anxiety have mistakenly concluded they are less capable at math, not realizing that their math learning and performance could very well improve if their math anxiety were successfully addressed. This information could potentially be life changing for those who suffer from math anxiety.

Preservice teachers frequently have high levels and rates of math anxiety, especially those who plan on teaching at the elementary school level. Gresham (2007) found that in the United States and Australia, preservice teachers experience higher levels of mathematics anxiety than other undergraduate students. Results of an earlier study found that elementary education majors had the highest levels of math anxiety when compared to other college majors (Hembree, 1990). More recently, a study

found that nearly all of the 70 preservice math teachers in the sample had experienced math anxiety at some point (Finlayson, 2014). Researchers Kelly and Tomhave (1985) found that female elementary preservice teachers with math anxiety avoided math at a higher rate than other college seniors. This tendency for math avoidance by those with math anxiety raises the question of whether math anxiety may cause teachers to avoid or reduce the math instructional time they provide to their students. This information could have important implications, given the clear relationship between the amount of instructional time offered and educational outcomes.

The amount of time that teachers engage in the delivery of direct math instruction impacts student academic outcomes. A study in 2010 revealed a positive and highly significant relationship between weekly instructional time and test scores in math, science, and language (Lavy, 2010). The relationship was consistent across primary and middle school levels. Increasing math instructional time also positively impacted math scores in an elementary school in Texas (Shafer, 1998) and resulted in reading achievement gains in secondary school students in Michigan and Indiana (Young, 1980). Findings from a more recent meta-analysis supported increased learning time as a way to improve both the academic achievement and the social-emotional skill development of students at risk of academic failure (Kidron & Lindsay, 2014). Rivkin and Schiman (2015) conducted an empirical analysis examining the impact of instructional time on student performance and found substantial evidence that additional instructional time improves student performance. These research results lead to further questions, and they highlight the need to examine the potential impacts of preservice teacher math anxiety on the amount of time these teachers spend engaging in math instruction.

There is a lack of current research exploring the relationship between preservice teachers' levels of math anxiety and the time spent engaged in math instruction. Most of the existing studies have focused on elementary and first-year teachers. Two earlier studies of note have explored math instructional time and elementary teachers with math anxiety (Bush, 1989; Trice & Ogden, 1986). Bush (1989) found that elementary teachers who were math anxious spent less time fielding student questions than they did providing whole-class math instruction. Trice and Ogden (1986) conducted a study with first-year elementary teachers and found a negative correlation

between the level of teacher math anxiety and the amount of math instructional time they provided each week. Perhaps of even greater importance, they found that students who were in the classrooms with more math-anxious teachers were up to 15 lessons behind their peers in other classes. Though the implications of these studies are large, these studies occurred over 25 years ago and were conducted with in-service teachers, not preservice teachers. Only one study has addressed math anxiety and math instructional time delivered by preservice teachers, and that study was completed decades ago (Trice & Ogden, 1985). Equally sparse are studies examining brief interventions that may help reduce math anxiety in preservice teachers. Because of the importance of instructional time on academic achievement and the previously demonstrated impact of math anxiety on math instructional time provided to students, it is critical to examine interventions that could potentially reduce preservice teacher math anxiety or mitigate the impacts of math anxiety on preservice teachers' time spent engaging in math instruction.

Expressive writing interventions show promise as a way of reducing the impacts of math anxiety. Expressive writing interventions are thought to have a mechanism of therapeutic impact that is similar to traditional exposure therapy (Sloan, Marx, & Greenberg, 2011). Sometimes referred to as written disclosure (WD) or written emotional disclosure (WED), expressive writing has been effectively applied as an intervention for coping with trauma and loss in numerous settings (Bragdon & Lombardo, 2012; Pennebaker, 2000; Pennebaker & Beall, 1986; Sloan et al., 2011). Other studies have revealed the positive impacts of expressive writing activities on such diverse health issues as the management of chronic pain, asthma, and arthritis (Pennebaker, 2000; Smyth, Stone, Hurewitz, & Kaell, 1999) and the improvement of immune functioning (Frattaroli, 2006; Pennebaker, 1989).

A study was conducted in 2011 to examine whether an expressive writing activity would improve the academic performance of high school students with test anxiety. The hypothesis was that an expressive writing activity would reduce "intrusive thoughts and worries," thus freeing up working memory resources and resulting in increased performance on an upcoming test (Ramirez & Beilock, 2011, p. 212). Those who participated in the expressive writing intervention had higher overall test scores compared

to those in the control group. Also of interest was that the students who were most text anxious were the ones who benefited the most from the intervention. The study found that it was expressive writing in particular, not writing in general, that accounted for the improved exam scores (Ramirez & Beilock, 2011). Though test anxiety and math anxiety are distinctively different constructs, they share many similarities, including the impact of the anxiety on working memory and resulting performance tasks (Mavilidi, Hoogerheide, & Paas, 2014; Morsanyi, Busdraghi, & Primi, 2014; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2015).

A study in 2014 examined the use of expressive writing as an intervention for university students with math anxiety (Park, Ramirez, & Beilock, 2014). Results indicated improved math performance after just a single 7-min session of expressive writing directly preceding a test. Taken as a whole, these studies above indicate that an expressive writing intervention can be a successful, efficient, and cost-effective way to reduce math anxiety and increase math performance.

Given the importance of a workforce consisting of individuals with strong math and math-related skills, it is critical to examine how math anxiety in preservice teachers may impact their instructional delivery and thus their future students' learning and life opportunities. It is also important to explore promising interventions for reducing math anxiety in future teachers, especially those who plan to teach students in the foundational elementary school years. The purpose of this study is to address two research questions: (a) What is the impact of a brief expressive writing activity on preservice elementary teacher math anxiety? and (b) What is the impact of a brief expressive writing intervention on math instructional time provided by preservice elementary school teachers with math anxiety?

Method

Design

To address the research questions guiding this study, a single-subject multiple-baseline, multiple-probe design was utilized (Christ, 2007; Horner & Baer, 1978). The principal researcher used an online random number

generator (<http://www.random.org>) to randomly assign baseline lengths of 3, 5, and 7 days, respectively, for Participants A, B, and C. Baseline stability criteria were established by the use of guidelines set forth by Gast and Spriggs (2010) and Perone (1991). The stability envelope criterion was defined as follows: 80% of the baseline data points needed to fall within 20% of the median in order for the baseline to be considered stable. If baseline stability was not reached by the assigned number of baseline data points, the baseline phase continued until either baseline stability as defined by Gast and Spriggs (2010) was evident or until Perone's (1991) fixed time-interval stability criteria were met. The independent variable was an expressive writing intervention following protocols similar to those established by Pennebaker (1989). The dependent variables were (a) math instructional time provided to students by the teacher and (b) teacher math anxiety.

Participants

The participants were three preservice elementary school teachers completing their student teaching on the West Coast. Participants were recruited within a teacher education program at a large research university. The student researcher contacted an instructor at the university and arranged a time to visit and speak to potential participants during a class session. Of the 27 students in the class, nine expressed an initial interest in participating in the study and completed the AMAS (Abbreviated Mathematics Anxiety Scale) screener. Those participants with an AMAS score of 22.9 or above were eligible to participate. Of the nine, all but one qualified for the study, and four agreed to participate. Before the start of the study, one participant withdrew due to scheduling conflicts, leaving a final count of three participants. The study was completed in the fall of 2017.

Participant A. Participant A was a 21-year-old Caucasian female who was student teaching at the elementary level. Her AMAS score was a 25, the lowest of the three participants. She shared that teaching math was a constant stressor for her and sometimes caused increased heartbeat and sweaty palms. She wanted to do what she could to help her students not develop math anxiety.

Participant B. Participant B was a 23-year-old Caucasian female completing her student teaching at the elementary level. Her AMAS score was a 29. She shared that her anxiety increased throughout her school years as the math concepts got more complex over time. She stated that algebra made sense to her, but geometry was more difficult.

Participant C. Participant C was a 26-year-old Caucasian female who was completing her student teaching at the elementary level. She believed her math anxiety and avoidance had begun in the third grade when she was struggling with learning multiplication tables. When talking about her relationship to math, she said, “I hate math,” that it “makes me feel stupid and incompetent,” and that she almost decided not to pursue teaching because of her math anxiety. Her AMAS score was a 30, the highest score of the three participants.

Measures

Abbreviated Mathematics Anxiety Scale (AMAS). The AMAS was used to screen potential participants for qualifying levels of math anxiety for the study. The AMAS is a nine-item, fully anchored, 5-point Likert scale, with response items ranging from 1 (low anxiety) to 5 (high anxiety). The combined score results can range from 9 to 45, with higher scores indicating higher levels of math anxiety. In a large sample of U.S. preservice elementary school teachers, Isiksal, Curran, Koc, and Askun (2009) found a mean AMAS score of 22.9 ($SD = 5.7$). The researchers considered that data, along with information from Morsanyi et al. (2014), and selected 22.9 as the cutoff score for inclusion in the study. There is strong evidence of validity for the AMAS through correlation with a well-established math anxiety measure ($r = .85$; Hopko, Mahadevan, Bare, & Hunt, 2003); it also demonstrates excellent internal consistency (Cronbach’s $\alpha = .90$) and test–retest reliability ($r = .85$ over a 2-week period). The AMAS is well-regarded due to its psychometric soundness and ease of use due to its succinct nine-item scale (Ashcraft & Ridley, 2005, as cited in Eden et al., 2013).

Fennema-Sherman Mathematics Anxiety Scale—Revised: anxiety subscale (FS-ANX). Participants’ levels of math anxiety throughout the baseline and intervention phases were measured using the anxiety subscale (FS-ANX) of the FMAS-R. The FSMAS-R is a nine-item, two-factor scale

designed for use in classroom-based settings as a way to measure math anxiety (Lim & Chapman, 2013; Ren, Green, & Smith, 2016). The FSMAS-R includes two subscales: EASE (four items related to feelings of ease with mathematics) and ANX (five items related to anxiety with mathematics). Psychometric data for the FSMAS-R is favorable, with subscales displaying good internal consistencies ($\alpha = .90$) as well as satisfactory test-retest reliability over a 1-month period ($r_{xx'} = .81$, $p < .01$). Correlations between the subscales as well as between theoretically related constructs support the construct validity of the FSMAS-R (Lim & Chapman, 2013). FS-ANX scores were collected for each data point during both phases and are presented in Figures 1 and 2.

Apparatus

Harvest. To track their time engaged in actual math instruction, participants used the Harvest time-tracking software application (<http://www.getharvest.com>) throughout both phases of the study. The Harvest application was chosen for its ease of use, its cross-platform availability, its reputation for stability, and its ability to encrypt, verify, and automatically store collected data. Participants were able to log their time online, and the results were immediately available to the researchers.

Qualtrics. The web-based survey tool Qualtrics (2016) was used to collect participant data for the AMAS screening assessment, the FS-ANX assessments during baseline and intervention phases, and the expressive writing interventions. For each item of both the AMAS and the FS-ANX, participants selected the radio button option that best described their answer. For the expressive writing interventions, participants entered their responses into a text box. The software program was configured to save their text answers and close the text box after 10 min had elapsed.

Procedures

Baseline. Twice each week (typically on Mondays and Thursdays), participants completed the FS-ANX online before the start of their student-teaching workday and tracked their math instructional time during the school day. Baseline stability was determined using the participants' FS-ANX score. Once the minimum assigned baseline days had been completed

and baseline stability had been determined, participants proceeded to the intervention phase. The staggered baselines are shown in Figure 1. Information regarding baseline stability procedures is presented in the Data Analysis section.

Intervention. The intervention consisted of three brief expressive writing sessions. Three times over the course of two weeks, participants used Qualtrics and responded to the following writing prompt:

Please take the next 10 minutes to write as openly as possible about your deepest thoughts and feelings regarding math. Thinking about math—whether it is completing math problems, taking math classes, teaching math to students, or recalling past experiences in your own math classes—can evoke many different feelings and responses. The important thing is that you really let go and dig down to your very deepest emotions and thoughts and explore them in your writing.

For the second and third intervention sessions, the following statement was added near the end of the prompt: “You can write about the same topic or event as you did the previous week, exploring it further, or you can write about a different topic or event.” At the end of 10 min, Qualtrics was configured to save the response and close the text box.

As with baseline, twice each week during the intervention phase (typically on Mondays and Thursdays), participants completed the FS-ANX online prior to the start of their student-teaching workday and tracked their math instructional time during the school day. Expressive writing prompts were scheduled to be completed the evening before the data collection days. Text-message reminders were sent to participants in the mornings of the data-collection days and in the early evenings of the intervention days.

Intervention fidelity. Several processes were employed to ensure a greater degree of procedural fidelity throughout the intervention and data collection. First, participants received written instructions and were offered training on Qualtrics and Harvest. Participants were given time to practice using the Harvest application and to ask any questions about the data-collection apparatuses before the start of the study. This process helped ensure that participants knew how to access and use the programs and had an opportunity to set the programs up for easy access within their work settings and routines. Second, math instructional time was operationally

defined for participants as the number of minutes per day that the participant was actively engaged with students in either direct whole-group math instruction (e.g., lecturing on a mathematical concept or lesson) or otherwise actively facilitating learning opportunities (checking for understanding or facilitating individual-, group-, or classroom-level mathematics-learning opportunities). Time students spent independently working on mathematical problems without direct and active teacher engagement (e.g., students completing math problems or a worksheet while the teacher was engaged in a different task) was not counted as math instructional time. Third, participants were instructed to complete the writing intervention within a 2-hr window in the evenings of the chosen intervention dates; the intervention writing response time was limited to 10 min. Fourth, participants were asked to adhere to the directions listed in the weekly writing prompt to the best of their ability and with minimal distractions.

Data Analysis

Data analysis was conducted through visual analysis methods to examine trend, level, and stability of data; nonoverlap of all pairs (NAP) was used to determine effect size. For the visual analysis, Lane and Gast's (2014) protocol was used. NAP analysis was conducted using an online NAP calculator (Vannest, Parker, & Gonen, 2011). The alpha level for all NAP analyses was set at .05.

Results

Results for each variable are presented below. Graphical representation of the results can be found in Figures 1 and 2.

Math Anxiety

Visual analysis of the data for Participant A reflected a slight decrease in the FS-ANX scores across conditions from the baseline during the intervention phase ($\bar{x} = 17.67$, $SD = 2.52$ in intervention phase vs. $\bar{x} = 18.00$, $SD = 1.00$ in baseline phase). Within-condition analysis indicated a stable decelerating, improving trend in the baseline phase and a decelerating, improving trend in the intervention phase. The NAP calculation was 0.5, with a p -value of 1.0.

For Participant B, visual analysis indicated a between-condition decrease in math anxiety ($\bar{x} = 17.33$, $SD = 2.08$ in intervention phase vs. $\bar{x} = 20.25$, $SD = 1.50$ in baseline phase). As with Participant A, within-condition analysis showed a stable decelerating, improving trend in the baseline phase and a decelerating, improving trend in the intervention phase. The NAP calculation was 0.08, with a p -value of 0.08.

Visual analysis for Participant C also indicated a between-condition decrease in math anxiety ($\bar{x} = 20.33$, $SD = 1.53$ in intervention phase vs. $\bar{x} = 22.25$, $SD = 0.96$ in baseline phase). Within-condition analysis showed decelerating trends for both conditions. The NAP calculation was 0.13, with a p -value of 0.11.

Teacher Math Instructional Time

For Participant A, between-condition visual analysis of math instructional time indicated no changes in median and mean levels ($\bar{x} = 80.0$ min, $SD = 0$ for baseline and $\bar{x} = 80.0$ min, $SD = 20$ for intervention phase); however, there was an improving positive change in trend direction and effect. Within-condition analysis showed a flat trend with no relative or absolute change in level during the baseline phase. During the intervention phase, there was an improving positive change in trend, with a relative level change of 20 and absolute level change of 40. NAP analysis calculation was 0.50, with a p -value of 1.0.

For Participant B, between-condition analysis showed a very slight improvement in the level of math instructional time ($\bar{x} = 56.50$ min, $SD = 1.73$ for baseline phase and $\bar{x} = 57.00$ min, $SD = 0.0$ for intervention phase). Trends for both conditions were stable, with a slight accelerating, improving trend during the intervention phase. Within-condition analysis shows multiple paths within trend during the baseline phase, with an overall trend line indicating a slight decelerating, deteriorating trend. Within the intervention phase, there was no change in level, reflecting a stable, unchanging trend. There was a slight decrease in absolute level change during baseline (-3) but no change in relative level. During the intervention phase, there were no within-condition changes in level or trend direction. The NAP analysis calculation was 0.50, with a p -value of 1.0.

Between-condition visual analysis for Participant C indicated decelerating, deteriorating levels and trends for math instructional time across phases ($\bar{x} = 58.33$ min, $SD = 7.64$ for intervention phase and $\bar{x} = 70.50$ min, $SD = 4.20$ for baseline phase). Between-condition relative level changes showed deteriorating levels for both relative (-3.5) and absolute (-7) changes. Within-condition analysis indicated multiple paths within trend during the baseline phase, with the overall trend being decelerating, deteriorating, and stable. There was a slightly decelerating, deteriorating variable trend during the intervention phase. Relative level change within condition was -4 during baseline and -15 during the intervention phase; absolute level changes were -3 during baseline and -15 during the intervention phase. NAP analysis resulted in a NAP figure of 0.04, with a p -value of 0.05.

Discussion

This study sought to explore two questions: (a) What is the impact of a brief expressive writing activity on preservice elementary teacher math anxiety? and (b) What is the impact of a brief expressive writing intervention on math instructional time provided by preservice elementary school teachers with math anxiety?

Math Anxiety

For all three participants, results showed decreasing math-anxiety levels overall within both phases, to various degrees. These decreases were more pronounced in the intervention phases as compared to the baseline phases. Still, visual analysis, combined with NAP results, suggests that the reductions in levels of math anxiety were relatively minor. Interestingly, the level of math anxiety for Participant A increased to 20 at the start of the intervention phase from a previous level of 17 at the end of the baseline phase. In some ways, this result is not unexpected. As Pennebaker and Beall (1986) found, there can be short-term increases in physiological arousal when writing about past traumatic experiences. However, they found that longer-term results typically show a decrease in problematic symptoms. Data for Participant A shows a similar pattern over the course of the intervention phase; after the third intervention, the level of math anxiety was the lowest score recorded during the study. For Participant B, math-

anxiety levels improved (decreased) during the intervention phase. Within the baseline phase, there were multiple paths within trend but the changes in direction were relatively minor and the overall trend line was nearly flat. Results for Participant C showed multiple paths within trends in both phases, though overall results indicated a slight decelerating (improving) trend during the intervention phase. Though all three participants showed improving trends during the intervention phase, with the multiple trends and relatively minor level changes, it is difficult to draw definitive conclusions from this data. Still, when taking into account the combined results from all three participants, these math-anxiety results may suggest possible positive effects for some of the participants.

Math Instructional Time

For math instructional time, no clear trend emerged. Trend lines for Participants A, B, and C showed accelerating, flat, and decelerating trends, respectively. For Participant A, math instructional time increased. Although the trend went from flat to improving, the mean and median levels for both phases were identical. The collection of additional responses after the conclusion of the intervention phase would have helped examine for potential delayed treatment effects. For Participant B, there was little to no between-condition level change, and the within-condition trend was flat. Participant C, however, showed a decelerating trend; this result was the opposite of the theorized direction. Without additional information from the participant, it is difficult to speculate what may have been the cause of this downward trend in math instructional time. The results for Participant C had the lowest proportion of overlap for all pairs for both variables in the study.

When considering the findings overall, three potential explanations for the obtained results stand out for consideration. First, it is possible that the measurement time frame was too short to demonstrate an impact of the intervention on the dependent variables. A second explanation for the results is that the number or length (dosage) of the interventions was not sufficient to produce change. A third possible explanation for the results is that the intervention simply does not impact either of the dependent variables. A fourth possible explanation is that this particular preservice

teacher sample—or even the overall teacher population—may not respond to an expressive writing intervention.

Of the three potential explanations above, the first explanation is the most probable for several reasons. A promising finding was that all three participants showed downward (improving) trends in levels of math anxiety during the intervention phase. Although one participant's level of math anxiety initially increased at the start of the phase, a temporary increase is relatively common for expressive writing interventions (Pennebaker, 1989). Also, positive effects of expressive writing interventions can take place weeks after the conclusion of the intervention (Pennebaker, 2004; Pennebaker, 1989; Pennebaker, Colder, & Sharp, 1990). For the present study, data were not collected beyond the intervention phase, and the intervention phase itself was less than two weeks long, resulting in a limited time frame in which to examine the impacts of the intervention. Given the factors mentioned above, it seems likely that improvements in one or both variables might have become more apparent if additional data had been collected beyond the 10-day intervention phase.

The second explanation could also be a reason for the limited changes between the baseline and intervention phases. It is possible that there needed to be more than three intervention sessions or that the sessions needed to be longer than 10 min, or both. Although some studies have shown that even a single writing time can be effective (Greenberg et al., 1996, as cited in Smyth & Pennebaker, 2008), anxiety-related conditions can prove to be persistent (American Psychiatric Association, 2013) and might require a larger dose of the intervention than was utilized in the present study.

The third and fourth possible explanations make less sense than the first and second explanations. Expressive writing interventions have been shown to have positive effects more times than not in studies that address a tremendously diverse range of variables (Frattaroli, 2006). Some of these studies have examined variables closely related to one or both of the dependent variables in the current study (Doherty & Wenderoth, 2017; Park et al., 2014). Similarly, expressive writing has been shown to be effective with a multitude of different populations, including college students pursuing a wide variety of majors (Doherty & Wenderoth, 2017; Harris,

2006; Pachankis & Goldfried, 2010; Park et al., 2014; Yogo & Fujihara, 2008). While it is possible that expressive writing is ineffective with these particular variables or with this population for reasons yet unknown, it is more likely that additional data collection beyond the conclusion of the intervention phase may have shown a positive effect on one or both dependent variables given the results of past studies.

Limitations

There are several limitations to the study. One limitation is that the study was conducted with only three participants, considered by some to be the minimum acceptable number for single-case research to demonstrate experimental control (Horner et al., 2005; Ray, 2015).

Also, participants were not based on a random sample, therefore increasing the potential for sampling bias. The study relied on self-reported data, which has the potential to increase the likelihood of response bias (Schwarz, 1999). The data for math instructional time was measured on individual days; calculating the mean over multiple days may have yielded more representative results. Another limitation is the lack of follow-up data after the intervention phase concluded. As mentioned above, some expressive-writing-intervention studies have found that positive gains may become more evident a few months after the intervention has occurred. In addition, the time interval between intervention and measurement may have influenced the results. Several previous expressive writing studies have administered the intervention directly prior to a performance task; it is unknown whether completing the intervention the evening prior to measuring math anxiety and instructional time could have impacted the results. Finally, the sample was very limited, consisting only of young Caucasian females in a single geographical location.

Implications for Future Research

The researchers of this study offer several suggestions to those considering conducting similar studies in the future. Scheduling a midstudy check-in with participants would allow for the opportunity to collect valuable information related to any unexpected changes in the data that may arise during the study. Such discussions would help researchers examine whether these changes may be related to the intervention or to

extraneous variables that may increase threats to validity (such as history and temporal effects). Also, collecting data several weeks to several months after the conclusion of the intervention phase would help to explore the possibility of a delayed treatment effect for one or both variables. Collecting instructional time data through the use of other means in addition to self-reported data would improve the reliability of the results. For example, one or more observers could record the amount of instructional time delivered, or videos of class sessions could be recorded and analyzed to identify and measure instructional time. In single-subject research design, experimental control can be improved by including at least four participants. Similarly, replication of the present study and including participants of different genders, ethnicities, and age groups would yield valuable data that, over time, could be used alongside this and other future studies to examine the potential of the generalizability of the results across populations (Byiers, Reichle, & Symons, 2012).

Past studies have shown that expressive writing interventions are effective in helping with numerous conditions and symptoms. In addition to their effectiveness, part of their appeal is that they can be implemented easily and with little to no financial expense. While the current study showed mixed results for math instructional time, the math-anxiety variable showed downward trends for all three participants. Still, further research is needed before more conclusive statements can be made regarding its effectiveness as an intervention for preservice teachers with math anxiety.

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Figure 1. FS-ANX results.

Figure 2. Math-instructional-time results.