TEST ANXIETY INTERVENTIONS IMPLEMENTED BEFORE SUMMATIVE SCIENCE ASSESSMENTS

by

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ABSTRACT

This investigation examined the effectiveness of tools to mitigate test anxiety on student performance and students' perceptions of anxiety. Additionally, this study explored whether or not students were impacted differently based on their age level. Participants included 3 classes of 9th-graders with 14, 15 and 16 students, and 1 class of 13 11th and 12th-graders. The investigation introduced students to three different anxiety-reducing techniques at the onset of three quizzes. At the semester final exam, students chose one strategy to implement. Quiz scores, final exam scores, surveys, and interviews were used as data collection instruments. The results suggested that students had an improved experience with the test anxiety intervention though there was not an impact on their performance. Students in 9th-grade and 11th or 12th-grade had similar levels of test anxiety. Students show a willingness to utilize test anxiety interventions in the future.

INTRODUCTION AND BACKGROUND

School Demographics

Marin Academy (MA) is a highly selective independent school in San Rafael, California with 433 students in grades 9-12 and over 100 employees. Seated in Marin County, our students are predominantly white, with approximately 24% of the school's student body self-identify as non-white. Tuition at MA for the 2018-2019 year was $45,755 and most students come from affluent backgrounds (T. Nutting, personal communication, December 6, 2018). The mean family income in Marin County is $133,389 per year, which is $74,089 more than the US median family income. Currently, approximately 24% of students are on financial aid. As part of our strategic plan, MA actively seeks out a more diverse population, which often draws from our neighbors in the East Bay and San Francisco. We have a bring-your-own-device policy and all students carry either a tablet or laptop to class. Marin Academy is a school that lives and breathes its mission statement, "Marin Academy asks every individual to think, question, and create in an environment of encouragement and compassion, and challenges each person to accept the responsibilities posed by education in a democratic society" ("Marin Academy Homepage," n.d.).

At MA, three years of science courses are required, though most students take the equivalent of four, five or six years of science. All students take biology in 9th grade, chemistry in 10th and choose elective courses in their 11th and 12th grade. Students are required to choose one physics from four choices in either their junior or senior year. The elective courses include advanced biology, advanced chemistry, advanced physics,

environmental science, neuroscience, anatomy and physiology (A&P), astrophysics, electrical engineering and computer science, and conceptual physics. All courses are available to any student except for advanced physics which requires calculus concurrently. We also offer a selective research program called Marin Academy Research Collaborative. Students apply to be a part of the two-year program in which they design and complete an independent research project. All courses, except for ninth-grade biology, take place in our impressive new Science and Innovation Center. The 18-million-dollar building opened in the Fall of 2017. It has Platinum LEED certification and state of the art equipment.

Teaching Context

I have been teaching life science in private high schools for the past 20 years. I spent two years at a boarding school in New Hampshire prior to moving to California for the position at MA. During my time at MA, I have primarily taught ninth-grade biology and A&P. I have served a variety of other roles, including Department Chair, Varsity Volleyball Coach, Outings Leader, and Study Coach. I work closely with three wonderful colleagues for ninth-grade biology, a course we teach in lockstep. Though I do not directly collaborate for A&P, members of my department are tremendously supportive and always willing to offer suggestions or help with curriculum design.

My classroom research project took place in three sections of biology and one section of honors human anatomy and physiology. The ninth graders in biology come from 40-50 different middle schools including private and public; hence, their skill level varies tremendously. Currently, there is no tracking in biology with all freshman taking

the same biology course. By contrast, the juniors and seniors enrolled in A&P have selected this course out of interest. Though the population at MA is very bright and hardworking overall, A&P students have a range of abilities. There are students that have excelled in science and chose A&P because they have an interest in a medical path or are doubling in science. There are also students that previously struggled in science but find connections in the coursework with their passion for sports or art. I proposed and designed the course in 2002 and have been the sole instructor every year since.

Background

Over that past few years, I have noticed a rise in the anxiety of students at Marin Academy. There has always been a drive for success at MA. As part of the community culture, students are reliable and put forward their best effort. The class averages range from B+ to A due to consistently high caliber work from the majority of students. However, recently I have seen more and more students showing paralysis from anxiety. This year I had more students with learning profiles due to diagnosed anxiety than in previous years. This is a new trend that has surfaced in the past few years. Anxiety is a topic that I have seen more frequently in educational circles and even surfaced at the parent night for my daughter's kindergarten. When students have told me that they do not perform well on assessments because they have anxiety, I desired strategies to share with them. In the same way that I have been able to share tools and techniques for taking good notes in class, writing a strong lab paper, or studying for assessments, I wanted to have some tools to offer students to help mitigate their feeling of anxiety when they sit down for a summative assessment.

In thinking about my classroom environment, my goal is always to create opportunities for Rigorous Learning Experiences (Figure 1). These Rigorous Learning Experiences are an emergent property created at the intersection of the cognitive, social, and emotional aspects. I found myself frequently focusing on cognitive skills, such as planning or goal setting, or the social components, such as collaboration and self-advocacy. The emotional skill set can be more challenging to cultivate in students, yet equally important. By focusing on test anxiety, I hoped to help students acquire coping skills for stressful situations.

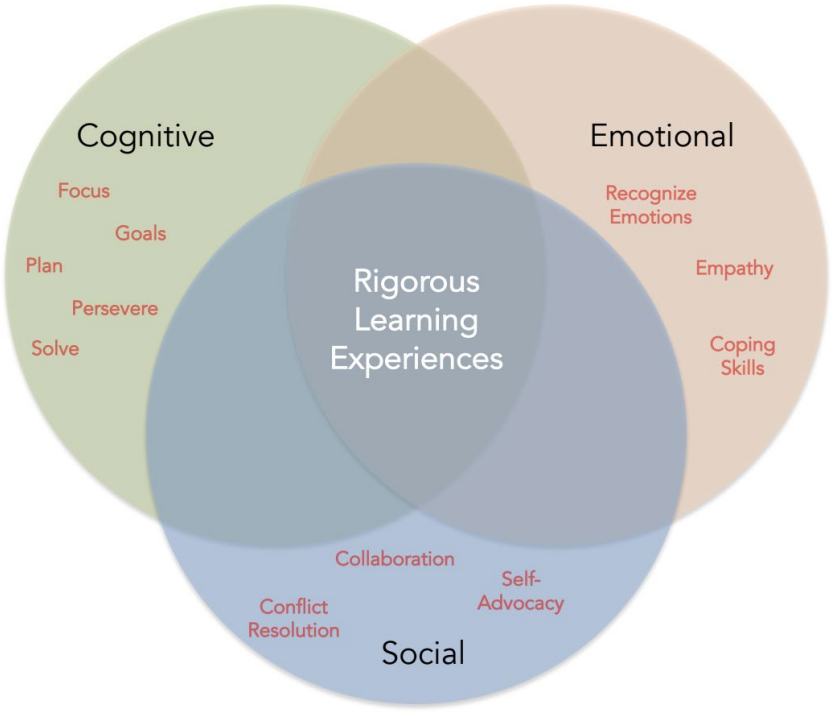


Figure 1. Venn diagram of aspects of Rigorous Learning Experiences (Gustin & Moses, 2019).

My hope was to find an intervention for test anxiety that would allow students to have a better assessment experience and allow assessments to more accurately measure student understanding. I wanted a method to inspire healthy mental states for assessments

and provide a tool for students to access a calmer disposition. If students had positive experiences with assessments more frequently, they may be able to break an anxiety cycle and be better equipped at handling stressful situations. Statistically, I attempted to determine whether my population would have significantly different performances and perceptions of summative assessments as a result of the intervention.

Focus Question

Concern about student anxiety during summative assessments led me to my primary focus question: What are the effects of anti-anxiety strategies on student performance during summative assessments in biology and anatomy and physiology? Additionally, I wanted to investigate the effects of interventions on students' perceived experience of anxiety. Furthermore, I hoped to discover if students were impacted differently by test anxiety based on their age level. Lastly, I desired to understand whether or not students would utilize test anxiety interventions on future assessments.

CONCEPTUAL FRAMEWORK

Anxiety is on the rise for teens in the United States. Anxiety is now the most common reason college students seek counseling service, overtaking depression from a decade ago. The American College Health Association found 62% of undergraduates reporting overwhelming anxiety (Tate, 2017). In survey data from U.C.L.A.'s Higher Education Research Institute, 41% of incoming students reported that they felt overwhelmed in 2016, compared with 18% in 1985 (Eagan, Stolzenberg, Zimmerman, Aragon, Saynon, & Rios-Aguilar, 2017). As the number of teens suffering from anxiety increases, implications for student learning are beginning to be noted.

One trigger for anxiety in numerous students is summative assessments. Test anxiety has been defined by Sean Dusek as “an unpleasant feeling or emotional state that has physiological and behavioral concomitants, and that is experienced in formal testing or other evaluative situations” (Hill & Wigfield, 1984, p.106). Levels of test anxiety have been increasing; University of Washington professors estimate that 15% to 20% of their students experience high levels of test anxiety. Their observations of teens indicate that anxiety at high levels negatively impacts academic performance (Doherty & Wenderoth, 2017). Other estimates of test anxiety show a range from 10% to 40% of students (Embse & Hasson, 2012). Students who score high on test anxiety assessments often score lower on tests (Hurren, Rutledge, & Garvin, 2006). Test anxiety can impede performance, as well as negatively affect student experience.

Test anxiety is considered one of the most disruptive factors in test performance (Cizek & Burg, 2006). There is a stronger negative relation of test anxiety with math subtests and a lesser relation with writing (Embse & Hasson, 2012). Reasons for the impacts of test anxiety on achievement vary. Entering a negative emotional state during summative testing could impede a student’s ability to recall information during the assessment. Test anxiety affects a portion of students working memory, specifically verbal-analogies task performance (Lee, 1999). Test anxiety may prevent students from focusing on their exam by consuming cognitive resources (Eysenck, 1992). Students may have a decrease in motivation, and efficacy of learning strategies may be reduced with test anxiety (Linnenbrink, 2017). Though the exact mechanism is not fully agreed upon, there is broad agreement that test anxiety lowers academic performance.

Different populations of students have disproportionate impacts from test anxiety. Peer reference groups show a correlation with levels of test anxiety (Marsh, 1987). Students in urban compared to suburban schools do not have a significant difference in test anxiety (Embse & Hasson, 2012). Compared with their male peers, female students usually report higher levels of test anxiety. Females in a study at the University of Barcelona, reported higher levels of test, math, and trait anxiety, though they did not show lower academic achievement than male students (Núñez-Peña, Suárez-Pellicioni, & Bono, 2016).

Classroom environments can potentially influence levels of test anxiety. There is evidence that cues from the surroundings impact people's anxiety. In a clinical setting, one study compared anxious patients with a normal control in regard to attention. The researchers used two words on a screen, one neutral and one threatening, along with a dot on a screen. The findings showed that if the dot followed the anxiety-provoking word rather than the neutral word, the high anxiety patients were relatively fast at pressing the key, compared with the normal control group. This indicates that anxious patients were sensitive to the content of the word and deploy attention more to the threatening words than does the general population. Knowing that patients with anxiety are more sensitive to threatening stimuli, might indicate that a calmer classroom environment can help to minimize the impacts of their anxiety (Broadbent & Broadbent, 1988).

Numerous studies are emerging that examine interventions for test anxiety. One study at the University of Washington in Seattle examined the feasibility of the intervention strategy of expressive writing on a large lecture course. The researchers

found that, for students with high levels of anxiety, the tests results were not an accurate representation of their abilities. With the expressive writing technique, students had five minutes at the start of the exam to write down thoughts, crumple them, and throw them away. The researchers found that crumpling and throwing papers seemed to dissipate tension in the classroom. Due to the anonymous nature of the writings, researchers were not able to determine whether the exercise changed exam performance. The researchers did find the technique was easily implemented in a large lecture course. Additionally, they name both gender and academic standing as having an impact on the relationship between test anxiety and performance. Other examples of interventions include relaxation techniques and training students to view physiological changes as something positive (Doherty & Wenderoth, 2017).

Mindfulness and relaxation techniques are beginning to emerge in schools. Activities such as meditation and focused breathing are helping to reduce test anxiety. Students who have been taught diaphragmatic breathing and guided progressive muscle relaxation self-report decreased levels of test anxiety (Larson, Ramahi, Conn, Estes, & Ghibellini, 2010). Teachers report positive impacts of relaxation techniques on their high school students (Gregor, 2005). In one study done on fifth graders, simply taking deep breaths before a timed math test significantly reduced self-reported feelings of anxiety and improved test performance (Khng, 2016). Introducing students to relaxation techniques can positively impact their experiences with assessments.

Incorporation of art is another means to reduce test anxiety. A study was done on university students to compare the effectiveness of mindfulness coloring (mandala), free

drawing/coloring, and a noncoloring control activity on test anxiety. Participants in both the mandala condition and in the free condition reported a significant decrease in their test anxiety following the coloring activities, while participants in the control condition reported significant increases in test anxiety (Carsley & Heath, 2018). Numerous studies are showing similar positive impacts from creation of art on anxiety.

There is a need for teachers to find ways to create a positive testing environment and offer tools to students to decrease test anxiety. In hopes of allowing all students to meet their potential and display their full understanding, educators must support a healthy mental state during assessments.

METHODOLOGY

My classroom research project based on the action research model aimed to assess the impacts of three different test anxiety interventions on achievement during summative assessments. In this study summative assessments will include both quizzes and the semester final exam, as both serve to measure the conclusion of instruction rather than progress. I also wanted to gauge whether student experiences during summative assessments were more or less positive with an intervention. Lastly, I sought to gauge whether or not students would utilize test anxiety interventions on future assessments. My goal was to help students discover a tool that would allow them to control their mental state in order to achieve at their highest capacity. I hoped my students would learn strategies that would benefit them throughout their academic career, or even translate to other stressful situations. The research methodology for this project received an

exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained (Appendix A).

Research Treatment

My project spanned from November through December 2018. This study took place while learning curricula that I have developed over more than a decade in anatomy and physiology (A&P), and five years in biology. The units were the nervous system in A&P and DNA and protein synthesis in biology.

Three biology classes and one A&P class were selected because they represented a spectrum of the students at Marin Academy. The selection process ensured that the data collected captured the attitudes from a truly representative cross-section of the student body. Each class contained between 13 and 16 students (Table 1).

Table 1
Classroom Demographics

Course	Gender	Number of students	Percentage of Students
A&P		13	
	Males	7	53.85%
	Females	6	46.15%
Biology - C		16	
	Males	9	56.25%
	Females	7	43.75%
Biology - F		15	
	Males	7	46.67%
	Females	8	53.33%
Biology - G		14	
	Males	8	57.14%
	Females	6	42.86%

In each course, students were given four quizzes to check for understanding on the recent content. Quizzes ranged from 4% to 6.5% of students' final grade in the course. Prior to the first quiz, no special treatment was implemented. Before the start of

the second quiz, students were introduced to Calming Counts with a Google Slide. Then students were asked to individually practice the intentional breathing (Wilson, n.d.). An image of students participating in Calming Counts can be found in Appendix B. For the third quiz, students were introduced to Expressive Writing with a Google Slide and provided three minutes prior to the start of the quiz to silently write down thoughts on blank paper, crumple the paper, and throw the papers away. A sample of a student's Expressive Writing can be found in Appendix C. On the fourth and final quiz, students were prompted to Visualize Joy with a Google Slide. Students were asked to imagine a place or activity that makes them happy, then during the three minutes prior to the start of the quiz, silently draw the scene. A sample of student work during Visualize Joy can be found in Appendix D. Students were directed to save the image or place in the recycling bin (Appendix E).

On the first quiz, with no intervention, students were assessed on their knowledge of parts of the brain in A&P and macromolecules in biology. The second quiz, with Calming Counts, covered the autonomic nervous system in A&P and the structure of DNA and steps of DNA extraction in biology. For the third quiz with Expressive Writing, students' understanding of the anatomy of a neuron was assessed in A&P and comprehension of transcription and translation was assessed in biology. The final quiz covered neuron physiology in A&P and protein folding and enzyme activity in biology. This fourth quiz followed the Visualize Joy intervention. Table 2 summarizes how the interventions were assigned to specific topics in A&P and Table 3 shows the interventions in biology, along with the relative weight of each assessment.

Table 2
A&P Interventions, Curricula Topics, and Weight of Assessment

Topic	Date	Intervention	Assessment Weight
Brain	12/7/18	None	6%
Autonomic Nervous System	11/9/18	Calming Counts	4%
Neuron Anatomy	11/29/18	Expressive Writing	4%
Neuron Physiology	12/3/18	Visualize Joy	6.5%
Semester Final Exam	12/18	Individual Choice	20%

Table 3
Biology Interventions, Curricula Topics, and Weight of Assessment

Topic	Date	Intervention	Assessment Weight
Macromolecules	10/22	None	5.5%
DNA Structure and Extraction	11/16-11/19	Calming Counts	5.5%
Transcription & Translation	11/29-11/30	Expressive Writing	6%
Protein Folding & Enzymes	12/3-12/4	Visualize Joy	5%
Semester Final Exam	12/18	Individual Choice	15%

On December 18, 2018, students in my biology and A&P sections all gathered together in the lecture hall for a cumulative semester final exam. The final exam was weighted 15% of the ninth-grade biology students' grade and 20% of the A&P semester grade. Prior to the start of this summative exam, students were given a handout with a reminder of the three interventions we had previously practiced, and included blank paper on the back. Students were permitted five minutes to individually choose and implement

one of the three interventions prior to the start of the exam. If they finished early, or chose not to participate, students sat silently until the exam officially began (Appendix F). An overview of the entire process can be seen in Figure 2.

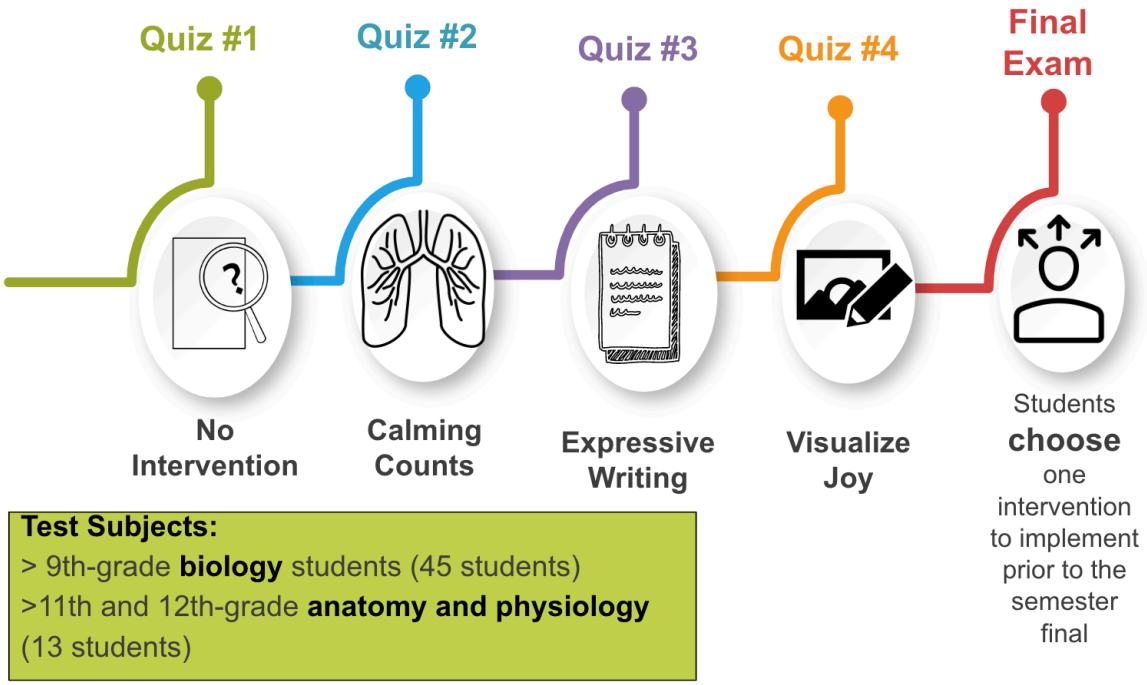


Figure 2. Overview of overall process.

Data Collection Tools

Summative Assessment Performance

To determine the impacts of the interventions on achievement during summative assessments, scores on the assessments were compared to each other. Scores on the four quizzes were compared with the Wilcoxon Rank-Sum statistical test. All sections of biology complete the same quizzes; however, the format and length of the four quizzes varied tremendously. Final exam scores were grouped by course and then separated by the three interventions. These scores were then compared using the Welch Two Sample t-

test. These quizzes and the final exam provided insights into the impacts of an intervention on performance.

Likert-Style Surveys of Student Experience

Students evaluated their perceptions of test anxiety and experience with the assessment immediately following each quiz by completing the Post-Quiz Survey (Appendix G). This six-question Likert-style survey was devised to measure student experience with the summative assessment. The final prompt provided each student a chance to write comments to further clarify their responses. Before the survey was administered, students were reminded of the voluntary nature of the experiment. Students were emailed the surveys and allowed to open their devices to respond to the survey. Survey results were compared between each of the test anxiety treatments using Fisher's Exact Test for Count Data. The Post-Quiz Survey questions provided great insight into students' experiences with summative assessments.

Following the final exam, students completed the seven question Likert-style Post-Final Survey to evaluate their experience with their chosen intervention (Appendix H). Again, students were reminded of the voluntary nature of the experiment. Questions were similar to the Post-Quiz Survey, allowing me to compare the impacts on this high-stakes assessment to the lower valued quizzes. Results were grouped by the three interventions and compared using Fisher's Exact Test for Count Data.

Individual Student Interviews

Additional feedback from five students was gathered through individual interviews (Appendix I). Interviews were conducted during the students' available free

periods, and I transcribed the students' answers during the interviews. My interviewees were chosen using a stratified random sampling technique with three males and two females interviewed. Students of varying academic ability, as determined by their grades on the first unit, were equally represented. After completing the Post-Final Survey, I completed personal interviews with the same five students that were selected at the beginning of the research process to compare their experience on the final exam with their previous assessments (Appendix I).

Teacher Journal

Throughout my research, I recorded in a teacher journal my impressions of the students during the summative assessments and notes regarding other factors that were impacting their experience. Notes were taken to address questions such as: What is the perceived anxiety of the students? What outside factors seem to be impacting their stress levels? How do they seem before, during and after their assessment? I also recorded solicited and unsolicited quotes from students. A final section chronicled my attitudes about each treatment. The journal allowed me to track individual and class successes and challenges. An excerpt of this teacher journal is in Appendix J.

The triangulation matrix shown in Table 4 summarizes the sources of data that were identified for each question. Triangulation of data helped to provide a more accurate conceptualization regarding the effects of the interventions and reduced the likelihood of misinterpreting a single source of data. The action research tools described below include individual student interviews, teacher journal**,** Likert surveys of student experiences, and assessment scores.

Table 4
Data Triangulation Matrix

Focus Question	Source 1	Source 2	Source 3
1. Primary: What are the effects of anti-anxiety strategies on student performance during summative assessments?	Individual Student Interviews	Quiz Scores	Final Exam Scores
2. Secondary: What are the effects of interventions on student experiences during summative assessments?	Individual Student Interviews and Teacher Journal	Post-Quiz Survey	Post-Final Survey
3. Secondary: Are students at different age levels impacted differently?	Individual Student Interviews	Post-Quiz Survey	Post-Final Survey
4. Secondary: Would students utilize test anxiety interventions on future assessments?	Individual Student Interviews	Post-Quiz Survey	Post-Final Survey

DATA AND ANALYSIS

Student Performance on Summative Assessments

On the biology quizzes that followed the Calming Counts intervention, students had the highest median score of 97.73, compared to a median score of 91.67 with Expressive Writing, 90.91 with no intervention and 90.00 following Visualize Joy *(N*=44*)* (Figure 3). A Wilcoxon Signed Rank test was implemented to compare all of the scores. The resulting p-values showed no significant difference between no intervention and Expressive Writing (p=0.18), no intervention and Visualize Joy (p=0.31), and Calming Counts and Expressive Writing. However, scores were significantly higher with Calming Counts than no intervention (p=0.01), Calming Counts than Visualize Joy (p=0.02), and Expressive Writing than Visualize Joy (p=0.04).



Figure 3. Boxplot of biology quiz scores following test anxiety interventions, *(N*=44*)*.

On A&P quizzes, students had the highest median score of 97.73 with no intervention, compared to a median score of 94.64 with Expressive Writing, 87.50 following the Calming Counts intervention and 72.28 following Visualize Joy, *(N*=10*)* (Figure 4). A Wilcoxon Signed Rank test was implemented to compare all of the scores. The resulting p-values showed significantly lower scores for Visualize Joy, but no significant difference between the other quizzes. One student mentioned that when she experiences test anxiety, she is more likely to make smaller mistakes and her ability to recall information feels blocked.



Figure 4. Boxplot of A&P quiz scores following test anxiety interventions, *(N*=10*)*.

On the final exam, Biology students that chose Calming Counts had the highest median score of 91.6, followed by Visualize Joy with a median of 91.0, and no response with a median of 82.3 *(N*=44*)* (Figure 5). A Welch Two Sample t-test showed no significant difference between these scores with p-values of 0.32 between none and Calming Counts, 0.39 between none and Visualize Joy, and 0.99 between Calming Counts and Visualize Joy.

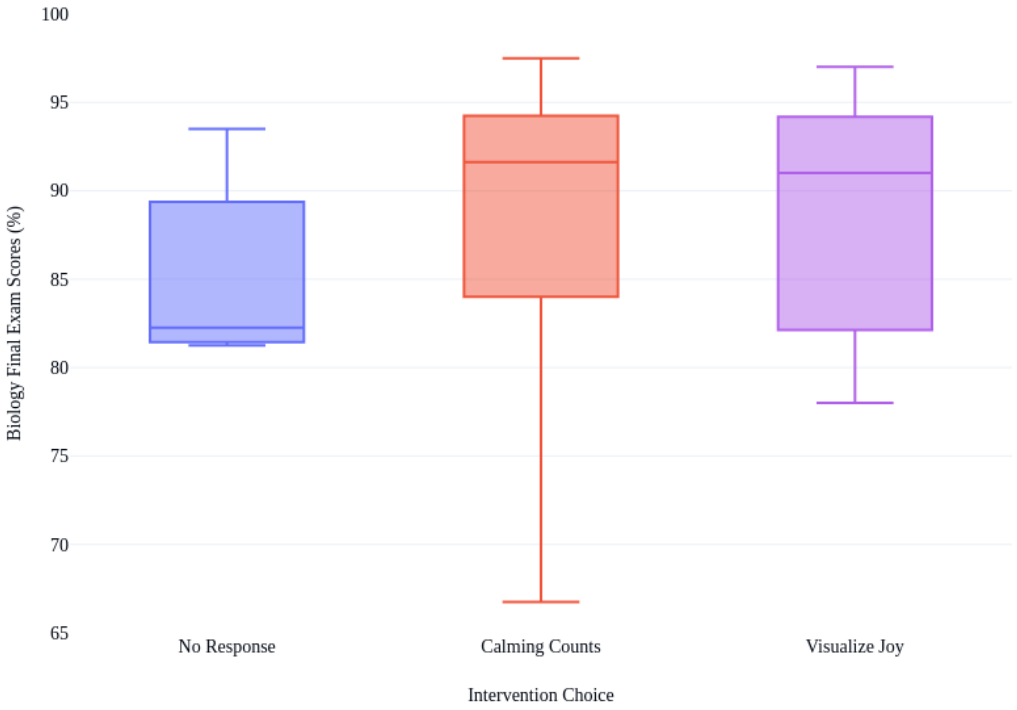


Figure 5. Boxplot of Biology final exam scores, *(N*=44*)*.

A&P students that either did not do an intervention or gave no response on the survey had the highest median score of 92.8 on the final exam, followed by Calming Counts with a median of 91.0, and Visualize Joy with a median of 89.0 *(N*=13*)* (Figure 6). A Welch Two Sample t-test showed no significant difference between these scores with p-values of 0.67 between none and Calming Counts, 0.87 between none and Visualize Joy and 0.30 between Calming Counts and Visualize Joy.

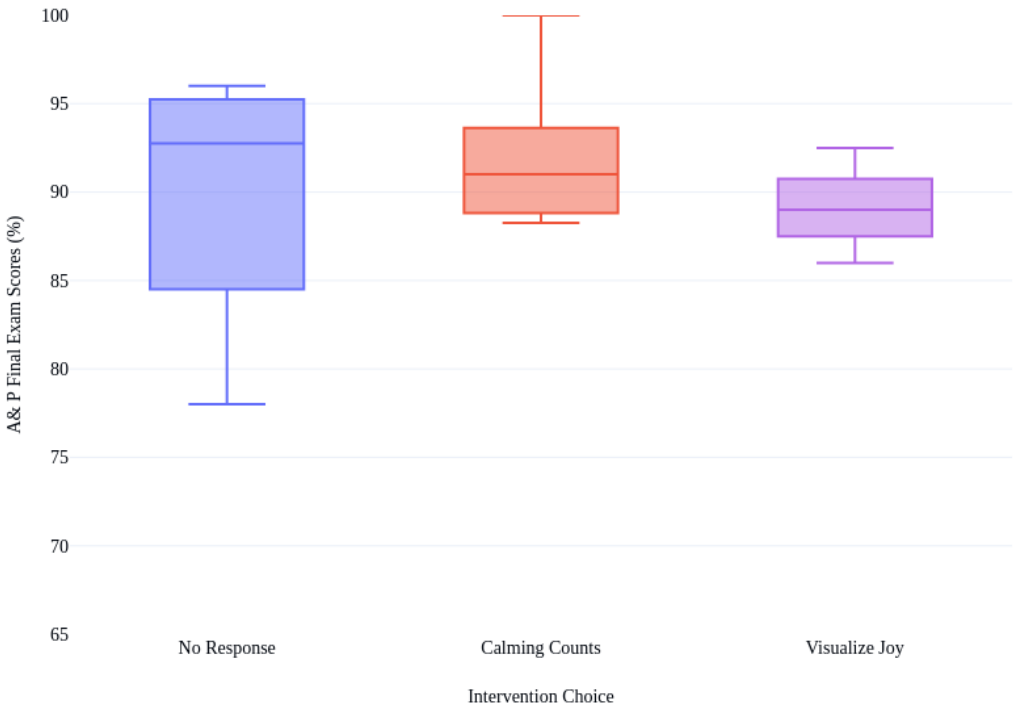


Figure 6. Boxplot of A&P final exam scores, *(N*=13*)*.

Student's Perceptions of Test Anxiety

The Post-Quiz Survey results in biology regarding the prompts that asked students to rate their test anxiety level as they walked into the room for the quiz and after participating in the Calming Counts intervention showed a significant difference with a Fisher's Exact Test for Count Data (p-value = 0.04) (Figure 7). Only 2% of students rated their test anxiety level as high or extremely high following the intervention, as opposed to 14% at the start. Following the Calming Counts intervention, 79% of students reported low or no signs of test anxiety, when compared to 51% at the start of class. The teacher journal shows, "Notable calm starting the quiz in the room." Although both Expressive Writing and Visualize Joy had improved ratings, there was no statistical significance with p-values of 0.07 and 0.17 respectively. Following Expressive Writing, 9% of students rated their test anxiety level as high or extremely high, as opposed to 25% at the start and

70% of students reported low or no signs of test anxiety, compared to 43% at the start of class. With Visualize Joy, 2% of students rated their test anxiety level as high or extremely high, as opposed to 14% at the start and 81% of students reported low or no signs of test anxiety, compared to 64% at the start of class.

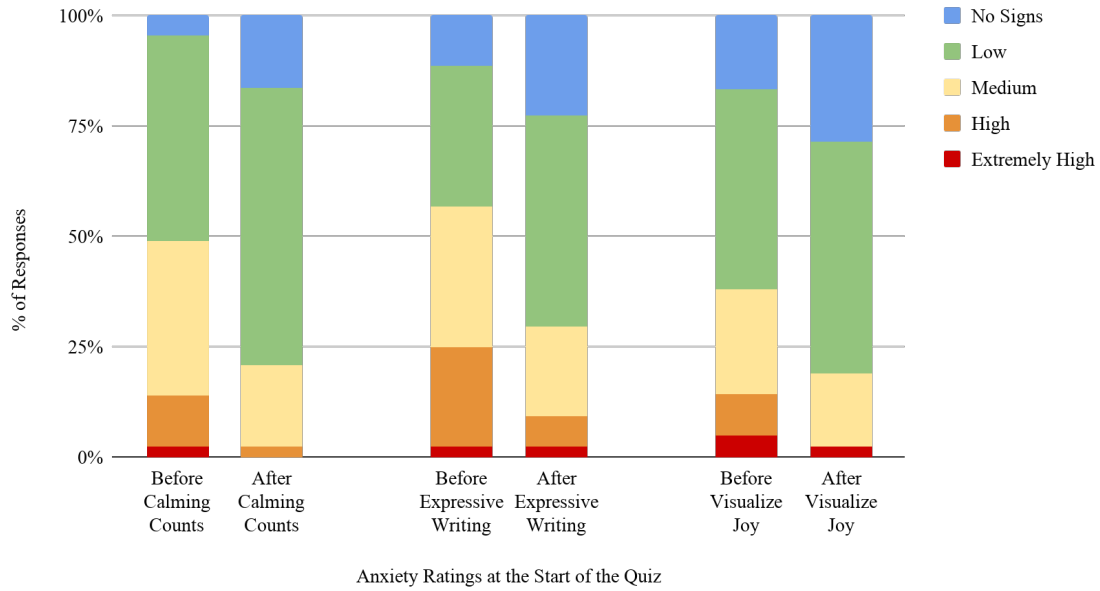


Figure 7. Likert responses from the Post-Quiz Survey in biology related to students' ratings of their test anxiety at the start of the quiz, (*N*=43).

The Post-Quiz Survey results in A&P showed no statistical significance with a Fisher's Exact Test for Count Data when regarding the prompts that asked students to rate their test anxiety level as they walked into the room for the quiz, and after participating in the interventions (Figure 8). With Calming Counts, 0% of students rated their test anxiety level as high or extremely high following the intervention, as opposed to 27% at the start. 64% of students reported low or no signs of test anxiety following the Calming Counts when compared to 45% at the start of class (p=0.04). Similarly, Expressive Writing had improved ratings; however, there was no statistical significance with a p-value of p=0.86.

Following Expressive Writing, 8% of students rated their test anxiety level as high or extremely high, as opposed to 17% at the start and 83% of students reported low or no signs of test anxiety, compared to 67% at the start of class. Visualize Joy also showed no significant difference in ratings with a p-value of 0.29; no students rated their test anxiety level as high or extremely high following the intervention, as opposed to 23% at the start and 38% of students reported low or no signs of test anxiety, compared to 31% at the start of class.

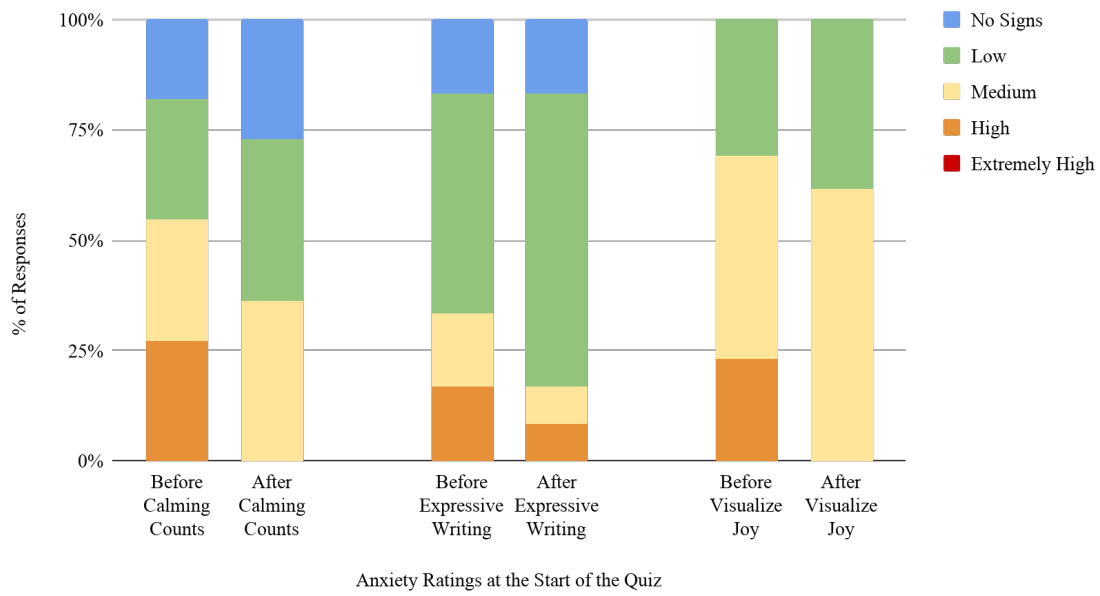


Figure 8. Likert responses from the Post-Quiz Survey in A&P related to students' ratings of their test anxiety at the start of the quiz, (*N*=13).

The Post-Final Survey results in biology showed a statistically significant decrease in students' ratings of their test anxiety level as they walked into the room for the final exam, and after participating in the interventions with a Fisher's Exact Test for Count Data (p=0.02) (Figure 9). The anatomy and physiology students did not show a

significant decrease in their perception of test anxiety with Fisher's Exact Test for Count Data (p=0.35).

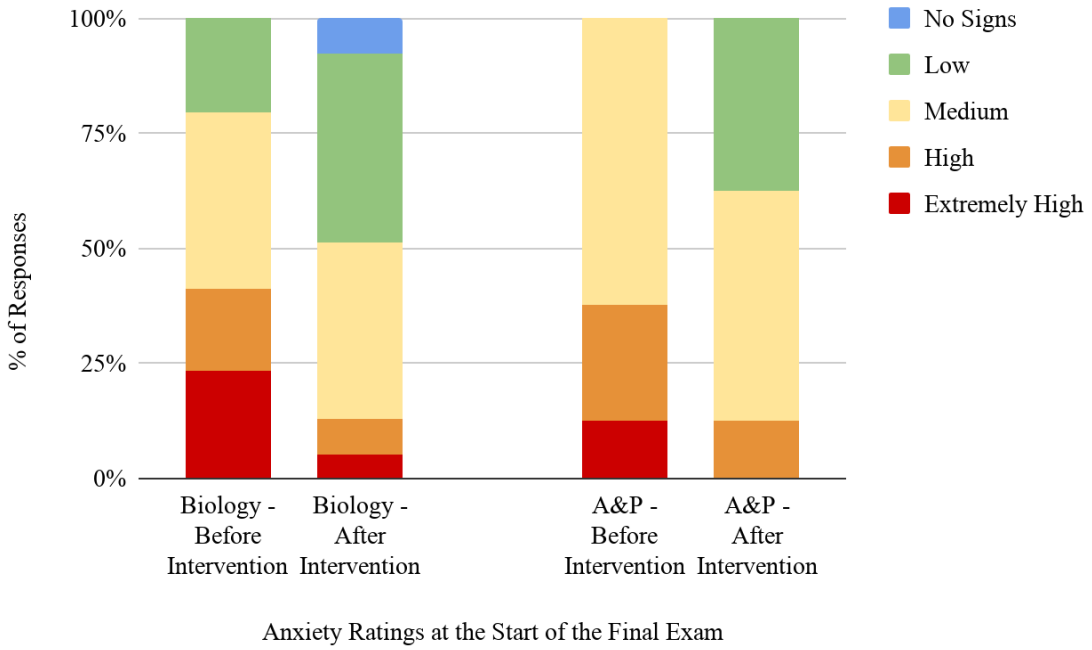


Figure 9. Likert responses on the Post-Final Survey from students in biology and A&P that participated in the intervention related to students' ratings of their test anxiety at the start of the final exam, (*N*=47).

9th-Graders Compared to 11th and 12th-Graders

Students in biology and A&P showed similar levels of test anxiety with 18% of responses at high or extremely high for the 9th-graders at the start of the quizzes compared to 22% for the 11th and 12th-graders (Figure 10). At the higher stakes final exam, students in biology showed higher levels of test anxiety with 41% rating their test anxiety level as high or extremely high (Figure 11a). A&P students had a similar increase in test anxiety with 37.5% of responses at high or extremely high (Figure 11b). In an interview, one student thought test anxiety improved as students got older. She stated,

"People deal with it better now because we are used to having the test anxiety so doesn't bother us as much."

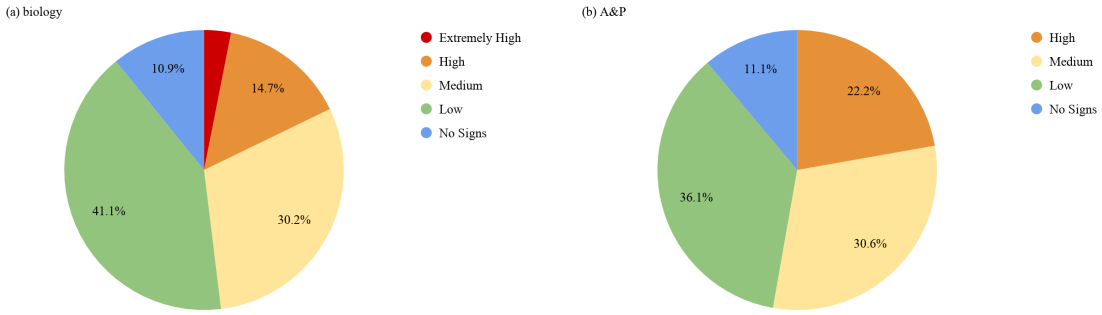


Figure 10. Ratings of test anxiety from students in (a) biology and (b) A&P on the post-quiz survey.

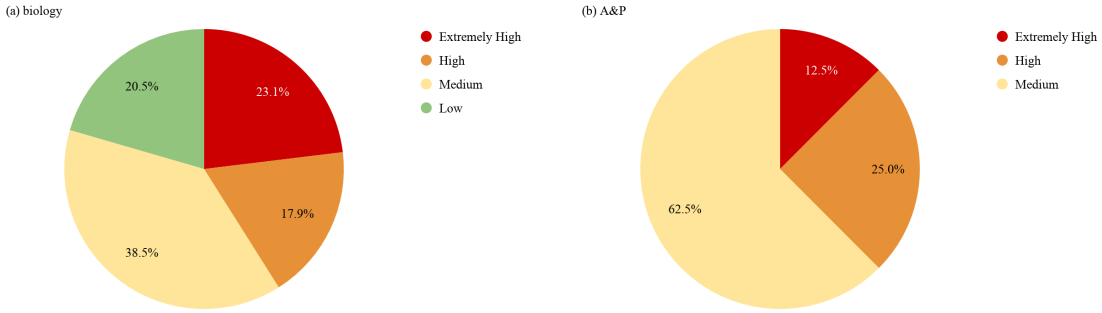


Figure 11. Ratings of test anxiety from students in (a) biology and (b) A&P on the post-final survey.

Student Enjoyment of the Intervention

The Post-Quiz Survey results in biology regarding the prompt "I enjoyed participating in this intervention," showed overwhelmingly positive responses (Figure 12). In an interview, one student stated, "I enjoyed participating in the exercises, and they gave me a better mindset entering the quiz." Calming Counts had the greatest level of

enjoyment with 95% of students responding with either Agree or Strongly Agree. With the Expressive Writing, 79% of students responded favorably, while 86% of students had positive responses following Visualize Joy. For Expressive Writing, the Teacher Journal shows that students expressed a concern that their writing would be seen by someone and students showed an inclination to draw rather than write during the assessment. The Teacher Journal shows that biology students participating in Visualize Joy during one of the blocks were "excited to share their pictures after with each other. Fun energy. One asked to keep it." One student remarked on the Post-Quiz Survey, "I thought it was really fun."

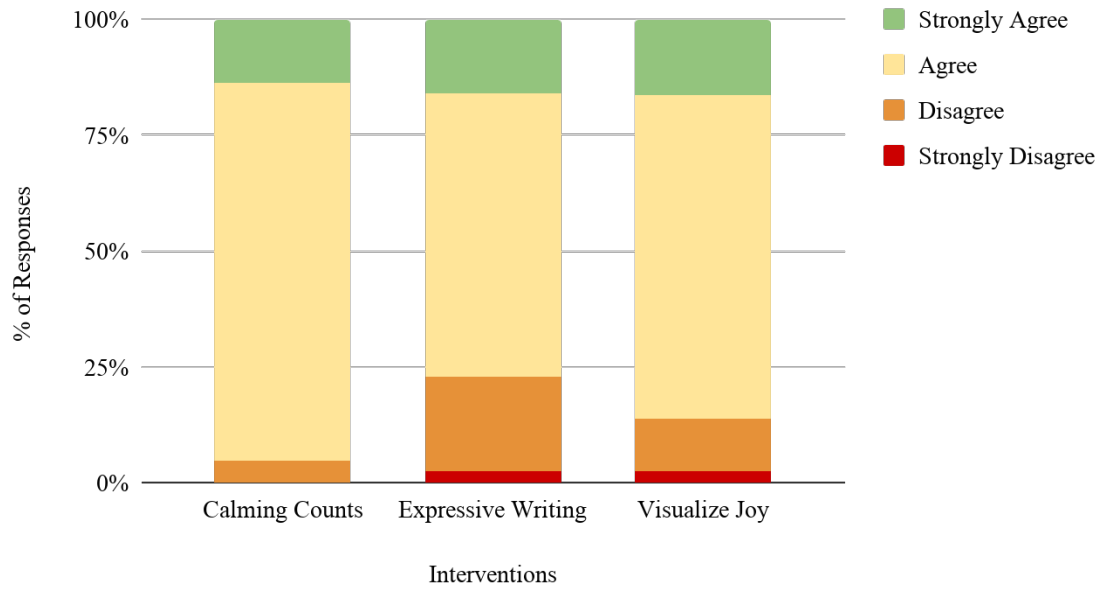


Figure 12. Likert responses from the Post-Quiz Survey in biology related to students' ratings of their enjoyment of participating in the intervention, (*N*=43).

Biology students had lower ratings for all the interventions for the statement, "As a result of this intervention, my experience with this quiz was more positive," though the majority of students did respond positively (Figure 13). Calming Counts had 79% either Agree or Strongly Agree, compared to 60% for Expressive Writing and 63% for

Visualize Joy. The Teacher Journal noted, “Student expressed that they felt more stressed after the Expressive Writing.”

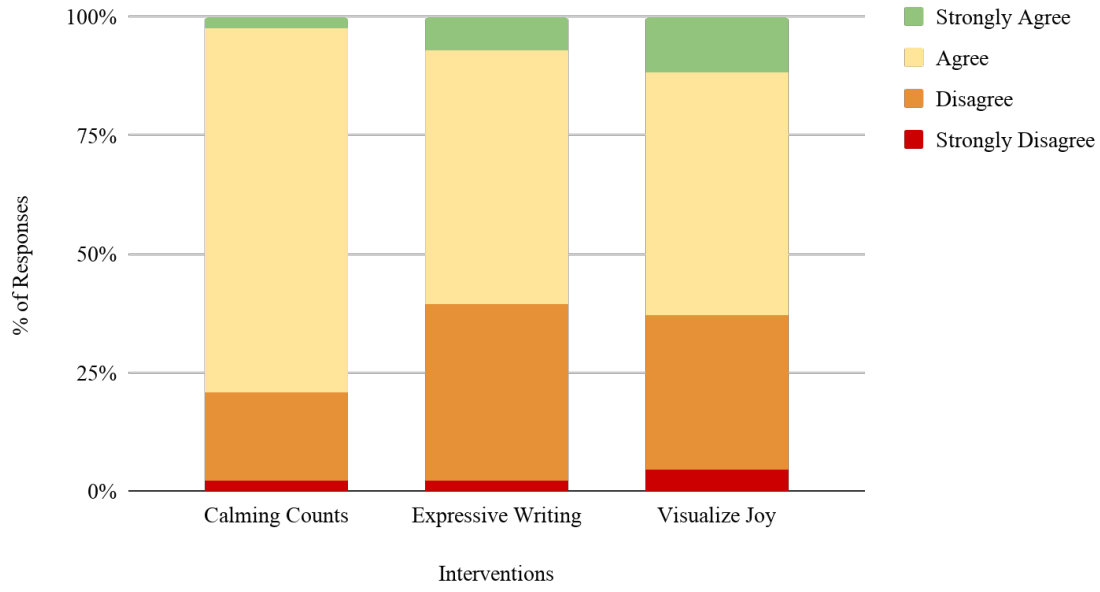


Figure 13. Likert responses from the Post-Quiz Survey in biology related to students’ ratings of “As a result of this intervention, my experience with this quiz was more positive”, (*N*=44).

Students in A&P also showed overwhelmingly positive responses in the Post-Quiz Survey prompt, “I enjoyed participating in this intervention,” (Figure 14). All of the students responded either Agree or Strongly Agree to this statement following the Calming Counts intervention. The teacher journal notes, “Participation varied. Some did not seem to fully engage, others full participation.” Similar to the biology ratings, Expressive Writing showed lower enjoyment with 75% of students responding favorably, compared to 92.3% of students recording positive responses following Visualize Joy. Following the Expressive Writing intervention, the Teacher Journal shows that one student stated, “That was nice.” The Teacher Journal also shows that A&P students were all quietly engaged, more so than with the other activities, for the Visualize Joy

intervention. Despite their enjoyment, A&P students had lower ratings for the statement, "As a result of this intervention, my experience with this quiz was more positive," though the majority of students did respond positively (Figure 15). Calming Counts had 81.8% either Agree or Strongly Agree, compared to 50.0% for Expressive Writing and 61.5% for Visualize Joy.

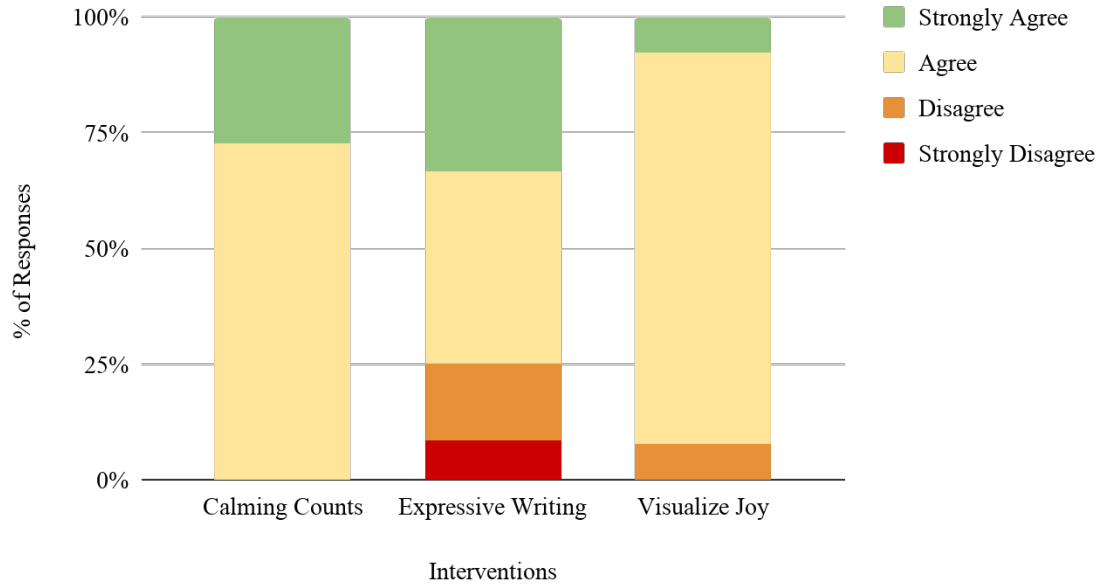


Figure 14. Likert responses from the Post-Quiz Survey in A&P related to students' ratings of their enjoyment of participating in the intervention, (*N*=13).

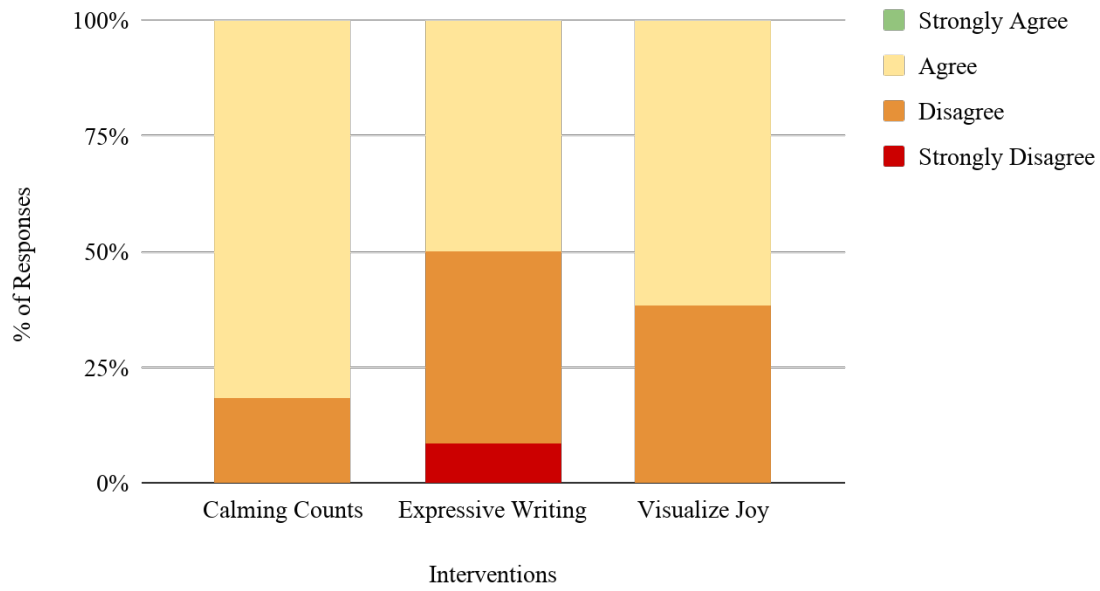


Figure 15. Likert responses from the Post-Quiz Survey in A&P related to students' ratings of "As a result of this intervention, my experience with this quiz was more positive", (*N*=13).

Student Potential for Future Use

When presented the opportunity to implement an intervention prior to the semester exam, the majority of students chose to utilize one with 88% of students in biology (*N*=44) and 77% of students in A&P (*N*=13) (Figure 16). At both age levels, Calming Counts was selected the most, followed by Visualize Joy. Expressive Writing was not selected in biology or A&P. No response does not indicate whether the student did not do an intervention, or if they chose not to respond to the survey.

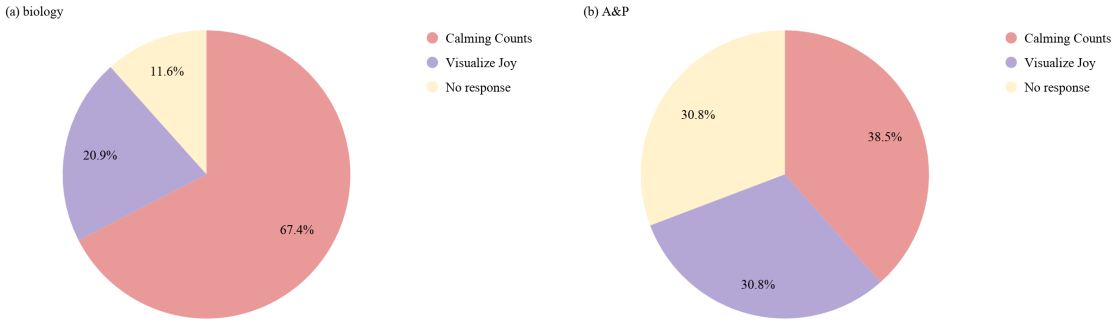


Figure 16. Percentage of students that chose each intervention type for the (a) biology final exam, (*N*=44) and (b) A&P final exam, (*N*=13).

The Post-Quiz Survey results in biology regarding the prompt "I would consider using this intervention on my own for future assessments," showed positive responses for Calming Counts with 74% of students selecting Agree or Strongly Agree (Figure 17a). However, only 32% of students would consider using Expressive Writing on their own and 40% would consider using Visualize Joy. One biology student commented, "I think that sometimes I would rather just start the quiz rather than wait." Anatomy and Physiology students also showed the greatest likelihood of using Calming Counts on their own in the future with 73% of students selecting Agree or Strongly Agree on the Post-Quiz Survey (Figure 17b). Affirming responses came from 50% of A&P students following Expressive Writing and 46% of A&P students after Visualize Joy.

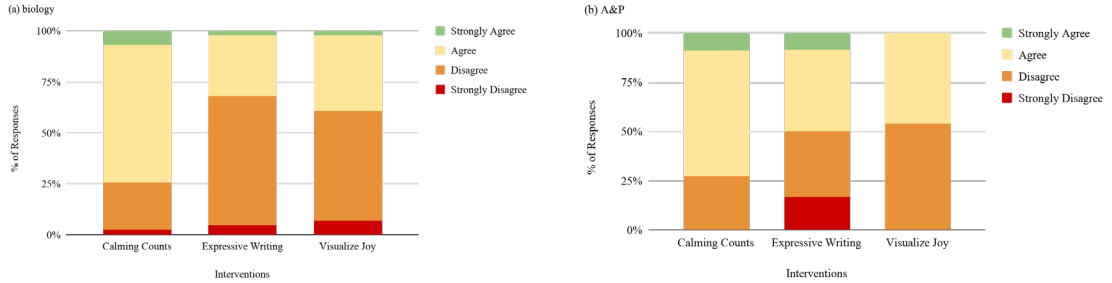


Figure 17. Likert responses from the Post-Quiz Survey related to students' ratings of "I would consider using this intervention on my own for future assessments" in (a) biology, (*N*=44) and (b) A&P, (*N*=13).

The Post-Final Survey in biology showed the majority of students enjoyed the intervention, thought it positively impacted their experience, and would consider using it again on their own with 93%, 83%, and 83% of biology students selecting Agree or Strongly Agree respectively (Figure 18a). As one biology student stated, "I would use it again but I wouldn't want to waste my valuable test time." Anatomy and physiology responses on the Post-Final Survey only selected Agree or Strongly Agree options for the three prompts regarding enjoyment, positive experience and use in the future (Figure 18b). The Teacher Journal notes that A&P students in the extended time room for the final exam were not fully participating and showed concern that they were losing time to answer questions.

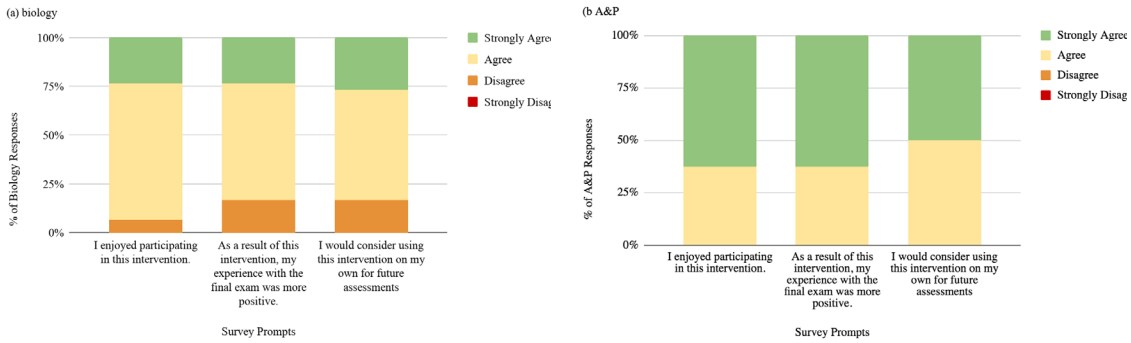


Figure 18. Likert responses on the Post-Final Survey from students that participated in the intervention related to students' experience with the intervention on the final exam in (a) biology, (*N*=30) and (b) A&P, (*N*=8).

INTERPRETATION AND CONCLUSION

The project investigated the impacts of test anxiety interventions on summative assessments. The quiz score data in biology showed significantly higher quiz scores with Calming Counts when compared to no intervention or Visualize Joy, and higher quiz scores with Expressive Writing than Visualize Joy. The quiz score data for A&P showed significantly lower scores for Visualize Joy, but no significant difference between the other quizzes. It is important to note that the quizzes varied tremendously in the level of challenge and the sequence of the interventions was not randomized. These two confounding variables should be considered; hence, it is not definitively clear whether or not the quiz scores were impacted by the intervention. The final exam scores showed no statistical difference between students that participated in Calming Counts, Visualize Joy or no intervention.

The qualitative analysis showed that students enjoyed participating in the interventions and had a more positive experience with the assessment as a result of the

activity. Students preferred the structured breathing during Calming Counts the most, followed by free-draw during Visualize Joy, then writing during Expressive Writing. Though students enjoyed the interventions, teachers need to allow extra time before an assessment for the intervention to mitigate student concerns about losing precious test time.

Younger students and older students had similar levels of test anxiety. Both the quizzes and the final exam showed students in biology and anatomy and physiology with similar ratings of test anxiety. The final exam marked an increase in test anxiety compared to the quiz levels for both ages.

When given the opportunity to participate in a test anxiety intervention prior to a major summative assessment, the majority of students chose to take part. However, students expressed concern about losing time on assessments. Most students stated they were likely to use a test anxiety intervention in the future, with Calming Counts having the most positive responses.

VALUE

The experience of this project has led to two significant changes in my approach to teaching. The first is that my concern about the levels of test anxiety in my students has been reinforced. Students showed a keen interest in this study and longing for ways to reduce their test anxiety. It is now clear to me that I can introduce strategies for test anxiety without losing significant amounts of teaching time. With just a few minutes prior to an assessment, I can provide students with an opportunity to practice a skill for managing their anxiety when faced with stressful situations.

This action research project raised new questions related to test anxiety. I am curious to better understand what factors contribute to test anxiety. I wonder if there are differences in levels of test anxiety related to gender, race, socioeconomic status, or performance level. It seems that peers can influence levels of test anxiety, as frantic energy gets passed around the room prior to assessments. I wonder if there are ways to foster positive relationships around assessments between peers. I notice there seems to be a relationship between feeling prepared for assessments and test anxiety. It would be interesting to study the way different resources for studying and coaching provided by teachers impacts test anxiety. There are many layers worthy of exploring that could impact a student's mental state as they begin an assessment.

Second, developing and conducting this study has been tremendously helpful in cultivating my research skills, which I can then share with my students. Through the literature review process, I have gained insights into how to search for useful articles and critique their reliability. We regularly have students research various topics in our science classes at Marin Academy. I am more equipped to help students navigate ScienceDirect, interpret findings, or utilize the citations to find more sources.

At Marin Academy, all 9th and 11th-graders participate in a Science Symposium project. Students design, implement, and analyze an experiment which they present with a poster at a modified science fair. My study has really helped to refine my thinking on this process. While shaping their experiment, I can suggest triangulating their data and focusing their experimental question on an issue that has personal value. Now I am able to coach students on how to create figures that illustrate their findings and ways to

properly format labels and titles. Even small details, such as including the sample size in the title, will enhance my students' projects. In their scientific writing, I will focus on each paragraph's analysis of results, being sure they present a claim with evidence to support it. I can draw upon the tools I have gained as well as empathize with the challenges they might face. From the work on my project, I feel a greater sense of confidence in guiding my students through their own process.

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APPENDICES

APPENDIX A

EXEMPTION MSU INSTITUTIONAL REVIEW BOARD

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

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Chair: Mark Quinn
406-994-4707
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Administrator:
Cheryl Johnson
406-994-4706
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MEMORANDUM

TO: Randi Bakken and John Graves

FROM: Mark Quinn Mark Quinn CTJ
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: October 30, 2018

RE: *"The Impact of Test Anxiety Interventions" [RB103018-EX]*

The above research, described in your submission of October 30, 2018, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

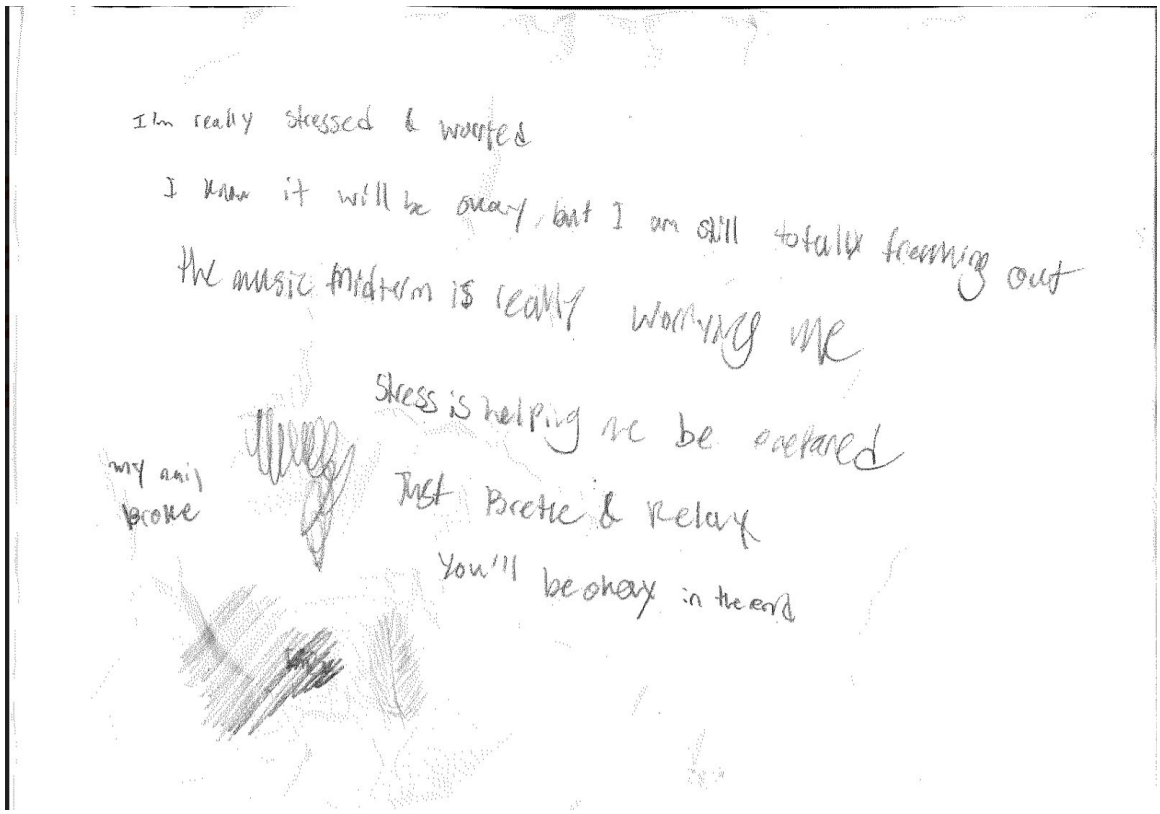
APPENDIX B

STUDENTS PARTICIPATING IN CALMING COUNTS



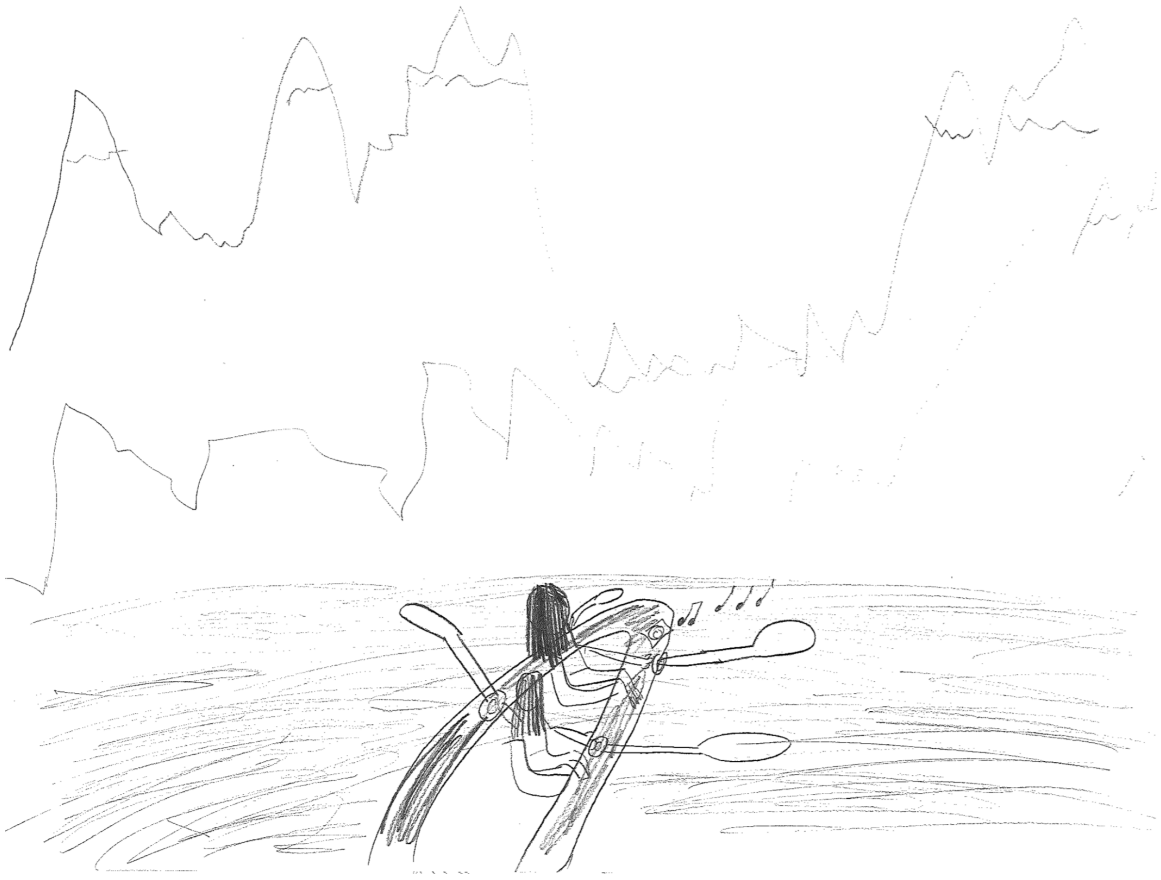
APPENDIX C

STUDENT SAMPLE FROM EXPRESSIVE WRITING


I'm really stressed & worried
I know it will be okay, but I am still totally freaking out
the music midterm is really worrying me
Stress is helping me be prepared
my nail broke
Just Breathe & Relax
You'll be okay in the end

APPENDIX D

STUDENT SAMPLE FROM VISUALIZE JOY



APPENDIX E

TEST ANXIETY INTERVENTION DIRECTIONS

Calming Counts

1. Sit comfortably.
2. Take a long, deep breath and exhale it slowly while saying the word "relax" silently.
3. Close your eyes.
4. Let yourself take ten natural, easy breaths. Count down with each exhale, starting with "ten."
5. This time, while you are breathing comfortably, notice any tensions, perhaps in your jaw or forehead or stomach. Imagine those tensions loosening.
6. When you reach "one," open your eyes again.

Expressive Writing

1. Write down any thoughts you have for 3 minutes.
2. When directed, crumple your paper and put in the recycling bin.

Visualized Joy

1. Think of a place or an activity that makes you happy.
2. Take 3 minutes to draw an image of yourself in this scene.
3. When directed, crumple your paper and put in the recycling bin.

APPENDIX F

FINAL EXAM INTERVENTION DIRECTIONS

Final Exam Intervention Options

You will have 5 minutes prior to the start of the exam to implement a tool for test anxiety. Choose either Calming Counts, Expressive Writing, or Visualized Joy. Participation this activity is optional and has no impact on your grade or standing in the class. You may choose to sit quietly until the start of the exam instead. Record on your exam which option you have chosen. Following your exam, please answer the short survey in your email. You will have an extra 15 minutes added to the final exam period to complete this work.

Thank you!

Calming Counts

1. Sit comfortably.
2. Take a long, deep breath and exhale it slowly while saying the word "relax" silently.
3. Close your eyes.
4. Let yourself take ten natural, easy breaths. Countdown with each exhale, starting with "ten."
5. This time, while you are breathing comfortably, notice any tensions, perhaps in your jaw or forehead or stomach. Imagine those tensions loosening.
6. When you reach "one," open your eyes again.

Expressive Writing

1. On the back of this paper, write down any thoughts you have for 3 minutes.
2. When directed, crumple or shred your paper and put in the recycling bin.

Visualized Joy

1. Think of a place or an activity that makes you happy.
2. Take 3 minutes to draw an image of yourself in this scene on the back of this paper.
3. When directed, crumple or shred your paper and put in the recycling bin.

APPENDIX G

POST-QUIZ SURVEY

Post-Quiz Survey: to be implemented following each of the 3 interventions

Participation in this survey is voluntary and has no impact on your grade or standing in the class.

1. As I walked into class today before the intervention, my anxiety level was…
    a. Extremely high
    b. High
    a. Medium
    c. Low
    d. No signs of anxiety

2. After we practiced the intervention, my anxiety level was....
    a. Extremely high
    b. High
    a. Medium
    c. Low
    d. No signs of anxiety

3. I enjoyed participating in this intervention.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree

4. As a result of this intervention, my experience with this quiz was more positive.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree

5. I would consider using this intervention on my own for future assessments.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree

6. Is there anything else you would like me to know?

APPENDIX H

POST-FINAL SURVEY

Final Exam Survey: to be implemented following the semester 1 final exam
Participation in this survey is voluntary and has no impact on your grade or standing in the class.

1. As I walked into the final exam today before the intervention, my anxiety level was…
    a. Extremely high
    b. High
    c. Medium
    d. Low
    e. No signs of anxiety

2. For my test-anxiety intervention, I chose:
    a. Breathing
    b. Writing
    c. Drawing
    d. No intervention
    e. Other:

3. After the intervention, my anxiety level was....
    a. Extremely high
    b. High
    c. Medium
    d. Low
    e. No signs of anxiety

4. I enjoyed participating in this intervention.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree

5. As a result of this intervention, my experience with the final exam was more positive.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree

6. I would consider using this intervention on my own for future assessments.
    a. Strongly Agree
    b. Agree
    c. Disagree
    d. Strongly Disagree
7. Is there anything else you would like me to know?

APPENDIX I

INTERVIEW QUESTIONS

Interview Questions

Participation in this interview is voluntary and has no impact on your grade or standing in class.

General Questions:

1. Do you notice test anxiety at MA? More with a particular grade level? Subject area?

2. Have any of your teachers tried techniques to help students with test anxiety? What were they? Did they seem helpful?

3. What types of things do you do just before assessments? For each, does it help your anxiety or contribute to it?

4. Are there factors that increase the likelihood that you will experience test anxiety? What are they? Anything from the classroom? Teachers? Peers?

Intervention Questions:

1. Did you notice any differences between coming into the quiz and after the intervention? What things did you notice?

    a. Did intervention impact your physical body at all? Heart rate, breathing, etc? Describe these.

    b. Do you think the intervention impacted your mindset? Describe.

2. In what ways was your performance affected by this intervention?

3. In what ways was your experience with the quiz affected by this intervention?

4. Would you use this tool again? Why or why not?

Final Exam Questions:

1. Which test anxiety intervention did you choose? Why did you choose this one?

2. Did you notice any differences between coming into the final and after the intervention? What things did you notice?

    a. Did intervention impact your physical body at all? Heart rate, breathing, etc? Describe these.

    b. Do you think the intervention impacted your mindset? Describe.

3. In what ways was your performance affected by this intervention?

4. In what ways was your experience during the final affected by this intervention?

5. Would you use this tool again? Why or why not?

All:

1. Is there anything else you would like to share with me?

APPENDIX J

TEACHER JOURNAL EXCERPT

11/27 Quiz 1 Anatomy (Calming Counts) *N*= 12, 7 points

- Content = autonomic nervous system
- Layne absent
- Participation varied. Some did not seem to fully engage, others full participation
- No tutorial before quiz. No review sheet until the night before
- New quiz - had not given this one before
- Originally 8 points, burt had to omit question on CNS

11/29 -11/30 Quiz 2 Biology (Expressive Writing) *N*=44, 12 points

- Content - transcription & translation
- Cupcake activity between the intervention and the kids. All kids loved the activity and mood was drastically changed (joyful)
- C Block (15)
    - Sophia absent
    - Lots of busy pens. All seem quiet and engaged in writing
    - Tough quiz
    - "Is anyone going to see this?"
    - 4 students ripped up their papers. 1 asked to keep it.
    - 1 guest so had a change in beginning flow
- F Block (15)
    - All present.
    - 2 students asked if they can draw. I said no, just writing for today. Next time we will draw.
    - 2 students not engaged, rest all writing.
    - Several seem to be sketching rather than writing.
    - Student expressed that they felt more stressed after the EW
- G block (14)
    - Class started late and all a bit giddy
    - 1 guest so had a change in beginning flow

11/29 Quiz 2 Anatomy (Expressive Writing) *N*=11, 7 pts

- Content = neuron structure
- Kevi absent, Layne not taking quiz
- No review sheet & forgot to input in my MA
- All seem to write for full 3 min. Some eye contacts and laughing and looking at other papers. Two student drawing a diagram of the content (synapse)
- "That was nice"

12/3 Quiz 3 Anatomy (Visualized Joy) *N*= 13, 12 pts

- Content = neuron physiology
- Tough content!
- All present
- Some laughter. All seemed quietly engaged, more so than with the other activities (training or enjoyment?).

12/3 Quiz 3 Biology (VJ), *N*=44, 10 pts

- Content - protein folding and enzyme activity
- C Block (15)
    - Sophia not taking quiz
    - Some laughing and whispering.
    - Excited to share their pictures after with each other. Fun energy. One asked to keep it.
- G Block (14)
    - All present. 2 shadows
    - Quiet and engaged in activity. Some using color pens.
- F Block (15)
    - All present
    - Seems most quietly engaged. 2 students not participating fully.