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# Math Anxiety and Assessment Strategies

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by

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Math Anxiety and Assessment Strategies

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## Abstract

This action research study investigated the connection between student choice and the levels of math anxiety exhibited in Geometry students at a Christian high school in the Twin Cities in Minnesota. The participants were 38 ninth, tenth, and eleventh grade students separated in three sections of Geometry. This study was conducted to see if providing choice would effectively combat the perceived stress and anxiety associated with math classes. Students were offered a choice of review projects that would be used to prepare them for an upcoming test. No other changes were made in the classroom. Class presentations, discussions, and assessments were given as normal throughout the study. However, during the review time, students were given opportunity to work on their review projects individually or collaboratively. Each student was responsible for turning in his/her own individual project. The results of the study were mixed; however, responses to survey questions administered after the study indicated that students with lower average grades perceived a benefit to the activity. These students felt more prepared and their average scores improved on statements relating to solving hard math problems.

*Keywords*: Math Anxiety

The National Council for Teaching Mathematics (NCTM) addressed the need for all students to have access to learning and understanding math throughout elementary, middle, and high school noting that all students must develop math skills even though many students find it difficult to learn the material (NCTM, 2000). Many students have developed fear and anxiety while struggling to build a foundation necessary to find success and confidence in math classes. In order to build the high quality math programs outlined by the NCTM, teachers must address the issue of math anxiety as they develop their curriculum and assessments.

Additionally, research studies have shown that math anxiety is associated with the area of the brain which registers pain (Lyons & Beilock, 2012). Since math anxiety can literally be considered a painful experience to some students, it is important that teachers understand how to help students address the causes and reduce the effects of math anxiety.

**Statement of the Problem**

There are many factors to consider when studying the issue of math anxiety. Parental and teacher attitudes toward the subject have been linked to math anxiety in students (Smith, 2004). Prior negative experiences can also have an impact on a student's view of mathematics and lead to increased math anxiety (Rossnan, 2006). However, the surprise in recent research is that studies show "neural evidence that the negative relation typically seen between math anxiety and math competence arises even before math performance begins" (Lyons & Beilock, 2011, p. 1). Students are actually feeling the effects of math anxiety when they are thinking about doing math, not just when they are in the process of performing math problems. In order to have an impact on the problem, therefore, the solution must address not only the attitudes of students while they are performing math problems, but must also address the state of mind the students have when they are preparing to perform the math problems.

Researchers have proposed potential solutions to the problem of math anxiety including providing better teacher training, giving students an outlet for their anxiety through writing, enhancing basic skills and understanding of math facts, and providing students a choice in their assessments (Beilock & Willingham, 2014). One solution that seems to address the anxiety experienced prior to the math experience is that of providing choice in assessment. This solution may give students an outlet and provide an alternative to traditional testing which could be adding to the stress of anticipating and performing math skills. To address the issue of math anxiety, this research study explored the following questions:

**Research Questions**

1. Does offering a choice of review activities to math students help students feel more prepared for a test?
2. Will the quality of individual student's work affect the levels of perceived preparedness?
3. Will the choice of review activities affect students' perceived levels of math anxiety?

**Definition of Terms**

A basic set of definitions is necessary to provide a foundation for discussion in this study. Unless otherwise stated, all definitions are presented by the author. For the purpose of this paper, the following definitions are utilized:

*Diagnosed anxiety* – A professional assessment of a student's level of stress associated with performing and understanding math skills.

*Highly math anxious students (HMA)* – Students who display a high level of stress associated with performing math skills.

*Low math anxiety students (LMA)* – Students who display a low level of stress associated with performing math skills.

*Math anxiety* – "Math anxiety is a learned emotional response to one or more of the following: participating in a math class, listening to a lecture, working through a math problem, discussing mathematics. Moreover, such anxiety can happen on elementary school children, high school and college students" (Rossnan, 2006).

*Perceived anxiety* – A student's view of how much stress and fear he/she has for performing and understanding math skills.

*Self-Efficacy* - "Self-efficacy is defined as a self-evaluation of one's confidence to successfully execute a course of action necessary to reach desired outcomes" (Zajacova, Lynch, & Espenshade, 2005, p. 678).

*Working memory capacity* – Cognitive system responsible for holding temporary information available for processing.

## Literature Review

Math anxiety can have a debilitating effect on people. Tobias (1993) as cited in Rossnan (2006) stated that millions of adults are limited in their professional and personal lives because of their fear of math or because of their poor performance in math (Rossnan, 2006). Based on these estimates, it is essential for math teachers to address math anxiety and come up with potential solutions to high levels of math anxiety in students. In order to combat the effects of math anxiety, Rossnan (2006) recommended several strategies including varied teaching strategies, active learning, presenting interesting lessons, and facilitating successful activities. Students are more apt to show interest in the material if they enjoy the activity and see a use for the curriculum in their lives. Encompassing all of these strategies and ideas, Rossnan (2006)

reminds teachers that cooperative learning is another beneficial teaching practice to consider in their classrooms.

Daneshamooz and Alamolhodaci (2012) verified the impact of cooperative learning in a study they conducted on the effect of math anxiety and working memory capacity on the mathematical performance of college students using three different learning methods. In this study, college students were taught three chapters of Calculus. The students were placed in one of three groups: an e-learning group, a cooperative learning group, and a traditional classroom group. The students in the e-learning group worked in isolation from the rest of their classmates. They downloaded online modules, watched videos, and corresponded with the teacher via email and video conference. The students in the cooperative class worked together in groups of 4-5 students monitored by a teacher. The students in the traditional classroom learned the material in a lecture-style classroom. One result of this study was that students in the cooperative learning group had significantly higher test scores than students in the other two groups. Another result from this study was that the e-learning group exhibited the highest levels of math anxiety and working memory capacity. Results from students in the traditional group fell between the other two groups in all categories. The results of this study indicated the need for students to work cooperatively and to move beyond high working memory capacity to understand math. Daneshamooz and Alamolhodaci (2012) found that high working memory was necessary for students to perform complex mathematical problems, but active learning and discussions were beneficial to students in retaining information and lowering math anxiety.

High working memory capacity has been correlated with high levels of math anxiety and low math achievement levels in other studies as well (Ramirez, Gunderson, Levine, & Beilock, 2013). Ramirez et al (2013) conducted a study involving 154 elementary students. They

measured the students' levels of math anxiety, working memory capacity, and math achievement looking for a correlation between each of these traits. Students took the Woodcock-Johnson achievement tests, along with the Child Math Anxiety Questionnaire, and the WISC-III Digit Span subtest. The results of this study showed that students displaying higher levels of math anxiety along with high working memory capacity were significantly more likely to display lower math achievement levels than students with lower levels of math anxiety or even high levels of math anxiety and lower working memory capacity (Ramirez et al, 2013). In their discussion on these findings, Ramirez, et al (2013) hypothesized that the higher levels of math anxiety disrupted the students' abilities to utilize their higher levels of working memory capacity, and without the ability to draw on their working memory, these students had not developed strategies necessary to overcome their struggles.

The issue remains: how can classroom teachers address the issues of math anxiety in their students? Cooperative learning is one strategy, but more must be done to combat the causes and symptoms of math anxiety. Several researchers suggest changing teaching strategies and assessment methods to help alleviate the strain of math anxiety in students (Bielock & Willingham, 2014, Iossi, 2007, Smith K, 2009, Smith M, 2004).

While research studies indicate that strategies can be implemented during math instruction to help alleviate math anxiety, newer research shows that the effects of math anxiety are exhibited at a higher level during the anticipation of doing math tasks compared to the act of actually performing the tasks. (Lyons & Beilock, 2012). In a study that measured brain activity through fMRI scans, students were believed to experience pain during times of anticipation of performing math activities (Lyons & Beilock, 2012). Lyons and Beilock (2012) separated students into two groups: high level math anxiety and low level math anxiety students. Students

in both groups were given a series of problems involving word association problems or math problems. The problems varied in their degree of difficulty from easy to hard. The conclusions from the testing showed "(1) neural evidence that the negative relation typically seen between math anxiety and math competence arises even before math performance begins, and (2) how some HMAs may overcome this math specific deficit" (Lyons & Beilock, 2011, p. 7). Further, Lyons and Beilock (2011) showed that the mechanisms associated with dealing with the reduction or elimination of the effects of the anxiety were initiated before the actual math problem solving began.

"Self-efficacy is defined as a self-evaluation of one's confidence to successfully execute a course of action necessary to reach desired outcomes" (Zajacova, Lynch, & Espenshade, 2005, p. 678). A student's perception of classroom environment has been directly connected to students' self-efficacy (Fast, Lewis, Bryant, Bocian, Cordullo, Rettig, & Hammond, 2010). Fast et al (2010) studied 1163 students in fourth, fifth, and sixth grade from California. Students were given the California Standards Test to measure math competency and the Student Motivation Questionnaire to measure self-efficacy. The results of this study showed a significant connection between positive classroom environment and higher levels of student self-efficacy. Positive classroom environment attributes were described as caring, challenging, and mastery oriented. The researchers also connected a higher level of self-efficacy to stronger levels of math performance. Students performed better on math tasks when they exhibit higher levels of self-efficacy. Students also exhibited higher levels of self-efficacy when they continue to perform well on math tasks. The correlation between successful past experiences and higher self-efficacy is confirmed by Loo and Choy (2013). Loo and Choy surveyed 174 college students majoring in Engineering. The purpose of their study was to connect higher achievement levels in math and

engineering classes to higher levels of self-efficacy in students. In this study, Loo and Choy (2013) found that mastery experience was the strongest indicator of academic achievement as well as self-efficacy. Students' judgements were based primarily on actual experience when solving math problems rather than students' feelings of their abilities in math.

Innovative and creative teaching methods are needed to combat the issue of math anxiety. Collaborative classrooms have been shown to have a positive impact on math anxiety. Providing students with a choice of review assignments along with a collaborative environment could show students that teachers care about their education, wish to challenge and enrich their learning, and want to focus on mastery and ownership of understanding rather than a checklist of skills. Since the brain senses math anxiety as pain even before the task of completing math problems begins (Lyons & Beilock, 2012), there seems to be a need to involve students in the process of selecting and modifying assessments for math ability and knowledge. In knowing what to expect as well as having a better understanding what is expected, students could then focus on the task of mastering the material rather than anticipating their performance on a test.

## Methods

Math anxiety can have a debilitating effect on high school mathematics students. Strategies have been suggested and tested to provide abatement for the stress and trouble caused by math anxiety. One possible treatment for math anxiety that has been repeatedly suggested is student choice in assessments. This study provided participants options during formative assessment and during preparation for a unit test. Participants proceeded as normal through a unit on area of polygons. At the conclusion of the unit, participants were given a review assignment. Participants were able to choose from a list of four activities to complete as their review assignment: 1) Create a review sheet with an answer key, 2) Complete an online study set

utilizing the website Quizlet, 3) Create a set of flashcards with definitions and sample problems from the unit, or 4) Meeting with the teacher and presenting the solutions to a teacher provided review sheet for the unit. Participants were able to work cooperatively on their projects, but each student was ultimately be responsible for turning in an individual project. Participants took a MAS assessment prior to the start of a unit in Geometry to get a baseline score for math anxiety. A post-test assessment using the same MAS assessment was utilized, along with a class survey to gauge the effects that the choice of projects had on the perceived levels of test preparedness and math anxiety in the participants.

**Participants**

The participants in this study were 38 high school Geometry students from a suburban Christian school. Participants were enrolled in one of three sections of Geometry classes at this school and all three sections participated in the study. The assignment of each class was determined by the master schedule in relation to the core classes and electives each individual student had chosen. Class sizes ranged from 12-16. The participants' make up was largely homogeneous in terms of age, ethnicity, and socioeconomic status. The participants were high school students primarily in ninth or tenth grade. A parental consent form (see Appendix A) was sent home for parent approval.

**Materials**

In order to determine the level of anxiety exhibited in the participants of the study, a version of the MAS (Math Anxiety Scale) assessment was used. The assessment is based on the work of Betz (Johnston-Wilder, Brindley & Dent, 2014) with general permissions given for the use of the test content for non-commercial and educational research. The test utilized ten statements given to students with a rating scale: "strongly agree," "agree," "undecided,"

"disagree," and "strongly disagree." Each positively worded statement was given 1 point for a "strongly agree" response, 2 points for an "agree" response, 3 points for "undecided," 4 points for a "disagree" response, and 5 points for a "strongly disagree" response. Each negatively worded statement was given 1 point for a "strongly disagree" response, 2 points for a "disagree" response and so forth.

A survey was also distributed to participants following the final math assessment. The survey addressed the perceived levels of preparedness students felt during the review activity as well as the impact that the activity had on participant stress levels before the test. The surveys were collected, analyzed and coded based on similarity in response wording.

The independent variable of this experiment was the choices of the review activity. The participants were given a review assignment which directed them to create a review project. There were four activities from which to choose. Participants could choose to create a review sheet which would mirror sample problems given to them in their assignments. Participants could alternately choose to create flashcards to help them study for the upcoming test. These flashcards were to include formulas utilized in the chapter as well as sample problems similar to those given previously in chapter assignments. Participants had the choice of creating their flashcards on notecards or electronically utilizing the website Quizlet.com. The final option that students could choose involved preparing a review presentation. Participants could fill out a teacher-provided review sheet and present the solutions of this worksheet to the teacher individually.

The dependent variable was the math anxiety levels perceived in the participants. The MAS (Math Anxiety Scale) was utilized to measure the participants' level of anxiety prior to the

unit and following the assessment of the unit. A survey was also distributed to collect feedback of participants' level of preparedness and understanding following the unit assessment.

**Procedure**

At the completion of the Geometry unit, the data from the pre- and post- assessments were entered into an Excel spreadsheet to help organize categories of students and calculate changes in perceived math anxiety scores. Surveys (see Appendix C) were also distributed to participants following the post-assessment for added depth in feedback. The surveys focused on participant reactions to having choice in the review process. Results from the MAS assessment along with feedback from the surveys were utilized to better understand the correlation between student choice in preparation for tests and levels of math anxiety.

## Results

**Research Question One**

The first research question asks the following: Does offering a choice of review activities to math students help students feel more prepared for a test? To answer this question, the researcher gave the students in the Geometry classes the choice of four review activities. A survey was also given to all students to gain a better perspective of individual reactions to the activity.

One of the questions on the survey (Question #3) asked students if the review activity helped them feel prepared for the test. Students responses were placed in three categories: "yes," "no," and "unsure." Students who responded with answers similar to "so-so" or "maybe" were placed in the unsure category. All other responses were clearly defined as "yes" or "no" responses.

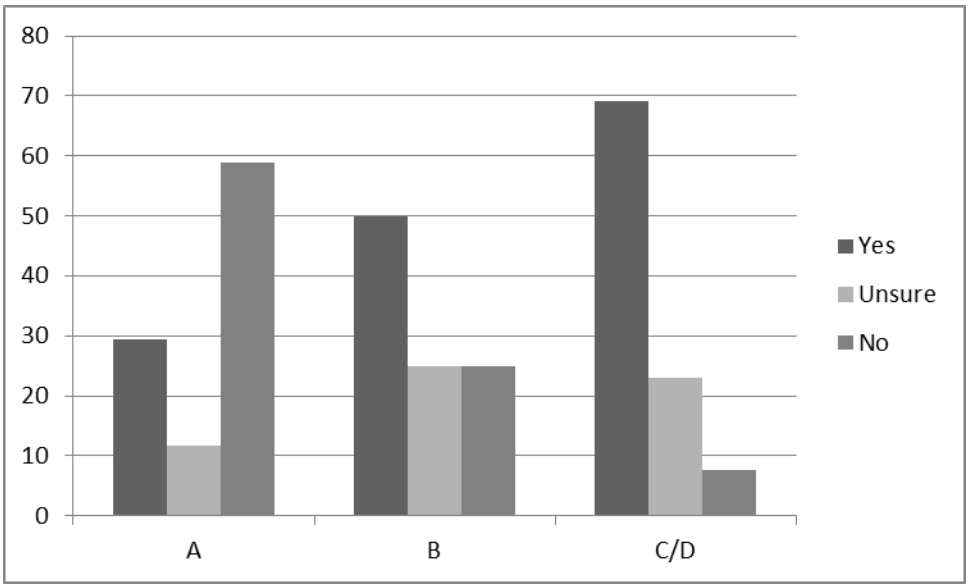


*Figure 1.* Bar graph of responses to question #3. Percent of responses by category of fall semester grades.

Figure 1 reflects the responses of students to the question: “Did this choice help you feel more prepared for the test?” The biggest difference from category to category was found in the number of “no” responses in each category. Students who earned As during the fall semester, were much less likely to see a correlation between the activity and the level of preparation they felt prior to the test. Fifty-nine percent (ten of seventeen students) in this category did not think that their choice of review activity helped them prepare for the assessment. Students who earned Bs during the fall semester were more evenly split in responses. Twenty-five percent (two of eight students) in this category thought the review activity helped them prepare for the test. Students who earned Cs and Ds in the class during the fall semester were much more likely to see a benefit to their preparation following the review activity. Only eight percent (one student out of thirteen) of the students earning Cs and Ds thought that his/her choice in the review activity did not help in preparation for the chapter test.

Students were also asked whether they would like to have more choices like this project in the future. A positive response to this question could further illustrate the students' connection between student choice and test preparation. The results from the data were categorized in a similar manner to survey question #3. Figure 2 shows the distribution of these responses.

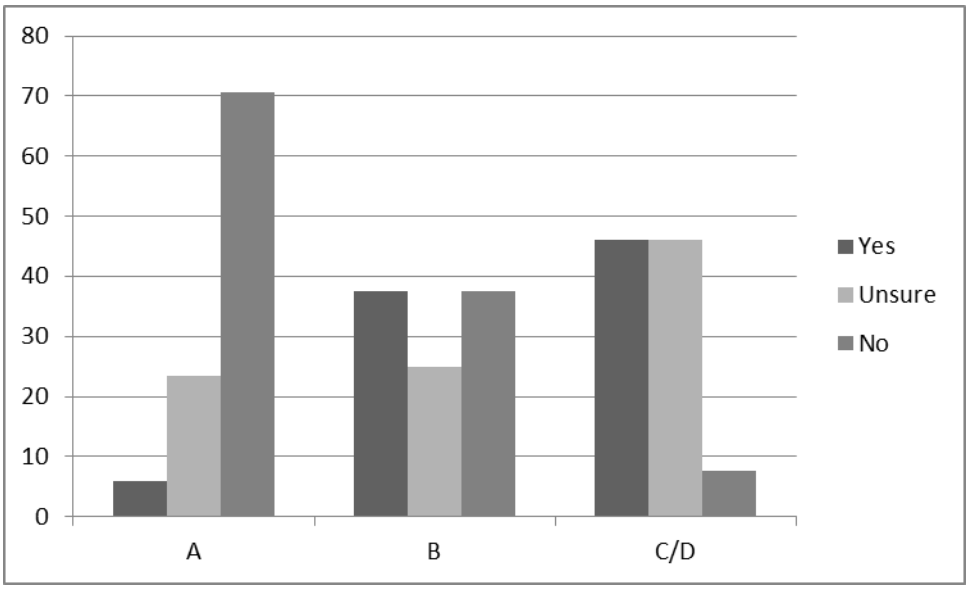


*Figure 2.* Bar graph of responses to question #13. Percent responses categorized by students' fall semester grades.

The results of this data again show the reaction to the activity and its potential to aid in student grades and understanding. Students who earned As showed much less desire to do more activities similar to the review activity. Six percent of the student responses (one student) was "yes," twenty-four percent of the student responses (four students) were "unsure," and seventy-one percent of the student responses (twelve students) were "no." Seventy-one (twelve of seventeen students) in this category responded that they would not like to have more review activities like this project in the future. Students who earned Bs were more evenly distributed as thirty-eight percent of the student responses (three students) in this category were "yes," twenty-five percent of the student responses (two students) were "unsure," and thirty-eight percent of the

student responses (three students) were “no.” Students who earned Cs and Ds during the fall semester, however, showed a higher likelihood to agree to another activity similar to the review activity. Only eight percent (one of thirteen students) who received grades in the C/D range during first semester responded that they would like more review activities in the future. Forty-six percent of the students in the Cs and Ds category (six students) in this category responded “yes,” and forty-six percent of the students in the Cs and Ds category (six students) had “unsure” responses to this question.

**Research Question Two**

Research question two asked the following: Will the quality of an individual student’s work affect the levels of perceived preparedness? The review activities were assessed and separated into three levels of quality: excellent, average, and poor. Activities were assessed based on their levels of completeness, accuracy of answers, and the similarity between the student-developed questions to the actual questions utilized in class as review questions. Figure 3 breaks down the percentage of responses to Survey Question # 3 based on the quality of student activities. Numbers shown in the table represent percentages of students in each category.

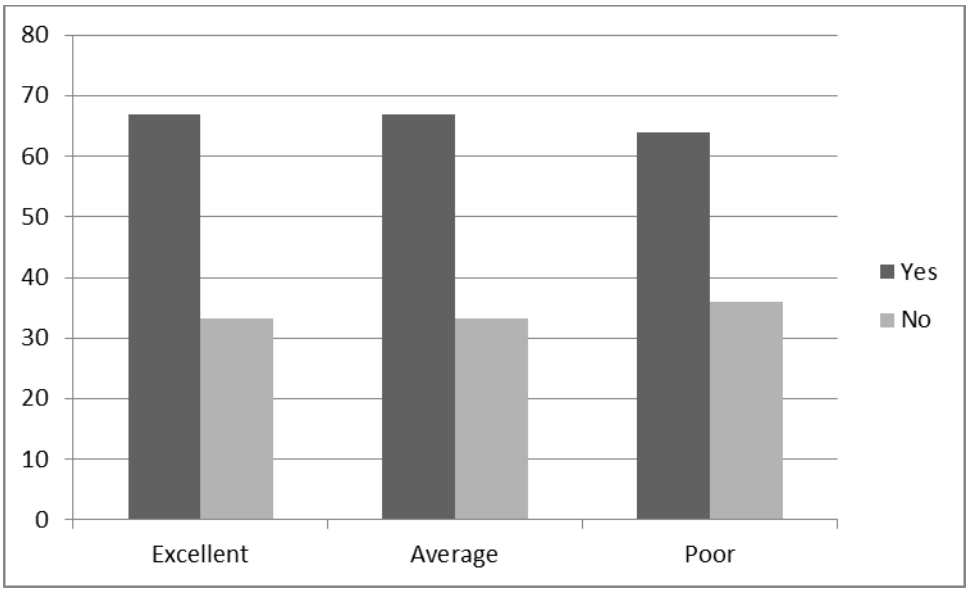


*Figure 3:* Percentage Responses to Help with Preparedness

The data shows a similar situation in each category of activity. Sixty-seven percent (8 of 12 students) who turned in excellent activities reported that they thought the activity helped them with preparation. Sixty-seven percent (10 of 15 students) who turned in average activities reported that they thought the activity helped with preparation. Sixty-four percent (7 of 11 students) who turned in poor activities reported that they thought the activity helped them with preparation.

In order to code the data to this question, responses were categorized based on class discussions following the survey. Several students responded with answers such as “kinda,” “somewhat,” or “a little” to this question. Through class discussions it was revealed that these responses were meant to affirm the perception that the students felt the activity helped with preparation. Therefore, these types of responses were categorized with the “yes” responses. There were 3 of these responses in the excellent category, 2 of these responses in the average category and 2 of these responses in the poor category.

**Research Question Three**

The final research question asked the following: Will the choice of review activities affect students' perceived levels of math anxiety? In order to answer this question, students were given the MAS assessment before starting the unit and again following the completion of the unit after students took the chapter test. Table 1 presents the MAS scores.

Table 1

*MAS Average Scores by Statement Number*

| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
|---|---|---|---|---|---|---|---|---|---|---|
| Pre-Test | 3.368 | 2.947 | 2.816 | 3.132 | 3.053 | 2.553 | 3.132 | 2.868 | 2.789 | 2.947 |
| Post-Test | 3.053 | 2.921 | 2.763 | 3.000 | 3.079 | 2.789 | 2.947 | 2.816 | 2.816 | 2.947 |
| p-value | 0.032 | 0.838 | 0.600 | 0.405 | 0.845 | 0.152 | 0.334 | 0.756 | 0.856 | 1.000 |

Based on the data in the table, the most significance was noted in the responses to Statements 1 and 6. Statement 1 showed significance ($p = 0.032$) as the average score dropped from 3.368 to 3.053. These scores represent student responses on a Likert scale assessment of perceived anxiety. A score of 1 refers to a response of "strongly agree" to a positive statement (Statements 1-5) and "strongly disagree" to a negative statement (Statements 6-10). A score of 2 represents a student response of "agree" to a positive statement and "disagree" to a negative statement. This pattern continues up to a highest response score of 5.

Statement 1 dealt with taking more math classes. Based on student questions during the study, however, this statement may have had flaws. Students were confused by this statement because all students in the study were required to take four years of math in order to graduate. Students were not sure if this statement meant that they would have to take additional classes as electives or if this simply was a hypothetical question asking if they would like to take more math classes. Based on the confusion surrounding this statement, this question was eliminated

from consideration and the study focused on the other statements included in the MAS Assessment.

Statement 6 showed a slight statistical significance (p = 0.152). This statement reads, “I get really uptight during math tests.” An increased average response from 2.553 to 2.789 for this statement shows that the activity used in the study may have had a negative impact.

Table 2 shows the pre-test and post-test scores of student anxiety ratings categorized by the quality of the activities.

Table 2

*MAS Average Scores by Project Quality*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | **Poor Projects** | | | | | | |
| Question | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 3.727 | 3.364 | 3.091 | 3.455 | 3.364 | 3.182 | 3.636 | 3.000 | 3.091 | 3.364 |
| Post-Test | 3.182 | 3.545 | 3.000 | 3.545 | 3.636 | 3.364 | 3.636 | 3.000 | 3.273 | 3.364 |
| p-value | 0.052 | 0.441 | 0.724 | 0.676 | 0.277 | 0.441 | 1.000 | 1.000 | 0.506 | 1.000 |
| | | | | **Average Projects** | | | | | | |
| Question | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 3.313 | 3.000 | 2.875 | 3.188 | 3.250 | 2.688 | 3.375 | 3.563 | 3.438 | 3.750 |
| Post-Test | 3.188 | 2.938 | 2.938 | 3.188 | 3.063 | 3.125 | 3.313 | 3.188 | 3.500 | 3.688 |
| p-value | 0.546 | 0.774 | 0.582 | 1.000 | 0.334 | 0.150 | 0.818 | 0.212 | 0.774 | 0.792 |
| | | | | **Excellent Projects** | | | | | | |
| Question | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 2.917 | 2.417 | 2.500 | 2.833 | 2.667 | 2.083 | 2.667 | 2.250 | 2.167 | 2.083 |
| Post-Test | 2.583 | 2.250 | 2.333 | 2.333 | 2.750 | 2.083 | 2.167 | 2.583 | 2.000 | 2.167 |
| p-value | 0.266 | 0.438 | 0.339 | 0.166 | 0.754 | 1.000 | 0.256 | 0.266 | 0.551 | 0.754 |

Statement 4 showed a slight statistical significance (p = 0.166) in the excellent category. This statement reads, “I usually don’t worry about my ability to solve math problems.” This was the only statement that showed positive statistical significance in the table. There was a slight

statistical significance found in Statement 6. Students who turned in average projects had increased responses scores to Statement 6 from 2.688 to 3.125. The statistical significance of this increase is slight ($p = 0.150$) but shows the most significance in the table. There is an increase displayed in the responses to Statement 6 in the poor category as well, but the statistical significance does not allow a confirmation of the correlation between the response and the category ($p = 0.441$). The breakdown of the responses by quality shows that students who turned in excellent activities on average showed no change on Statement 6.

Students who turned in poor activities generally averaged higher scores on the post-test MAS assessment for Statement 6. However, the significance level shown in this category does not allow a correlation between the project and the increased average in response scores. In fact, all statements had high p-values associated with the change in average responses for students who turned in poor activities, except for statement 1 which was eliminated from consideration in this study.

Table 3 breaks down the average MAS points based on students' grades. In this table student responses were broken down by student grades achieved during 1st semester (A's, B's, C/D's). This table of data gives a representation of responses to the MAS assessment based on student achievement level during 1st semester.

Table 3

*MAS Average Scores by 1st Semester Grades*

| | **A's** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 2.882 | 2.471 | 2.529 | 2.824 | 2.824 | 2.529 | 2.882 | 2.412 | 2.529 | 2.647 |
| Post-Test | 2.647 | 2.588 | 2.471 | 2.588 | 2.824 | 2.706 | 2.647 | 2.471 | 2.353 | 2.588 |
| p-value | 0.104 | 0.543 | 0.579 | 0.260 | 1.000 | 0.332 | 0.260 | 0.791 | 0.188 | 0.718 |
| | **B's** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 3.125 | 3.500 | 2.625 | 3.000 | 3.125 | 2.875 | 3.250 | 3.000 | 2.750 | 3.000 |
| Post-Test | 3.000 | 3.375 | 2.875 | 3.125 | 3.000 | 3.125 | 3.125 | 3.000 | 2.875 | 3.000 |
| p-value | 0.685 | 0.685 | 0.351 | 0.685 | 0.685 | 0.649 | 0.815 | 1.000 | 0.685 | 1.000 |
| | **C/D's** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Pre-Test | 4.154 | 3.231 | 3.308 | 3.615 | 3.308 | 2.385 | 3.385 | 3.385 | 3.154 | 3.308 |
| Post-Test | 3.615 | 3.077 | 3.077 | 3.462 | 3.462 | 2.692 | 3.231 | 3.154 | 3.385 | 3.385 |
| p-value | 0.131 | 0.502 | 0.273 | 0.656 | 0.613 | 0.303 | 0.700 | 0.513 | 0.513 | 0.808 |

Data found in these examples show that results were mixed as about half of the questions indicate higher average post-test scores and about half indicate lower average scores. The statistical significance of most of these scores is not strong enough to show correlation between grades and any change in MAS scores. The only change that shows slight statistical significance is found in Statement 9 for students who received an A during 1st semester. Scores in this category for Statement 9 decrease from an average of 2.529 to 2.353 with a p-value of 0.188. This statement reads, “Mathematics makes me feel uncomfortable and nervous.” All other statement changes showed p-values that ranged from 0.260 and 1.000. Responses to Statement 6 showed an increase in every grade category, but the statistical significance of these changes were

not high enough to show correlation (p-values ranged from 0.303 to 0.332 to 0.649). This means that the increase in response averages to Statement 6 cannot be linked to the achievement levels students had previously in the class.

## Discussion

### Overview of the Study

The purpose of this study was to answer the question: How does student choice in review activities affect the perceived levels of math anxiety in high school students? In order to address this question, the research offered four different activities for students to choose from in order to prepare for a chapter test. Students filled out the MAS Assessment prior to the teaching of the unit and then again after the chapter test was administered. A follow-up survey was given to all participants to gain further insight into the mindset of the students and effectiveness of the study. Following the conclusion of the study, an informal class discussion about study habits and results of the project gave the researcher more insight into the thoughts students had about the activity and further use of activities similar to the one used in the study.

### Summary of Findings

Initial results from the pre-test administration of the MAS assessment revealed that the students' average anxiety score had an inverse correlation with the students' semester grades. Students who earned A's during the first semester were more likely to have lower levels of anxiety revealed in their MAS score. Students who earned C's or D's during the first semester were more likely to have higher levels of anxiety revealed in their MAS scores. Lower achievement levels correlated with higher anxiety scores which reflected data from past studies summarized in the literature review about self-efficacy. This was evident in the pre-test average scores as well as the post-test average scores.

When looking at the results of the survey given to students following the project, it was evident that students who perform well in class (achieving A's in Semester 1) did not feel the activity helped them prepare for the test. Students who achieved lower Semester 1 grades were much more likely to feel there was a benefit to their preparedness for the upcoming test. Informal class discussions following the study revealed that the activity forced some of these students to study more than they usually do for a test. Comments such as, "I usually don't study as much for a test, but this activity made me spend more time on the material with something that I could choose" indicated that the activity could be useful for students who struggle in math classes or have not figured out how to study for a math test. In contrast, responses from students with higher grades in the class responded that the activity felt more like busy-work and took them away from their regular routine of studying. Many of these students voiced that they actually felt less prepared for the test because they did not have time to go through their regular routine of reviewing.

This perception was evident in the response to Statement 6. In general, student average response scores actually increased for this statement. There was no correlation seen between student grades and the increased average response score to this statement. There was a slight statistical significance ($p = 0.152$) evident to the increased average response score and students who turned in average projects. These students had voiced frustration with the time constraints that accompany extra projects assigned in class. Several students voiced that they did not see a connection between the review project and preparation for the test. One possible reason for this failed connection is that students who tuned in average activities split their time between using the teacher provided review sheet and finishing the review activity by splitting their time, students did not have enough time to fully invest in one method for preparation for the chapter

test. This could have led to a higher level of anxiety for the upcoming test and a lack of confidence in mastery of the material. During the class discussions, students confirmed that they did not feel fully prepared for the test because of the time spent trying to figure out how to complete the review activity. This frustration had an impact on the levels of anxiety perceived by students who tried to split their time between their normal study habits and an assigned review project. Even with the choice given to them for studying, these students perceived the review project as separate from their normal study routine.

**Recommendations**

The true benefit revealed in this study was the impact that variety can bring to a struggling student. Many of the students who revealed that they enjoyed the activity and asked to continue similar activities in the future were students who earned lower grades in the class. This response did not show a clear significant correlation in the study. There needs to be further study to test what the effect would be long-term on students who lack strong study skills. These students need extra guidance and support in learning not only content but also study skills. Giving students a variety of review activities may be appropriate to help students find the best method for test preparation. However, the option to choose from a list of review activities may be too overwhelming for a student who needs help with study skills and strategies. There needs to be more time dedicated to study skills instruction prior to giving students these options. Class time was utilized to go over the expectations and options given in this study, but there were students who needed more time and direction than what was available for the study. Informal class discussions revealed this primary issue with the project: student choice actually added stress and anxiety to several students as they second-guessed or regretted their choice of activity part-way into the project. Responses such as “I realized by the end that I should have done the

presentation, but it was too late to change my plan" revealed how students felt stuck in their choices and this elevated their levels of stress and anxiety during the project. Careful consideration and guidance would be needed to help students choose the best option for their individual learning styles and skills. Extra time would be needed in class to accommodate this process at the beginning of the year. If this strategy is maintained throughout the year, the time restrictions may be lessened as students become comfortable with the options presented to them for review projects. Longer term research may be necessary to confirm these suggestions and hypotheses.

**Limitations of the Study**

While the researcher took great care to plan and carry out the research in this study, there were some limitations to the project. The pool of participants utilized for this study was limited to 38 Geometry students in a single school environment of primarily homogeneous students. In order to better assess the correlation of the variables in the study, more research should be done involving more students coming from more diverse school settings.

Also, due to family vacations and sickness-related absences, several students in the Geometry classes had to be eliminated from the study due to long-term absences during the study. Sickness-related absences also prevented the researcher from collecting data from the students immediately following the unit test, while the students had a clear memory of the impact that the project had on their levels of anxiety.

The project was completed during a single unit of a Geometry class during the second semester of the school year. In order to more accurately assess the impact that this type of project could have on levels of anxiety in a math student, a long-term research project should be implemented. The time between pre-test and post-test was only 2 weeks and even minimal gains

in anxiety could indicate a positive correlation. It would be naïve to think that a two week time period for a research project would have a dramatic effect on perceived levels of math anxiety in students. These feelings and fears are built up over time. A study that commits to long-term research could reveal a more dramatic effect on perceived levels of math anxiety. This may also limit the potential issues that arise from students who felt the project interfered with their ability to utilize their normal test preparation routines.

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## Appendix A

Parental Consent Form for Math Anxiety Research

Dear Parents,

I am currently working on my Master's in Education at Dordt College. As a final step in this process I am required to conduct an action research project in my classes. I have chosen to focus on stress and anxiety in a math class. Your child is currently enrolled in a Geometry class at Southwest Christian High School, and I would like to include him/her in this study. The purpose of the study is to understand the connection choice has on alleviating the levels of stress and anxiety in a mathematics class. Students will be given the choice of review projects to prepare for the upcoming chapter test.

During the study, students will take a short assessment on math anxiety known as the MAS (Math Anxiety Scale) at the beginning and end of the study. This is a 10 question Likert type scale that asks students to respond to questions about their general feelings and attitudes toward mathematics. Follow up interviews will be conducted with a few selected students to further understand the benefits of giving students choices during the review process. The responses given on the MAS and in the interviews will have no effect on student assessments, and all information given in the study will be kept confidential and student identities will be protected in any reporting of results.

It is completely up to you whether or not your child participates in the study. There will be no harm or risks involved in the study. All students will participate in the review project for the chapter, but I need parental consent to administer the MAS and follow up interviews in the study.

I appreciate your consideration for participation in the study as this is an important project not only for my continuing education, but also for understanding best practices in teaching and student learning.

If you have any questions about the study, please contact me at 952-443-6133 or email me at r_vis@swchs.org. If you and your child have decided to let him or her participate in this study, please read the statement below with your child and both sign your names.

Thank you very much for your help.

Ron Vis

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I understand the information on this page and am willing to allow my child to participate in the study. I understand that he/she can withdraw at any time and his/her results will not be used. Please have your child return this form by February 9.

| _____ | _____ | _____ |
|---|---|---|
| Printed name of child | Signature of child | Date |
| _____ | _____ | _____ |
| Printed name of parent/guardian | Signature of parent/guardian | Date |

## Appendix B

Math Anxiety Scale Assessment

Circle the response in each statement that best describes you.

1. It wouldn't bother me at all to take more math classes.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
2. I have usually been at ease during math tests.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
3. I have usually been at ease during math courses.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
4. I usually don't worry about my ability to solve math problems.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
5. I almost never get uptight about taking math tests.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
6. I get really uptight during math tests.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
7. I get a sinking feeling when I think of trying hard math problems.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
8. My mind goes blank and I am unable to think clearly when working on mathematics.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
9. Mathematics makes me feel uncomfortable and nervous.
   Strongly Agree Agree Undecided Disagree Strongly Disagree
10. Mathematics makes me feel uneasy and confused.
    Strongly Agree Agree Undecided Disagree Strongly Disagree

## Appendix C

Survey Questions

1. What choice did you make for your review project?

2. What was the main factor prompting you to choose the review method for the project?
3. Did this choice help you feel more prepared for the test?
4. How much time do you typically spend reviewing for a test?
5. How does this amount compare to the amount of time spent preparing for this past test?
6. How was this time split between the project and the regular review sheet?
7. What impact did spending time on the project have on your confidence toward the test?
8. How did you feel about being offered a choice in the process of reviewing for the test?
9. How did the possibility of choosing a project change your attitude toward the test?
10. How did the possibility of choosing a project change your approach toward the test?
11. Did you enjoy the project activity?
12. Did the choice of projects give you more motivation to prepare for the test?
13. Would you like to have more choices like this project in class?