Analyzing the Impact of Active Learning in General Education Mathematics Courses

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Abstract

In this paper, we share the preliminary results of a study that explores the overall perceptions and attitudes of students in general education mathematics courses. Our work includes an analysis of survey data collected from two different general education mathematics courses on three occasions throughout a semester: pre, mid, and post. We compare students' responses in one course taught using primarily active learning-based methods such as group work, projects, and discovery learning to the responses of those in a different general education course taught using a more traditional, lecture-based method. The surveys explore students' disposition, mindset, mathematical confidence, mathematics anxiety, and perceptions of pedagogical methods. In both courses, our analysis showed that students indicated a growth-mindset view of learning mathematics. While our analysis did not indicate any significant difference in students' math anxiety level, the students in the active learning-based course experienced lower confidence levels compared to students in the lecture-based course. By comparing pre-survey and post-survey responses, our analysis also explored how these perceptions and dispositions evolved over the duration of each course. For example, our analysis indicated that student enjoyment of mathematics in general was increased throughout the semester in both courses. As we continue

to collect data, we predict the differences of student attitudes towards effective learning styles, math confidence, and math anxiety will become more pronounced over time.

1 Introduction

Undergraduate general education requirements account for, on average, approximately 30% of a student's curriculum [7]. Because of the large impact general education has on a student's academic career, its reform in higher education has remained an ongoing topic of discussion [2, 7, 13]. Many majors, including STEM, business, and the social sciences, have courses within their own curriculum that will satisfy the general education requirement for mathematics, analytical reasoning, or quantitative reasoning. For those whose discipline curriculum does not already have a required course that will fulfill their mathematics general education requirements, universities often create special mathematics courses.

In this paper, we share our preliminary analysis of the introduction of a nonstandard mathematics general education course taught using primarily active learning-based methods, such as group work, projects, and discovery learning. Specifically, we examine the overall perceptions of students in this new general education mathematics course and compare those to the attitudes of students in a more traditional mathematics general education course taught using a lecture-based method. Students in both courses filled out pre- and post-surveys that assessed their views of the impact of participation in a mathematics course. In particular, these questions explored the students' dispositions and mindsets toward learning in general and the learning of mathematics, their confidence in doing mathematics, their mathematics anxiety, and their perceptions of pedagogical methods used in mathematics courses. By comparing pre-survey and post-survey responses, we were able to analyze how these perceptions and dispositions evolved, or remained unchanged, over the duration of each course.

This paper first discusses relevant past research of active learning and mathematics anxiety in Sections 2 and 3, respectively. We then describe our study design in Section 4. Sections 5 and 6 share and analyze the preliminary results of our study. Finally, we conclude by describing our plans for future work in Section 7.

2 Exploration of Active Learning Techniques in Higher Education

Higher education aims to help students cultivate the ability to communicate effectively, think critically, and solve problems [23]. In [19], Halpern defines critical thinking as the "purposeful, reasoned, and goal-directed" use of cognitive skills that requires students to be actively engaged in applying, analyzing, synthesizing, evaluating, and communicating information [33]. In order to achieve this, a broad consensus is that it is important for professors to provide meaningful learning opportunities in which students can engage in open problems and tasks [18, 23]. Some teaching methods used to create these learning opportunities include active learning techniques such as cooperative learning, project-based learning, and discovery learning, Many studies have been completed in order to determine the impact of these different active learning techniques in general education and STEM courses [10, 23–25, 38].

Collaborative learning and small group learning is believed to foster critical thinking. For example, Scardamalia and Bereiter [31] and Vygotsky [37] found that social interactions between students often help them tackle problems they may not have been able to solve individually. In [38], Ward compared a group study approach to learning to a lecture-based approach in a general education science course. He found that lecture worked better for lower achieving students while a group-based method resulted in better content retention for higher achieving students. Furthermore, the study in [18] found that the use of open problems and tasks in small cooperative groups was effective for enhancing students' critical thinking skills in science courses. Kim et al. [23] implemented group-based learning modules in which students were asked to solve real-world natural disaster problems. They found that although students did improve in critical thinking, they did not "master" critical thinking. Instead, students were only able to reach the mid-level subcategory of "developing" critical thinking skills. Their conclusion was that their active small-group learning environment helped students engage cognitively and enhanced student engagement [23].

Discovery-based and project-based learning may also help student engagement with course material. We follow Bruner's definition of discovery-learning [8, 9], which states that in discovery learning, the instructor's primary goal is to assist students in discovering the concepts and ideas of the course and to facilitate students in developing knowledge through exploration and experimentation [25]. Kyriazis et al. [25] explored discovery learning techniques using Mathematica electronic worksheets, which allowed students to conduct computational experiments in mathematics and science courses. Although they found that students' beliefs about physics and mathematics did not change, they reported higher percentages both in passing grades and overall grades for the students who had the discovery-based methods included in their class [25]. Additionally, Havenga [20] found that project-based learning in programming courses contributed to the development of a variety of important critical thinking skills including solving complex problems, working within a team, and establishing self-directedness.

Cherney [10] also explored the impact active learning had on free recall in undergraduate courses. She found that active learning helped students have better recall of material across introductory level and upper level courses taught by the same instructor. Furthermore, connecting the course material to real-life, concrete examples and experiences enhanced student understanding in introductory psychology and statistics courses [10].

Studies have shown active learning techniques positively impact student learning; however, student perception of active learning does not necessarily reflect these positive impacts. For example, Vadav et al. [39] found that although students' learning gains from problem-based learning were twice their gains from traditional lecture, students thought they learned more from traditional lecture. Similarly, Lake [26] reported that students in the active learning sections of a course perceived that they had learned less than students in the lecture section of the same course. Additionally, students' perceptions of course and instructor effectiveness were lower in the active learning sections than in the lecture section [26]. Smith and Cardaciotto [35] found that although students participating in active learning activities reported greater retention of and greater engagement with course material, students participating in content review activities showed a greater enjoyment of the class and a more positive overall evaluation of the course. Not all active learning techniques are perceived equally among students. In [28], Machemer and Crawford compared eight teaching techniques utilized in a single class, each classified as either cooperative, independently active, or lecture. They found that students valued lectures and being individually active equally well and that students valued cooperative activities significantly less. Their conclusion was that active learning is valued from the students' perspective, but working with others significantly diminishes the value [28].

3 Mathematics Anxiety

A mathematics or quantitative reasoning component is typically required as part of a major's general education curriculum, and many students who are taking these quantitative reasoning general education courses have lower confidence in their mathematical abilities and/or have high anxiety levels when performing various mathematical tasks [27]. Both factors may contribute to student disengagement and ultimately failed learning outcomes. The first factor, known in the literature as "mathematics self-efficacy," is summarized as a student's conviction that he or she can successfully solve a math problem or complete a mathematical task. Students with low levels of mathematics self-efficacy are at a high risk of underperforming in mathematics despite their actual abilities [32]. The Programme for International Student Assessment (PISA) provides the most extensive set of data on mathematics self beliefs by collecting responses from students among the 34 Organisation for Economic Co-operation and Development (OECD) countries. In its 2012 assessment, 43% of students reported that they agree or strongly agree that they are not good at mathematics, whereas 38% reported to have always believed that mathematics is one of their best subjects [14]. The assessment showed mathematics self-efficacy is strongly associated with mathematics performance. In particular, students with low mathematics self-efficacy perform worse in mathematics than students who are confident about their ability to handle mathematical tasks [14]. On the other hand, the assessment showed mathematics self-efficacy tended to increase among countries that show reduced levels of math anxiety, another factor that can plague a student's experience in a mathematics general education course.

Mathematics anxiety is defined as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations" [30]. A considerable number of children and adults have mathematics anxiety. In fact, according to Luttenberger et al. [27], 93% of adult US-Americans report experiencing at least some math anxiety and 17% report high levels of anxiety. This anxiety can lead to avoidance of mathematical activities as well as overloading working memory during mathematical tasks, both of which disrupt mathematical learning and performance in the classroom [11]. On average across OECD countries, 30% of students reported that they feel helpless when doing mathematics problems; 59% of the 15- to 16-year-old students reported that they often worry math classes will be difficult for them; 33% reported that they get very tense when they have to complete math homework; and another 31% stated they get very nervous doing math problems [14]. These self beliefs are observed to have substantial negative impact on mathematical performance. The assessment reveals that greater mathematics anxiety in OECD countries is associated with a 34-point lower score in mathematics, the equivalent of almost one year of school [14]. While math anxiety is universal, studies show that students who mostly enjoy humanities or social sciences subjects have higher mathematics anxiety compared to those who mostly enjoy mathematics-related subjects [16, 36]. This suggests mathematics anxiety is a particularly influential factor in the mathematics general education classroom where most students are pursuing non-mathematical majors.

Researchers continue to find that that having high levels of math anxiety has a negative impact on math performance, math confidence, and math self-efficacy [1, 5, 17, 22]. On the other hand, math confidence, self-efficacy, and growth-mindset are shown to positively influence math performance [1,5,6]. Therefore, identifying causes of math anxiety and working to alleviate this anxiety and math avoidance has become a special effort of researchers, universities, and societies like the Mathematical Association of America and the National Institute of Education [3, 21, 34]. One way that professors are attempting to ease math anxiety is through researching and introducing different assessment methods and learning techniques. For example, Collins et al. found decreased anxiety levels for mathematics courses that used mastery-based testing [4]. Mastery-based testing is an assessment scheme that gives students multiple attempts to demonstrate full "mastery" of problems derived from clear course concepts. In [6], Boaler found that active, heterogeneous high school classrooms led to positive beliefs about relational equity and mathematics. Further exploration of active learning techniques in the classroom found positive impact on student learning in STEM classrooms [12, 15].

4 Study Design

This study was conducted at Lewis University, a four-year, private, Catholic university located outside of Chicago. The enrollment is approximately 6,800 with an undergraduate population of around 4,500. Lewis is a primarily teaching-focused university, and many of its students are from the Chicago and Joliet areas. Because of its increasingly diverse population, Lewis is also an Emerging Hispanic-Serving Institution that services a 34% minority population.

In 2019, Lewis University rolled out a new revised General Education Plan. Prior to 2019, the mathematics general education requirement could be satisfied by Finite Mathematics, Introductory Statistics, College Mathematics, or one of several calculus options. During this transition, we introduced a new mathematics course, "Win, Lose, or Draw," which could also satisfy the math general education requirement. Our initial study compares the attitudes of students in Win, Lose, or Draw to those of the students in College Mathematics over a one-year period. Specifically, the following questions guided our research:

1. Is there a difference in math anxiety levels between students in these courses?
2. Do students in these courses reflect different mindsets of learning?
3. Is there a difference between students' confidence levels in their mathematical ability?
4. What are the opinions regarding effective teaching techniques in mathematics courses for students in these courses and do they differ?

We also tracked the changes, if any, of student perceptions over the entirety of the semester in each of the courses.

4.1 Courses Examined

College Mathematics covers many of the same topics as a typical discrete mathematics course, but at a less exhaustive and rigorous level. Topics include set theory, counting, probability, and statistics. This course has been taught at Lewis University in a traditional lecture-based setting by experienced mathematics adjuncts for the past 20 years.

Created by Dr. Karen Holmes of Butler University, Win, Lose, or Draw is an analytical-reasoning course that covers set theory, counting, and probability. Each topic is motivated by games, and there are many active learning components including collaborative, cooperative, and problem-based learning. While class time is structured around group work, the majority of the course assessment is individual. In the classroom, students work together in groups of four on problems in their interactive workbook, which serves as their course textbook. What they do not finish in class, they take home as homework, and each student must submit his or her own workbook as a homework grade. All tests and quizzes are taken individually. At the end of the semester, students work on a group project that they present to the class. Since this course was adopted by Lewis in the fall of 2018, all instructors teaching this course were teaching it for the first time. The student population of these two courses are the same; the majority of students enrolled are either nursing or humanities majors.

4.2. Survey Design

To perform our analysis, we created and administered surveys to students at three stages in the semester: pre-surveys (given on the first day of classes), mid-surveys (given in the middle of the semester), and post-surveys (given on the last day of classes). The surveys asked students how much they agreed or disagreed with statements involving math intelligence, confidence in their mathematical ability, techniques that help them learn mathematics, and enjoyment in doing mathematics. Students were also asked to rate their current anxiety level with regard to nine aspects of enrollment in a math course as well as give an overall anxiety rating compared to that of previous math courses. Students were assigned an identification number to preserve their anonymity, but also to allow us to track individual changes in feelings over the course of the semester. A complete version of our survey is available upon request. The questions were adapted from the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ), which was found to be highly reliable and relatively valid [29]. In total, we surveyed 126 students from eight sections of College Mathematics and 60 students from four sections of Win, Lose, or Draw. Note that there were 191 students enrolled in College Mathematics at the beginning of the respective semesters, which means our response rate was 65%. Similarly, there were 66 students enrolled in Win, Lose, or Draw at the beginning of the respective semesters, which gives us a response rate of 91%. The lower response percentage for College Mathematics could be at least partially attributed to our totals not accounting for any students who dropped the course.

5 Results

Our analysis considered data from the pre-survey and post-survey results gathered from students enrolled in College Mathematics and Win, Lose, or Draw. We did not include the mid-survey results in this analysis because there was a low response rate. In this section, we present our initial findings from comparing the two course types, organized into the following categories based on our research questions: effective learning styles in the classroom, mathematical confidence level, enjoyment of course as well as mathematics in general, and mathematics anxiety level. On our pre-surveys and post-surveys, students were provided with four statements related to how students learn, four statements related to mathematical confidence, and four statements related to enjoyment. Responses to each of these questions could range from 1 to 5, with a 1 signifying “strongly disagree" and a 5 signifying “strongly agree."

We present the resulting means and standard deviations of two questions related to mathematical learning styles in Tables 1 and 2. Table 1 indicates that while there was no significant difference in how students valued active learning, students did seem to believe that it was helpful to their studies. Table 2 gives the results of students' overall perceptions of lecture-style teaching. Coming into the course, students in Win, Lose, or Draw indicated on their pre-surveys that they found lecture significantly less helpful than their College Mathematics counterparts, with a t-test providing a p-value of 0.0060. In the post-survey, however, both types of students valued lecture-based learning similarly. In fact, Win, Lose, or Draw students seemed to find lecture more helpful after taking their course, with a t-test providing a p-value of 0.0306. The exact breakdown of the proportions of Win, Lose, or Draw (WLD) students' responses to this statement about the usefulness of lecturing is illustrated in Figure 1.

Course	**Pre-survey mean (sd)**	**Post-survey mean (sd)**
Win, Lose, or Draw	3.91 (0.73)	4.06 (0.66)
College Mathematics	3.79 (0.82)	3.84 (1.00)

Table 1: Average and standard deviation of pre-survey and post-survey responses to the statement: *I generally find interactive learning activities helpful to my studies.*

Course	**Pre-survey mean (sd)**	**Post-survey mean (sd)**
Win, Lose, or Draw	3.03 (1.12)	3.51 (1.02)
College Mathematics	3.31 (1.23)	3.53 (1.17)

Table 2: Average and standard deviation of pre-survey and post-survey responses to the statement: *Listening to a lecture is helpful for learning mathematics.*

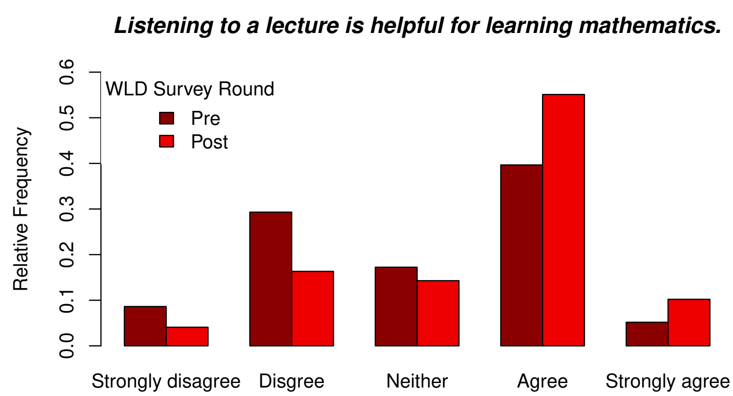


Figure 1: Breakdown of Win, Lose, or Draw (WLD) students' responses, divided by survey round, to the statement: *Listening to a lecture is helpful for learning mathematics.*

Students' perceptions of growth mindset and mathematical confidence are summarized in Tables 3 and 4, respectively. There was no significant difference in the results between the classes for the statement referenced in Table 3 about being able to change one's mathematical intelligence, nor when comparing the pre-survey responses to the post-survey responses within classes. Table 3 indicates students seemed to disagree with this statement with little variation, which indicates they did feel they could change how well they performed.

In the pre-survey, there was not a significant difference between Win, Lose, or Draw and College Mathematics for the statement referenced in Table 4 about mathematical confidence. However, in the post-survey College Mathematics students were significantly more confident than Win, Lose, or Draw students, with a t-test obtaining a p-value of 0.006. We can see how much more confident the College Mathematics (CM) students were by the end of the semester in Figure 2, which illustrates the breakdown of post-survey responses to this statement. While the average for Win, Lose, or Draw seemed to go down, it did not go down significantly, with a p-value of 0.1343. Similarly, the average for College Mathematics seemed to go up but also not significantly, with a p-value of 0.1075.

Course	Pre-survey mean (sd)	Post-survey mean (sd)
Win, Lose, or Draw	2.10 (0.86)	2.08 (0.73)
College Mathematics	2.15 (0.95)	2.28 (1.08)

Table 3: Average and standard deviation of pre-survey and post-survey responses to the statement: *To be honest, you can't really change how intelligent you are in mathematics.*

Course	Pre-survey mean (sd)	Post-survey mean (sd)
Win, Lose, or Draw	2.92 (1.37)	2.71 (1.14)
College Mathematics	2.89 (1.12)	3.21 (1.18)

Table 4: Average and standard deviation of pre-survey and post-survey responses to the statement: *I feel confident when doing mathematics.*

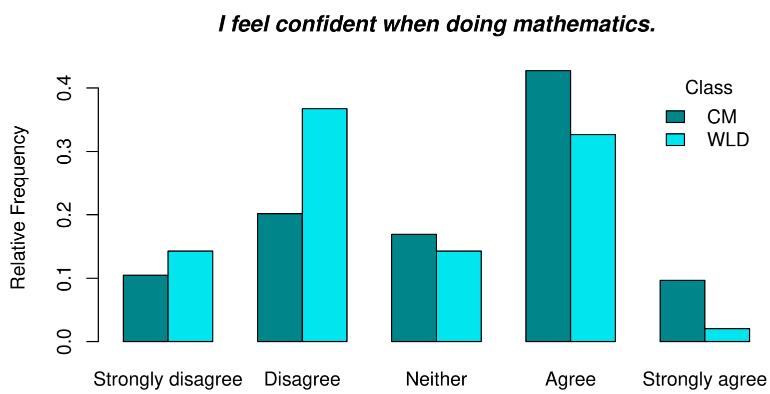


Figure 2: Breakdown of students' post-survey responses, divided by course, to the statement: *I feel confident when doing mathematics.*

We present the means and standard deviations of responses to two questions relating to enjoyment in Tables 5 and 6. Overall, students did not seem to agree or disagree that they enjoyed mathematics in general (Table 5). Between the two classes, t-tests did not find a significant difference between student enjoyment in College Mathematics and Win, Lose, or Draw. However, a t-test did indicate that College Mathematics students had higher enjoyment after taking their class, with a p-value of 0.0102.

Students enrolled in Win, Lose, or Draw were significantly more excited about their class in the pre-survey than their College Mathematics counterparts, with a t-test resulting with a p-value of

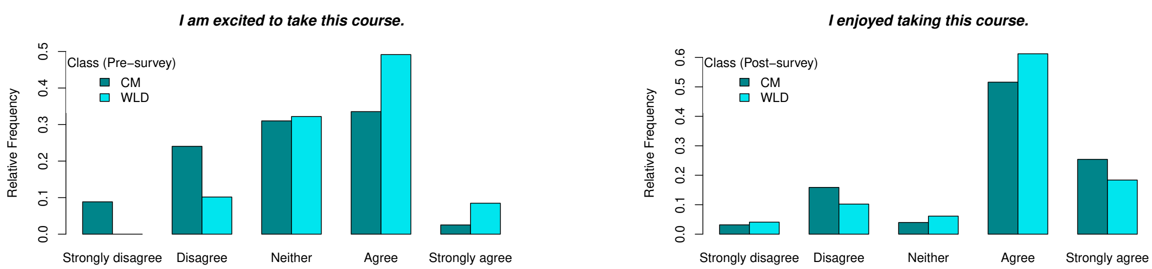
0.0040 (Figure 3a and Table 6). In the post-survey, however, both classes seemed to enjoy their course just as much as each other (Figure 3b and Table 6). While both courses went up in average, College Mathematics had significant results, with the t-test providing a p-value of 2.305×10^{-10} and with the breakdown of responses shown in Figure 4a. On the other hand, the t-test conducted for Win, Lose, or Draw did not have significant results, with a p-value of 0.0759 (Figure 4b).

Course	Pre-survey mean (sd)	Post-survey mean (sd)
Win, Lose, or Draw	2.83 (1.28)	2.96 (1.32)
College Mathematics	2.82 (1.22)	3.22 (1.20)

Table 5: Average and standard deviation of pre-survey and post-survey responses to the statement: *I enjoy mathematics.*

Course	Pre-survey mean (sd)	Post-survey mean (sd)
Win, Lose, or Draw	3.56 (0.79)	3.80 (1.00)
College Mathematics	2.97 (1.02)	3.80 (1.09)

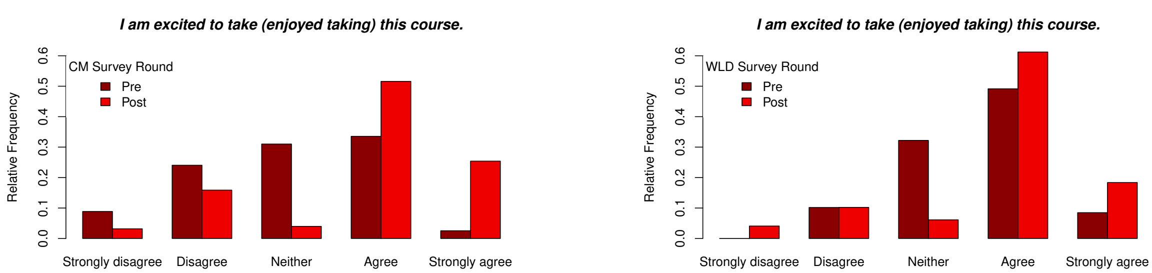
Table 6: Average and standard deviation of pre-survey and post-survey responses to the statement: *I am excited to take (enjoyed taking) this course.*



(a) Pre-survey

(b) Post-survey

Figure 3: Breakdown of students' responses, divided by course, to the statement *I am excited to take (enjoyed taking) this course.*



(a) College Math (CM)

(b) Win, Lose, or Draw (WLD)

Figure 4: Breakdown of students' responses, divided by survey round, to the statement: *I am excited to take (enjoyed taking) this course.*

On the mid-surveys and post-surveys, students were asked to finish the following two statements relating to anxiety with the answer choice that best fits their experience:

1. *At this point in the semester my anxiety level has ...*
   decreased, stayed the same, increased, I have no anxiety, no response
2. *Compared to other math courses, my anxiety level in this course is ...*
   lower, about the same, higher, I have no anxiety in math courses, no response.

For our initial analysis, we focused on students' responses to these two statements on the post-survey only. We grouped the two questions together and analyzed their responses as a whole since the response choices were similar: "decreased" is grouped with "lower", "increased" is grouped with "higher", etc. Our main question was whether or not anxiety levels differed depending on the class being taken. To answer this, we ran a Chi-Square Test of Independence with the assumption that anxiety levels were independent of the class. The data we used included students' responses to both of the above anxiety statements.

This test resulted in a p-value of 0.058, so there was not enough evidence to conclude that anxiety levels depended on the class. However, due to extenuating circumstances, one College Mathematics professor had to leave the country with two weeks left in the semester and finished the course online. If we complete a Test of Independence without including this outlying College Mathematics section, we obtain a p-value of 0.003. This is enough evidence to conclude that anxiety levels did, in fact, depend on the class being taken. To further explore this, we ran a t-test to see if the mean anxiety levels, of those who had anxiety, were higher for those in Win, Lose, or Draw than for those in College Mathematics. This test resulted in a p-value of 0.0005, so we have strong evidence to conclude that mean anxiety levels are higher for those in Win, Lose, or Draw than for those in College Mathematics. Figure 5 shows the proportions of each response, divided by class, not including the previously mentioned College Mathematics section.

6 Discussion

Our initial findings indicate that College Mathematics, our traditional lecture-based course, seems to be better for the confidence levels of students when compared to Win, Lose, or Draw, our active learning-based course. One reason for this may be due to the experience level that our instructors had in teaching these courses. College Mathematics has been taught in a traditional lecture style for many years, and the instructors have been able to cultivate their assignments and notes to effectively teach this course. On the other hand, Win, Lose, or Draw is a new course to instructors. Consequently, instructors have not yet had the opportunity to adjust the material to their own teaching styles. Any lack of confidence displayed by the instructors of Win, Lose, or Draw may have translated to the students. We will track future data to determine if repeat instructors will have more confident students. Additionally, students may be more accustomed to lecture-based classes, especially in their previous math courses. Since Win, Lose, or Draw is based on active learning, students may feel a sense of discomfort while trying a different method for the first time. The open-ended methodology of interactive learning courses may also cause students to doubt their own abilities, resulting in lower confidence levels.

When comparing learning styles, students from both types of courses found active learning helpful while they were relatively neutral about lecture-based learning. This seems to contradict our

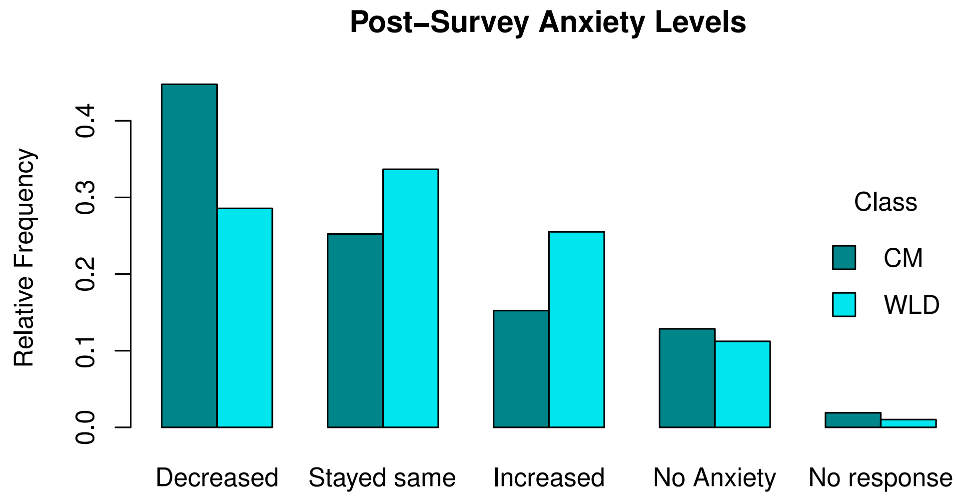


Figure 5: Breakdown of students' post-survey responses (excluding those in the "outlying" College Mathematics section), divided by course, to the two questions about anxiety levels, where "decreased" is grouped with "lower", "increased" is grouped with "higher", etc.

results on confidence and anxiety, as College Mathematics students were confident and less anxious. Perhaps students do not know what is meant by "interactive learning."

In the future, we may wish to ask about specific methods used in these styles of learning. For example, asking students to evaluate the statement, *I find that discovering new concepts while working on problems is helpful for learning mathematics*, may be better than asking them to evaluate the statement, *I generally find interactive learning activities helpful to my studies.*

Overall, our findings indicate the students enjoyed their courses, and the levels of enjoyment were similar. Students seemed neutral in their attitudes towards mathematics otherwise. To further investigate enjoyment levels, we could ask about specific course topics. For example, both courses cover probability, so we might include the statement, *I enjoyed learning about probability in this course.*

In our analysis of anxiety levels, we saw no difference between the two classes unless we removed what we considered to be an outlier section. In that case, we observed that anxiety levels were overall higher for those in Win, Lose, or Draw than for those in College Mathematics.

7 Conclusion and Future Work

As we continue to study the impacts of active learning in our general education courses, our future endeavors include the following:

- **Modify future surveys.** For our initial round of surveys, we passed out paper forms that had check-boxes and places for students to write. This led to a number of errors in skipped questions. In addition, one question asked students to perform a ranking; however, students instead gave each individual response a rating. A number of these problems will be resolved when we move to an online version of the survey in Fall 2019.

- **Track students pre and post.** We provided students with a way to create anonymous, individualized tracking numbers. In the future, our goal is to use these in order to track student changes throughout the semester.
- **Continue to add data, especially as instructors gain experience teaching Win, Lose, or Draw.** A larger sample of students will improve our results, as we will be able to more easily identify significant results between the courses. Additionally, many of our instructors teaching College Mathematics were familiar with how they expected the class to run but our Win, Lose, or Draw instructors were not. As our instructors gain confidence with Win, Lose, or Draw, we may see some results change.
- **Add analysis of another new math general education course.** Starting in Fall 2019, we plan to offer another general education course, Storytelling with Data. This multidisciplinary course follows Wesleyan University's Passion-Driven Statistics curriculum (available at (https://passiondrivenstatistics.com/) and follows a project-based approach in which students work with existing data covering health, biology, government, business, education, etc. to conduct data analysis on a research topic of their own choosing. With this new course, we will expand our study to gauge student disposition and attitudes in a course utilizing project-based learning.
- **Explore trends for teachers who teach both courses.** In our initial study, only one professor taught sections of both College Mathematics and Win, Lose, or Draw. Going forward, we would like to see more instructors teach both courses. This will reduce confounding variables and allow us to more thoroughly assess the differences between students' attitudes in the two courses. We did take a look at the data collected from the one instructor who taught both types of courses during our initial period, but with our small sample sizes, we did not find any significant results.

Our initial findings in this study motivate further research questions concerning student disposition and attitudes in our lecture-based College Mathematics course compared with our active learning-based Win, Lose, or Draw course. Our analysis did not indicate any significant difference in students' enjoyment of their math course, their math anxiety level, and their disposition of effective learning styles. In both courses, students indicated a growth-mindset view of learning when asked about math intelligence. Also, student enjoyment of mathematics in general was increased in both courses when considering pre- and post-survey data. These results speak highly of our mathematics general education courses, which is encouraging for our department. Our analysis did find that students in Win, Lose, or Draw experienced higher anxiety levels and lower confidence levels when compared to students in College Mathematics, which was surprising. As instructors become more familiar with the Win, Lose, or Draw course, it will be interesting to see if there are any changes in this finding. We predict the differences of student disposition and attitudes towards effective learning styles, math confidence, and math anxiety will become more pronounced as we continue to collect data over time as well as expand our study to include our project-based learning course.

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