The Effects Mathematics Competitions have on Stimulating Optimal Performance in the Classroom

Dr. Linda B. Hayden
Principal Investigator
Elizabeth City State University
1704 Weeksville Road, CB 672
Elizabeth City,NC 27909
haydenl@mindspring.com

Shatoya Estime
Mentor
Elizabeth City State University
1704 Weeksville Road, CB 672
Elizabeth City,NC 27909
teamestime@gmail.com

Tangee Beverly
Researcher
Elizabeth City State University
P.O. Box 324
Powellsville, NC 27967
tlbeverly96@gmail.com

Joselyn Hathaway
Researcher
Elizabeth City State University
P.O. Box 2537
Elizabeth City, NC 27967
hathawayjoselyn@gmail.com

***Abstract*—The presence of mathematics competitions originates from the International Mathematics Olympiad (IMO). The IMO began in 1959 in Romania and is the largest, most prestigious scientific Olympiad for high school students around the world [1]. The competition consists of six, 42-point problems varying in subject. The questions are primarily based on pre-calculus, which is a common level of mathematics for high school students. Subjects beyond high school level are also incorporated into the competition such as projective and complex geometry, functional equations, and number theory [2]. MATHCOUNTS and the American Mathematics Competitions are just two examples of mathematics competitions open to middle school students. MATHCOUNTS is a multilevel national program established in 1983 that provides students the opportunity to compete with their peers [4]. The American Mathematics Competitions (AMC) is a series of examinations based on curriculum materials that focus on building problem-solving skills and mathematical knowledge [5]. The most important value of a math contest is to kindle student's interest in mathematics while encouraging them to value intellectual activities. Students will often turn an activity into a contest; they love games and always want to be the best at what they do. Mathematics competitions can inspire them to become good at mathematics in the same sense that sports encourage physical fitness. Competitions train students to deal with success, failures, and prove that practice is effective to their performance. In our daily lives, we often have to deal with elements of pressure. Competitions can be a model by which students learn how to cope with and overcome pressure [3]. The discussion of our research is focused on extending friendly mathematics competitions to local and surrounding high school students in the 9th grade, examining how their mathematics knowledge plays a role in their competition performance, and discussing the importance of student participation in mathematics competitions.**

Keywords—Mathematics Competitions, Student Performance, Problem-Solving Skills, Gender Performance

I. Introduction

During the Spring of 2018, the Center of Excellence in Remote Sensing Education and Research (CERSER) undergraduate Mathematics Education research team were faced with the challenge of conducting research about mathematics competitions. In the past, CERSER has hosted mathematics competions for middle and high school girls from surrounding counties. For the teams' research project, they were focused on high school students. In order for the team to provide appropriate competions questions, it was essential to consider the audience. Important factors that needed to be known in order to conduct the competition inlcuded grade level, gender, content, and subjects or topics. At the end of the competition and after analyzing the results, the team searched for evidence as to why mathematics competitions can be beneficial when implemented in the classroom.

II. Objectives

The goals of their research include many broad factors, but we focused on four specific areas: 1) the importance and benefits that mathematics competitions hold; 2) the presence of gender dominance in mathematics; 3) the role of parents and teachers in the students involvement in mathematics competitions; 4) the result of implementing mathematics competitions in the classrooms.

III. Research Questions

The answers to the following questions will be answered and discussed:

1) What is a mathematics competition and its purposes?
2) What influences contribute to a students' willingness to participate in mathematics competitions?
3) Is gender a contributing factor in students' mathematical performance in mathematics competitions?

A. What is a mathematics competition and its purposes?

A mathematics competiton is an academic event that promotes testing students ability in mathematics. The studens can vary in age such as elementary, middle, or high school. In order to promote higher thinking skills, students are often given questions that are slightly above grade level and considered as challenging. Having students to participate in a mathematics competition contains many positive reasons. The purposes of hosting mathematic competitions includes hightening students interests, preparing them for the competitive real world, introducing them to collaborative pairs

or groups, and teaching them how to handle stress. Often times participants enjoy being involved in a competition due to the setting that mimics competing in sports [6].

B. *What influences contribute to a students' willingness to participate in mathematics competitions?*

One of first factors the determines whether a student is likely or willing to participate in a mathematics competitionis their attitude. It is common that a students' performance in a classroom is based on how they feel about the subject. If the topic is not something that piques their interest, they are not going to put forth a good effort. Another factor to consider is parental and teacher involvement. In the classroom, it should be the teachers upmost concern that the students are succeeding. When teachers encourage student engagement, the students often feel that they have the support needed from their teacher in order to reach academic goals. When students leave school and go home, it is also important to have parental support. The positive results of this support can come in many such as homework, projects, and extra-curricular activities. When the student receives support from school and home, there is a minimum amount of lack of motivation.

C. *Is gender a contributing factor in students' mathematical performance in mathematics competitions?*

To determine whether gender is a contributing factor for students performing their best in mathematics competitions, we must first discuss the distribution of the individual's scores in terms of center, shape and spread. Next we must compare the mean scores between the males and females that answered the 10 individual competition questions, to see if there is a difference in the way both genders tended to have scored.

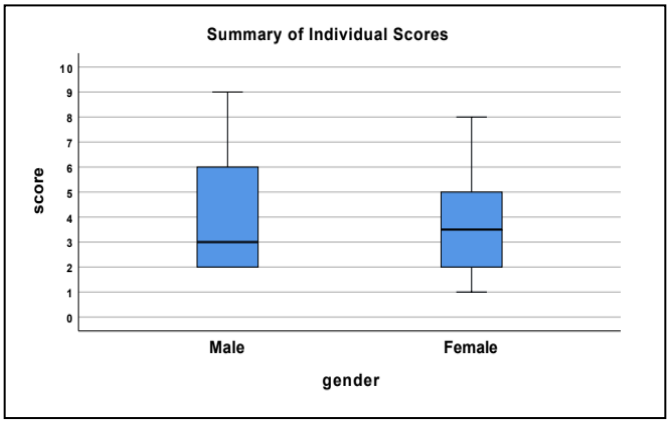

Fig. 1.

Figure 1 displays boxplots that captures the individual scores for each male and female. The distribution of the male scores are skewed to the right while the female scores appear to be roughly symmetric. As the boxplots portray the males having a mean score slightly lower than the females, the IQR of the male scores is clearly larger than that of the female scores.

	GENDER		Independent Samples Test T-test for Equality of Means (Equal variances not assumed)	
SCORE	**Male**	**Female**	**t**	**DF**
N	6	10	.349	8.801
Mean	4.17	3.70	**Sig. (P-value)**	**Mean Difference**
Std. Deviation	2.787	2.214	.735	.467

Fig. 2.

Figure 2 displays the results from performing an independent, 2-samples t-test, to confirm our belief that the two groups don't appear to demonstrate a significant difference in scoring. The null hypothesis states , "There is no difference in the mean scores of males and females in the mathematics competition." The alternative hypothesis would be "There is a difference in the mean scores of males and females in the mathematics competition." With an observed difference .467 between the mean scores, we want to know how likely is this difference to occur? The reported p-value is .735, which means this type of difference has a 73.5% chance of happening. Our decision would be to fail to reject the null hypothesis and conclude there is no evidence of a difference between the mean scores of males and females in this competition.

IV. Methodology

This study was conducted at three participating high schools. Namely, the schools were Northeastern and Pasquotank County High Schools in Elizabeth City, North Carolina, and Perquimans County High School in Hertford, North Carolina. The math teachers at each school were asked to select at most 8 (4 boys and 4 girls) 9th grade students, each of average mathematical ability, as determined by their performance in the classroom, and from different ethnic backgrounds. The selected students were given a total of 20 multiple choice questions to complete within two 30-minute sessions. These questions were obtained from a variety of resources used in preparing students for the SAT. During session one, a mini math competition was held between the male and female teams. Each team was required to answer a set of ten questions. On the timer's mark, the students worked out each question, the team runner then turned in their answer to the appropriate competition leader, and in return, received the next question. This cycle continued until all 10 questions were answered by both teams, in the allotted time frame. In the second session, each individual was given a set of 10 questions that mirrored those in the first session. Students recorded their answers and turned in all 10 upon completion. Students used calculators only in the second session.

V. Results

In order to compare the results between the individual students, their scores were first separated by school and gender in the following diagram.

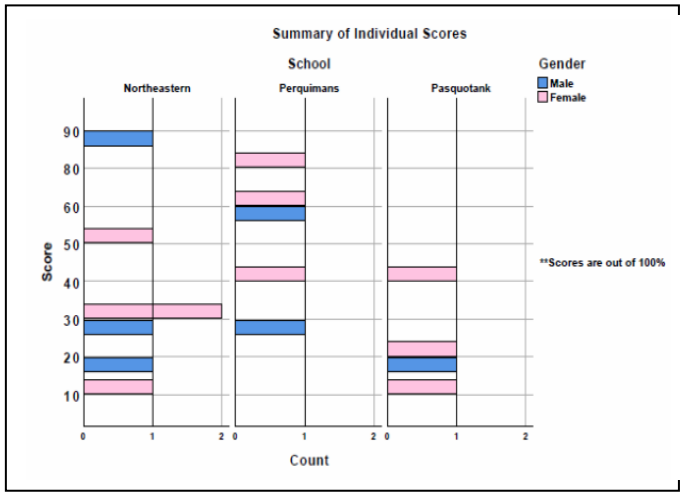

Fig. 3.

Figure 3 reports the scores that were collected from the individual questions portion of the competition. The scores were classified by school and gender. This summary gives us insight into how the students performed. The students at Pasquotank were clearly outscored by Northeastern and Perquimans. Although Northeastern may boast a high scoring student, we see that the students at Perquimans performed consistently higher than those students at Pasquotank and Northeastern.

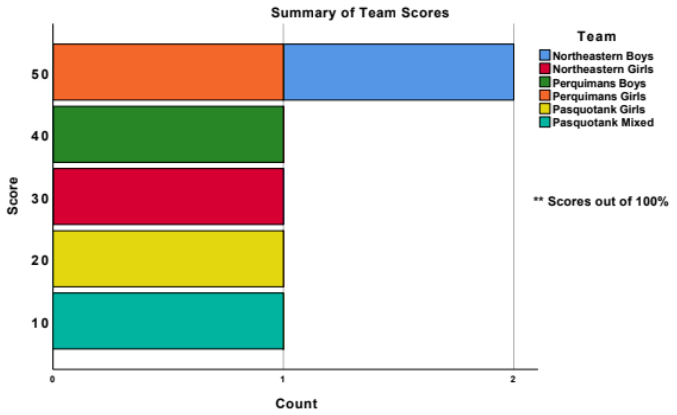

Fig. 4.

Figure 4 displays the scores obtained by each specific team, ordered from highest to lowest. The teams produced scores that were at or below 50%.

VI. Conclusion

After analyzing the data of the students scores, we found that the students, both girls and boys, performed higher as a group than individually. The difference in the ind/ividual average score versus the group average score for the girls was 3.0. The difference in the boys individual average score versus the group average score was 3.3. When we compared the compared the average scores of the group portion, the girls scored 40.0 while the boys scored 45.0. The maximum score out of all of the girls was 80.0 and the maximum score out of all the boys was 90. We also found that the boys performed higher overall than the girls.

Girls (10)

- Average for Individual = **37.0**
- Average for Group = **40.0**
- Maximum Score for Individual = **80.0**

Boys (6)

- Average for Individual = **41.7**
- Average for Group = **45.0**
- Maximum Score for Individual = **90.0**

VII. Future Work

In the future, the team has the ability to extend the research into mathematics competitions being used as an indicator of student growth in the classroom. One goal might be to consider opening our pool of competitors to those that attend STEM high schools. Since these schools implement more mathematics and science in their classes, the comparison between the STEM high schools and the regular high schools would show if the students perform higher in mathematics competitions while attending a STEM high school. Another option would be to extend the research to high schools in Virginia. With Chesapeake, Virginia being the closest major city in Virginia, the opportunity would allow us to compare student performance under different state standards. The final goal would be to compare students performance based on same-sex classrooms. Based on the data we collected and seeing that the males performed better than the females in the competition, we would like to see if performance of females in mathematics increases while working in an all female setting. This has been done in a local school and would be beneficial to research in order to improve students mathematical performance.

VIII. Survey

At the end of the competition, students were given a survey that consisted of 5 questions. The questions were created on a 5 point likert scale based. These questions included topics based on how they felt about the mathematics competition, the type of problems they were given to solve, the benefits of participating in mathematics competitions, and how they feel working with others on a team. The responses were evaluated and separated by gender and the frequency of responses. The full survey and total evaluation can be found in the back of this document.s

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Math Sprint Competition

Student Survey

Directions:

1. **Identify your gender (circle one): MALE or FEMALE**
2. **Please indicate your agreement or disagreement to the 5 statements listed by checking the appropriate box to the right of each statement.**

Survey Statement	1 Strongly Disagree	2 Disagree	3 Neutral	4 Agree	5 Strongly Agree
1. I felt prepared for this math competition.					
2. I have seen these types of math problems in my math class.					
3. I feel a math competition can help prepare me for a math test.					
4. I am comfortable working with my peers during a math competition.					
5. I am willing to participate in another math competition.					