Determination Differences Between Men and Women in Mathematics

by

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Approved by:

Capstone Coordinator
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Abstract

We analyzed data collected from 35 Tyler Junior College Students collected over three testing sessions. Students were asked to take a five-question math test. The test included four questions from the American High School Math Examination, where the problems are designed to be solvable for students without any upper level (calculus) mathematics background as well as one randomly generated question. Students were asked to take as much time as they needed, but no longer than one hour to complete the test. We used the amount of time spent on the test to measure the students’ level of determination. The goal of this trial was to identify whether there was a difference between the two genders when it came to persistence. We found that there was little statistical difference when examining the data we collected. There was a strong overlap in times for females and males, so despite the samples mean persistence times being different, evidence suggests that it is possible that the mean persistence times could be equal. With a null hypothesis of the mean persistence times being equal, we were unable to reject the null hypothesis that men and women would have equal persistence times. This might be a result of the small sample size. The implication is that if there is a difference in persistence times, different approaches for teaching students in mathematics would be beneficial.

Introduction

Mathematics is still today a male dominated field, and this research aims to discover why there is a difference between the amount of men and women in the STEM field with a focus on mathematics. At a young age, girls begin to associate mathematics with males rather than females. The goal of this experiment is to identify whether college aged men or women are willing to spend more time working on a math test. This information will then be used to draw conclusions as to whether men or women are more determined in the subject, and then use existing statistics to comprehend the significance of the gathered data. This study is focused on the mathematics component of STEM.

Women being outnumbered in upper level mathematics courses can cause more STEM anxiety to exist, thus leading to more women leaving the field prior to job placement (Dasgupta & Stout, 2014). While the gender gap in STEM performance is shrinking, the self-confidence is
still very apparent and not going away (Dasgupta & Stout, 2014). Research is geared toward identifying and understanding why this gap exists and how to fix the existing gap of STEM confidence in women compared to men.

The research question being asked was:

Does a difference in determination exist between men and women in mathematics?

The study used the amount of time each student spent on the test to measure how “determined” they were in mathematics. The connection here is that a student who is willing to work longer is more determined to find the correct answer. The research is constructed to discover whether a man is willing to work longer than a woman. If we can identify an answer to this research question, we could go about reaching students and learning what makes them more or less determined. Defining whether the determination has a gender preference could open new exploration opportunities, such as answering why women might feel more or less determined. Women comprise 70% of college students, but less than 45% of them are STEM majors (T, 2016). This is alarming in the fact that women are needed to help balance the need for more STEM majors.

One study mentions that even very career focused women were not more likely to enter STEM jobs than those women that were more family oriented (Sassler, 2016). We must then ask, what is causing this gap if it is not a lifestyle difference? We need to ask why women are not entering the field as steadily as men, and what would make them more likely to enter the field.

**Background and Methods**

In a 1979 a similar experiment was conducted with a fourth grade class in Japan. The students were asked to draw a three dimensional box, and being so young they had not encountered this task before. The teacher asked a student who was struggling to complete the task to attempt it on the board, and the student did not quit attempting until he had completed the task given. The observer, Jim Stigler, knew that in an American classroom students would be focused on finding the correct answer and getting it right, but this student clearly struggled and was not discouraged. American students see struggling as a sign of failure, whereas these students see it as a sign of good work ethic.
This particular experiment was the building block for this research done to compare whether men or women are willing to struggle to solve a problem for longer, and measuring their success not by a correct answer, but by how long they spent struggling through the test. The test was based on questions that your average student had the knowledge to solve, just as these students had the ability to draw the box, but completing the task required more persistence. As this experiment compared Japanese and American students, our research compared men and women in a similar manner.

The gender gap in STEM has been shrinking as time passes, but a gap still remains today (Degol & Wang, 2016). The STEM field is currently lacking in diversity, primarily lacking in the representation of women, blacks and Hispanics (Google & Gallup Inc, 2016). Women are steadily becoming more recognized in the field, but they are still majorly underrepresented. Research indicates that there are no scoring differences between boys and girls through grade eleven (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). If cognitive ability was the cause of underrepresentation, testing would scores illustrate that claim.

Confidence in mathematics is a factor in why women do not obtain a higher education degree in mathematics. Women report lower self confidence in mathematics, possibly further causing underrepresentation in the field. Any gender is more likely to pursue an occupation in a given field when he or she is motivated and able to succeed in that field (Su, Rounds, & Armstrong, 2009), and women are suffering from lack of motivation in the STEM field. The Research Consortium on STEM Pathways conducted a national survey of 7,325 high school students in STEM classes during Spring 2015 which shows that 27% of women would choose a STEM career compared to the 65% of men that would choose a STEM career (STEM Classroom to career, 2016). Though women have earned more degrees in mathematics and statistics since 2004, the proportion has diminished in bachelor’s and master’s degrees (Field of Degree, n.d.), and though women make up 50% of the total U.S. college educated work force, they make up only 29% of the science and engineering work force (Statistics, n.d.).

The impact of this gap between genders is that gender equality could lead to a smaller skills gap, an employment increase, and reduce occupation segregation. The demand for engineers is growing, and it is important to attempt to close the gender gap to help feel this demand. One study suggests that the gender gap starts at an early age, the study had two groups
of students comparing boys and girls and consistently girls rated men as being better at math than women, but ranked boys and girls as equal (Steele, 2003). This demonstrates that the gender gap occurs sometime when students are still young.

This research used a test compiled of ASHME (American High School Math Examination) questions and randomly generated questions to measure student determination. The questions were competition-based questions and were all solvable without calculus. This was important to maintain fairness in the difficulty of the test. Students were not scored on right or wrong answers. We only recorded the time spent as the measurement of persistence.

The sample population included 35 Tyler Junior College students ranging from the ages of 18-39 years old. Students were given a copy of the test and asked to write their start time. The students were then to begin working for as long as they needed and record the time they completed the test. They were then asked to answer a multiple-choice survey to record their gender, age, highest math course taken, how they felt about math, and their current major area. The survey questions were asked to gather excess information to discover whether another factor affected a students’ persistence times. The data gathered was then used for a statistical analysis of the study.

Results

Based on data collected, a hypothesis test was conducted of a null hypothesis of the population mean persistence times for males and females are the same, versus an alternative hypothesis that the population mean persistence times are different. At a 5% significance level, we failed to reject the null hypothesis. This implies that although the population means may be different, we do not have sufficient evidence to claim as such.

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>21</td>
<td>13.95</td>
<td>9.45</td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>16.35</td>
<td>9.913</td>
</tr>
</tbody>
</table>

Based on data collected, we estimate that the mean persistence time for all males is 13.95 minutes with a margin of error of 5.99 minutes, or equivalently, that the mean persistence time for all males is between 7.96 minutes and 19.94 minutes. We also estimate that the mean
The persistence time for all females is 16.35 minutes with a margin of error of 4.30 minutes, or equivalently, that the mean persistence time for all females is between 12.05 minutes and 20.65 minutes. Both intervals were constructed at 95% confidence. Since the intervals overlap, we cannot conclude that the population means are different.

Based on these boxplots, we see there is a strong overlap in times for females and males. Despite the samples mean persistence times being different, evidence suggests that it is possible that mean persistence times for all males and females could be equal.

Discussion and Conclusion

Do men and women have a difference in determination? We were unable to clearly define an answer. The sample size used did not provide sufficient data for a statistical. While there is no real one-size-fits all answer to correcting the gap in the STEM field, using methods of research to determine what causes this gap is one step in the right direction. Using the current data collected, there is no direct conclusion. If we repeat the survey and testing process we could yield a larger sample size giving us adequate data to accept or reject a null hypothesis.

This data could be used to transform the way students are taught in a classroom environment. If teachers knew whether men or women were willing to try harder, they could adjust testing periods and use alternate grading criteria. For example, rather than grading
students purely on right or wrong answers a teacher could grade all written work, and some educators have already adopted this approach. This could reward the amount of effort put in rather than just achieving the correct answer. Many mathematic courses already use this tactic to some extent, but future research could cause it to become the social norm to grade papers in this manner. Previous research strongly suggests that the lack of women in the STEM field is not being caused by a lack of capability, but a lack of mathematics confidence (Linver & Davis-Kean, 2005).

Limitations

This study was conducted in an environment where students may not have attempted the test for as long as they would have under non-voluntary circumstances. Some students were offered extra credit for participation. This could cause an error in the amount of time a student would have regularly spent if the test had a significant impact on the student's daily life. Another limitation is the small sample size. The sample being larger would increase the margin of error and could possibly still produce a statistically insignificant difference. Students were also attempting the test during a school day, causing some students to rush the event to move on to their next activity.

Appendices

Age versus Mean Persistence Times
Regression analysis comparing age versus persistence time reveals a coefficient of determination of $R^2 = 4.32\%$. This means that based on this sample, only 4.32% of variability in persistence times can be attributed to variability in ages. As such, we do not have sufficient evidence to conclude that persistence times is affected by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>18-19</td>
<td>19</td>
<td>17.94</td>
<td>11.79939</td>
</tr>
<tr>
<td>20-21</td>
<td>10</td>
<td>11.13</td>
<td>4.221434</td>
</tr>
<tr>
<td>22+</td>
<td>5</td>
<td>11.46</td>
<td>5.449804</td>
</tr>
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An analysis of variance (ANOVA) was performed on the mean persistence times for age groups 18-19, 20-21, and 22+, to test a null hypothesis of the mean persistence times for all age groups are equal, versus an alternative hypothesis of at least two mean persistence times are not equal. The results produced a p-value of 0.14. Since this is greater than a standard significance level of 0.05, we failed to reject the null hypothesis. As such, even though our samples produced
different mean persistence times, we do not have sufficient evidence to conclude that age impacts persistence times.

*Feelings about Math versus Mean Persistence Times*

<table>
<thead>
<tr>
<th>Feelings</th>
<th>N</th>
<th>Mean</th>
<th>St. Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly dislike</td>
<td>8</td>
<td>10.62</td>
<td>5.524862636</td>
</tr>
<tr>
<td>dislike</td>
<td>7</td>
<td>11.16</td>
<td>3.155577912</td>
</tr>
<tr>
<td>neither like nor dislike</td>
<td>9</td>
<td>20.07</td>
<td>10.29732563</td>
</tr>
<tr>
<td>like</td>
<td>7</td>
<td>14.87</td>
<td>11.65160422</td>
</tr>
<tr>
<td>strongly like</td>
<td>3</td>
<td>23.08</td>
<td>17.62002491</td>
</tr>
</tbody>
</table>

An analysis of variance (ANOVA) was performed on the mean persistence times based on feelings about math (strongly dislike, dislike, neither like nor dislike, like, strongly like), to test a null hypothesis of the mean persistence times for all types of feelings are equal, versus an alternative hypothesis of at least two mean persistence times are not equal. The results produced a p-value of 0.17. Since this is greater than a standard significance level of 0.05, we failed to reject the null hypothesis. As such, even though our samples produced different mean persistence times, we do not have sufficient evidence to conclude that feelings about math impact persistence times.

Though the experiment was unable to yield any results of statistical significance, we were able to develop a measurement for determining persistence and ways to understand what affects a students’ persistence.

**References**

Field of degree: Women. (n.d.). Retrieved from


