So What's All This I Hear About a Math Gender Gap?

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Overview
Objectives
Strategies
Rationale
Classroom Activities
Annotated Bibliography
Appendix/Content Standards

Overview

This unit is designed for a fifth grade classroom and is intended to amplify student understanding of the concepts contained within the statistics strand of the math curriculum by closely examining a question through the lens of social research methodology. Students will consider the question of the existence of a gender gap in math in our school. They will pose a hypothesis, create surveys, collect and analyze data, determine the answer to their question, and publish their results in graphic form. Additionally, they will explain their methodology in a written paper. The unit can be implemented in stages over several weeks and is intended to supplement the Math Common Core curriculum of the School District of Philadelphia.

Objectives

The primary objective of this unit is to actively engage students in the real work of social scientists and statisticians. Rather than "passively received" instruction with its heavy emphasis on computation skills and data landmarks, students will have the opportunity to use , as Bradstreet notes, the tools of their education actively rather than just acquire them…so as to build an increasingly rich implicit understanding of the world in which they use the tools and of the tools themselves (1) .

As any math teacher knows, there is a question that hovers in the air during every lesson, throughout every year. If the students are polite, it is never voiced, but it's really the elephant in the math classroom. And just what is that question? "When will I ever need to use this (insert concept)?" So, when students see that the work they do can be applied to questions that are meaningful and interesting to them, that the math they do is in aid of something real, they can be drawn in and significant learning can take place. One issue that seems to captivate fifth graders is how the boys and girls compare to one another academically. The rivalry is generally good natured, but the competition, in say something like a jeopardy type game, can be fierce. No points are easily ceded, and you better not misspeak as you deliver your answer! Based on these informal observations , I thought my student would be interested in exploring the concept of a gender gap in math. This unit is designed to have students do the work of social scientists as

they research the concept of a gender gap, determine if one exists in our school, and prove or disprove its existence.

Strategies

Students will:

- Understand what social science is
- What is involved in social research
- Understand how statistics are derived and how they are important in providing evidence in support of a theory or argument
- Develop a hypothesis
- Learn how to create unbiased survey questions
- Understand what constitutes a representative sample
- Administer the survey
- Collect the data
- Analyze the results
- Create an appropriate graphic representation of their results
- Write a report that explains how the data did/did not support their hypothesis
- Explain the methods used in their research
- Present their findings

Rationale

"Well, you know, I just really don't like math," ten year old Sophia seriously intones on the first day of fifth grade. A hundred questions and encouraging responses immediately run through my mind. "Why?" "Did someone – teacher, parent, friend tell you that you weren't good at it?" "Do you really find it difficult?" "Do you think it's ok to not like math – being a girl and all that?" Instead, I give her the standard teacher demur – a non-committal, "Hmmmmm", while silently vowing that she will love math and "be good at it" before she leaves my class in June. Sophia is not alone in her attitude toward math. Like many girls I've had in my math class over the years, she would rather not have to contend with a subject she feels is beyond her abilities – one that she will never master. She is, after all, a girl and everyone know that girls just aren't good at math. She will always lag behind the boys in this and future math classes, and that's just the way it is.

Over the last few decades, much has been made about the gender gap in mathematics. Its existence is hotly debated in academic circles with one set of data supporting the existence, another set purportedly debunking it as a myth. This notion of a biological basis for a gender gap would appear to have its roots in the early part of the 19th century beginning with the work of anatomist, Johann Mekel (Hollingworth 510). Mekel theorized that males had greater variability from the mean on both ends of the ability spectrum and, as a result, were more represented in the highest performing sector. In response to the naturalists of the day, this theory was reframed and variability came to be regarded as an advantage, a characteristic according the greatest hope for (evolutionary) progress and finally as the probable explanation of the fact that all the world's greatest deeds of intellect have been the deeds of men (Hollingsworth 512). There was little, if any, empirical evidence to support this greater male variability hypothesis. (Two notable

exceptions were Karl Pearson, a British psychologist who had studied variability in 1897 and found no difference between the sexes and American psychologist Leta Hollingsworth whose work with more than 1000 patients led her to concur with Pearson). Despite the lack of evidence the theory gained widespread acceptance primarily as a result of the writings of two influential psychologists of the day, Cattell and Thorndike. As recently as 2005 the theory was referenced by then president of Harvard University, Lawrence Summers, who cited it as a plausible explanation for the lack of outstanding women mathematicians.

Thorndike's support of the theory had a great and lasting influence on pedagogy throughout much of the twentieth century.

> This one fundamental difference in variability is more significant than all the difference between the average male and female capacities…a slight excess of male variability would mean that of the hundred most gifted individuals in this country, not two would be women, and of the thousand most gifted, not one in twenty. Not only the probability and the desirability of marriage and the training of children as an essential feature of women's career, but also the restriction of women to the mediocre grades of ability and achievement should be reckoned with by our educational systems. The education of women for such professions as administration, statesmanship, philosophy, or scientific research where a very few gifted individuals are what society requires is far less needed than education for such professions as nursing, teaching, medicine, or architecture where the average level is essential..post graduate instruction is a far more remunerative investment in the case of men. (qtd. in Hollingworth 510).

Despite the widely held belief in the early part of the twentieth century that the intellectual abilities of women and girls was negligible and it was therefore neither cost effective to educate them nor to expect them to achieve much in the arts and sciences, women and girls made great progress in all areas. This is particularly notable in the most recent half century. Girls are more prepared as they enter college and now represent the majority of college graduates. Many more high school girls are taking math and science courses and now the mean and standard deviation in performance on math test scores are only slightly larger for males than for females. However, even though there are minor differences in mean performance, many more boys than girls perform in the right tail of the distribution. This gender gap has been documented for the SAT, AP calculus, and the GRE among other standardized tests. Examining the top 5% of the SAT math scores researchers noticed a 2 to 1 ratio of males to females. The gender gap widened even more when looking at the right tail of the distribution in the American Math Competition (Niederle and Vesterlund 129).

Fryer and Levitt examined the question of a gender gap and published their findings in a 2009 paper. They used the Early Childhood Longitudinal Study Kindergarten Cohort (ECLS-K), a data set administered by the US Department of Education. The survey sampled more than 20,000 children entering kindergarten in the fall of 1998 from approximately 1,000 different schools. Information in the survey for each child included family background, school and neighborhood characteristics, teacher and parent assessments and expectations, and test scores. The original sample of students was re-interviewed in spring of kindergarten, first grade, third grade, and fifth grade. Their findings indicate a "substantial gender gap in mathematics in the early years of schooling among US children"(2). Kindergarten students seem to show the same

abilities in math and reading, but by the time students are ready to enter middle school (by the end of fifth grade) girls have fallen behind boys. By the end of the sample, boys outperform girls in every tested math skill. Underperformance is seen in mean math scores and also in the upper distribution. Fryer and Levitt found that "girls are losing ground in math in every region of the country, every racial group, all levels of the socio-economic distribution, every family structure and in both public and private schools"(4).

Though the existence of a gender gap and its magnitude has been the subject of much debate in academic circles for some time, most research seems to substantiate that there is, indeed, a gender gap in math performance. Researchers are turning their attention to determining why and what can be done about it.

A 2011 study by Kane and Mertz found no basis for the assumption that girls have less ability in math than boys as a result of innate biological differences. Their study looked at data from the 2007 TIMMS results and the 2009 PISA results. TIMMS – Trends in International Mathematics and Science is an assessment of the mathematics and science knowledge of 4^{th} and 8^{th} grade students from 47 countries. It is given every four years and includes an assessment as well as teacher and student questionnaires. It measures more traditional, procedural knowledge. PISA- Program for International Student Assessment is a triennial test of academic achievement of fifteen year olds in 41 countries. This test requires students to apply their mathematical knowledge to solve problems in a variety of real-world contexts. What made their examination of these tests results different from previously examined results was the participation of many more non-western countries. As a result, data from these international assessments provided them with a good sampling and enabled them to carry out a cross- cultural analysis of student performance. "If gender differences in means and variances are primarily a consequence of innate, biologically determined differences between the sexes, one would expect these differences to be similar among countries regardless of their culture and to remain fairly constant across time" (Kane and Mertz10).

The authors used a gender gap index – a composite, weighted measure that compares boys and girls in terms of income, education, political empowerment and health- and compared these to math scores. They concluded that the gap in performance between boys and girls … "is not a matter of biology: none of our findings suggest that an innate biological difference between the sexes is the primary reason for a gender gap in math performance at any level. Rather, these major international studies strongly suggest that the math gender gap, where it occurs is due to sociocultural factors that differ among countries, and that these factors can be changed"(19).

Researchers have studied many of the sociocultural factors influencing/contributing to the gender gap. One explanation is the persistence of stereotyping. Girls are not socialized into believing that math is doable for them, necessary or carries any great importance in their lives (Fryer and Levitt 7). Stereotypes are hard to counteract. Hyde, in her 2008 paper notes that the belief that boys do better at math is still widely held by parents and teachers. And teachers and parents still guide girls, giving them advice about what courses to take, what careers to pursue. " I still hear anecdotes about guidance counselors steering girls away from engineering, telling them they won't be able to do the math… (but) when girls see opportunities for themselves in science ,

technology, engineering , and math, they're more likely to take higher math in high school and more likely to pursue those careers"(Hyde 40).

Another area where stereotyping affects a child's confidence was seen in parental estimation of math abilities. Mothers who believed in the male math dominance tended to underestimate their daughters' math abilities. The daughters, in turn, were likely to underestimate their actual academic performance. This stereotype threat theory suggests that stereotypes not only influence a child's confidence, but may result in the child "choking" in a performance setting because they are afraid of confirming it (Steele 617).

An interesting observation noted in Fryer and Levitt in their examination of cross country data was the performance of girls in single sex classrooms. Girls in this setting seemed to perform better to the point where the gender gap seemed to be eliminated. They are careful to note, however, that...to date there has been little in the way of large scale, rigorous empirical testing of gender-segregated education…but the patterns suggest that further study of this issue may be warranted (27). Kane and Mertz note that "We found that boys – as well as girls – tend to do better in math when raised in countries where females have better equality, and that's new and important (18).

US schools themselves might be a contributing factor to the gender gap. Robinson and Lubienski note that the United States has the greatest gender gap in the elementary grades – greater than most countries. One possible explanation is that our country has a predominance of female teachers in the first and second grades and that these teachers identify themselves as "math anxious". They found a link between teachers who are scared of teaching math , and just want to " get it over with" and girls' lesser math performance. Girls picked up on their teachers' anxiety, but not the boys because young children are more likely to identify with and emulate adults of their gender (Beilock 1862). On the other hand, a 2007 study examining the effects of a teacher's gender in higher level math courses on students' found that female students' performance greatly improved when their teacher was a woman, especially the gifted students (Dee 550).

Additionally, there is some evidence to suggest that teachers' perceptions contribute to the gender gap. In the classroom, girls are generally more compliant. They pay attention, show an eagerness to learn, are persistent, sit still, and seem better able to work independently. Teachers might tend to mistake these behaviors as comprehension. As a result, the underestimate the further instruction and explanations girls might need in order to fully comprehend the concepts being taught.

Test scores have been examined and used in order to document the existence of a gender gap. But researchers know that scores measure more than just an individual's cognitive abilities. Other factors such as motivation, drive, and obedience have an effect on test results as well. Niederle and Vesterlund have investigated the effects of an individual's response to competitive pressure as one of the variables affecting performance. They believe that the differences in math scores are more reflective of the difference in gender attitudes towards competition than any underlying gender differences in math skills. Girls tended to perform well in same sex groups, but underperformed in mixed-sex groups. Their study reviewed the literature related to mixed-

sex competition and they determined that the reported studies suggest that a woman's performance and willingness to compete is sensitive to the gender of those she is competing with. If a large fraction of competitors on math tests are male, then gender differences in attitudes towards competition may play a particularly large role, and this may be exacerbated at the more male dominated upper tail (140).

While researchers seem to agree that a gender gap in math performance does exist, the causes, as the literature indicate, are myriad. Social scientists can neither attribute the gap to any single factor, nor can they find support for any particular theory. They do, however, seem to concur that any gap that exists is about the culture and not the biology. As Hyde and Mertz note, "Math performance correlates with several measures of gender inequality, so it is largely an artifact of changeable sociocultural factors, not innate biological differences (8806). It is interesting to note though, that while girls don't do as well in math as their male counterparts, they do much better than the boys in their verbal test scores. One would think there would be as many studies to determine the causes of this aspect of the gender gap. But there aren't. Why not? "One reason is that in contrast to, say, verbal test scores, math test scores serve as a good predictor of future income. Although the magnitude of the effect of math performance on future income varies by study, the significant and positive effect is consistently documented" (Niederle and Vesterlund 130).

The investigation into the math gender gap, its causes and effects on society, is an example of social science at work. The social sciences – anthropology, psychology, political science, and sociology involve the study of people – their beliefs, behaviors, interactions, and institutions (Neuman 3). The goal is to help us better understand the world in which we live and ourselves. The social sciences are relatively new disciplines compared to the physical sciences. But their importance and influence are growing. As Bailey notes, "It's clear that our complex society must be understood in depth, as our social environment affects us just as directly and profoundly as our physical environment, although in different ways"(11).

The earliest social scientists writing in the mid nineteenth century believed that humans had free will, so no one could really predict their actions or generalize about them. Emile Durkheim, considered to be the father of modern sociology, however maintained quite a different position. He believed that human activity could be generalized. Consequently, methods of scientific inquiry employed by physical scientists could also be applied in this area of research in order to systematically study social phenomena (Bailey 33).

Though different from the physical sciences, there is no less science in the social sciences. Both rely on logical and systematic methods to answer questions. They are based on observations, a belief that it is possible to discern patterns that explain phenomena and help us understand life more fully. Additionally, there is an underlying belief that results are shared and thereby contribute to a body of knowledge that is constantly growing and evolving (Shutt 53).

Social scientists employ a variety of approaches to their work and often combine several in their research processes. Neuman observes that social research is not neat and linear. "It is an interactive process in which steps blend into one another..and may flow in different directions before it concludes." Generally though, the research processes share basic stages. Researchers

begin with a topic. This is then narrowed to a specific question. A study is designed in which they decide what techniques to use – questionnaire, experiment etc. Once the design has been decided upon, the researcher will collect data, analyze it, interpret it, and finally inform others.

The following classroom activities are modeled on the stages of social research and were designed to provide students with an opportunity to do the work of social scientists – researching, collecting and analyzing data and using the data to answer a question. An additional goal of the activities is to strengthen students' knowledge of statistics by making connections between the features of the data they are able to describe and what those features tell them about what the data represent.

Classroom Activities

Introduction

"How do you know this stuff?"

Begin the session by playing an interactive, "Concentration" like memory game on the US Census Bureau website www.census.gov/schools/census_for_kids/census
In teams, students turn over spaces by matching two at a time. When all spaces are matched, there is revealed an interesting statistic about children garnered from the census data.
There is also a quiz section with interesting statistics.

This activity is most effective when presented using a smart board, but the game can be played with prepared construction paper squares taped to a regular board.

After playing several rounds, ask students if they know how this information was obtained. Record their answers on chart paper. Refer to this as applicable during the following discussion.

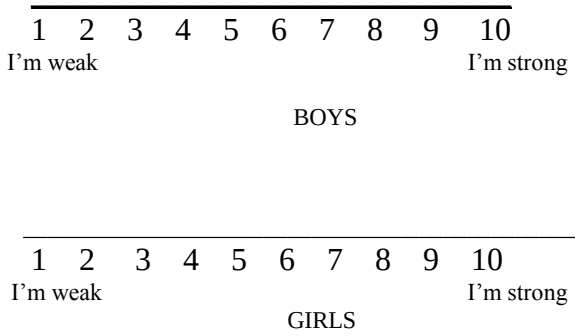
Using the census as a springboard, explain to students the process of surveying, collecting data, and analyzing data to learn about the population or to answer questions about people and how they live or what they think.

Session 1
This session will set the stage for the work students will do during the unit of study.
Through a series of quick surveys, students will explore, albeit in a limited way, 5th graders' attitudes towards math. Additionally, they will be introduced to the concept of a gender gap in math performance.
Materials needed: two different color post-its - enough for each student to have 3
notebook for each student, or – begin a separate section in existing notebook

Question 1

Pose the Question: How do you view your math skills?

Draw the following number lines on the board. These will be the basis for the line plots students will create later.



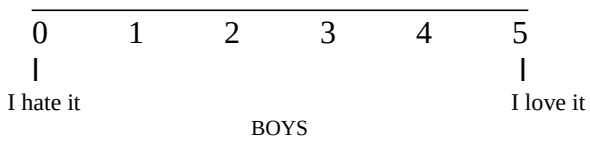
Hand out post-it notes to students – one color for boys, a different color for girls.
Ask them to consider the question, write down the number they feel best represents them, and then turn the post-it face down on their desk.
Collect the notes.
Ask students to think about why the information was collected the way it was.
With anonymity, was it more or less likely that the sample would be accurate? Why?
As they respond in their notebooks, place the data on the number lines, then discuss their responses to the questions

Class Discussion Questions:
Are the data spread out or close together? Does it differ for the boys? For the girls?
Are there clumps? Where are they?
Are there any outliers?
What is the median for the boys? For the girls?
What is the mean for each group?
Is there a difference between what the boys think about their skills and what the girls think about their skills? Where do you see that in the data?
What can you say about how the class feels about their math skills? (Record on chart paper for future reference.)
Is this conclusion supported by the data? How? Which measure was the most useful as evidence in support of your argument?

Question 2

Pose the question: How much do you like math?

Create the number lines as in question 1

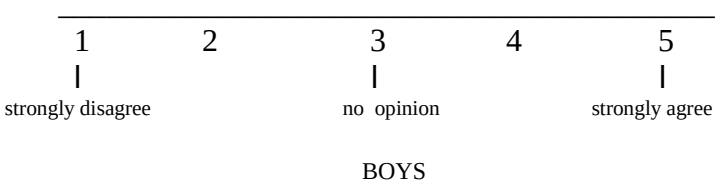


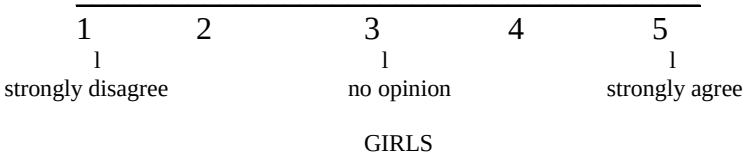
Follow the same procedure with the post-its and responses as in the first question.
Ask students to analyze the data and then discuss it.
Here again, what can we say about our class's attitude towards math?
Who likes math more, the boys or the girls?

Question 3

Pose the question: Do you agree with the following statement:
Boys are better at math than girls.

Create two lines:





Have students respond as before. Collect and place data on the scale.
Ask students to analyze the data and draw a conclusion as to the class's views on the statement
Discuss results of the survey question with the students.

Session 2

Briefly review the work of the previous session – the procedure and the results of the surveys.

Ask students if they think that the results would be the same for the other fifth grade classes in the school.

Would they be the same in the fifth grades in another school?
Record responses on chart paper for later reference.

At this point, students should be introduced to the concept of sampling and its significance in statistics.

Some key terms to explore: population, sample, elements, representative sample, sampling error, census, generalization (generalizability). See glossary for a definition of terms.

Materials Needed:
Large bag(s) of different colored marbles
Large glass /transparent container
Smaller transparent container
Copy of graphic organizer for each student (see appendix)
Copy of worksheet for each student (see appendix)
Flow chart diagram of social research process

Part One

Begin by explaining to students that most of what we know about the world around us is because of something called social research - work done by social scientists trying to answer a question about the way we think and live. Example: Bullying and how to deal with bullies; what we buy and how we decide to buy that particular thing; young people's choices about smoking

Introduce students to the process of social research with the flow chart.

Explain the importance of sampling in the research process:
One of the most important parts of social research is getting the information by surveying, asking people questions about the topic. This is done through a process of sampling.

For example, suppose we had a question about the topic of children's sneaker preferences. Specifically, we wanted to know what sneakers elementary school children in Philadelphia liked the best.
How would we get our answer? Would we ask every elementary school child in Philadelphia about his/her favorite sneaker? Why?/Why not?
Explain that polling all students would constitute a census.

What could we do instead?

At this point, introduce the marbles as a further example of the concept of sampling.

Look at this container. Suppose we wanted to know what percent of the Skittles were red?
This whole jar represents the *population* (Have students record this term on the graphic organizer.)

We know we can't possible count all the red ones, so we'll take a handful. This is known as a *sample.* (Record term)

Ask students if they noticed how you got your sample.
Did I pick through the marbles? Grab a handful from one particular corner? Just the top? This is known as getting a *random sample.*

Ask students to compare the handful of marbles to those in the large jar.
Do they look pretty much the same? This is known as a *representative sample*. (Record)
Each of these marbles is known as an *element.* (Record)

Now, let's see if we can determine the percent of red marbles in the bag.
Have students count the elements in the sample, note, and record. Count the red elements and record. From this determine the percentage.

Answer the question. We can expect _____percent of the marbles to be red.
Can we expect about the same percent of red marbles in most bags of marbles? (*generalizing)*

Part Two

Students will work through a similar exercise using a population of tropical fish.
Project a Google image of a large population of fish.
Ask students to create a question about the fish.
Follow the steps in the worksheet, drawing and labeling the elements of their population and sample.
Answer their question.
Choose several students to share their results.

Part Three

Discuss each of the sampling terms as they relate to the math survey students completed in the previous session:

Describe the population of our school.
Would our class be considered a sample of the population? Explain
Would our class be considered a good representative sample? Explain.
If we took a census of our school about a particular question, how would that differ from asking that question of a sample of the school?
Could we generalize our answers about our attitudes toward math to the whole school? To the other 5^{th} grades?

Discuss each of the terms relating to sampling in terms of the survey just conducted in class.
What would be considered the population of our school?
Would our class be considered a sample of the population? Explain
What are the elements of our sample?
Is our class representative of the population? Describe how we are representative
What is the census of the school?

At the end of the discussion, determine if the sampling was appropriate and if the results could be generalized.
Tell students that they will be conducting a census.

Session 3 – Conduct a census of all the other fifth grades

Since a census is a survey of all members of the population, this may not be feasible in a school with many fifth grade classes. If that is the case, decide with students how many additional classes they think should be surveyed in order to have a representative sample of the population, and conduct the survey in those classrooms.

The surveys can be conducted over the course of several days.

Have students prepare survey questionnaires.
These will contain the same questions they were asked in Session 1, but will include a question about the gender of the respondent.

Arrange with other teachers for a time when your students would be able to come to their classes to conduct the census. (This may not be possible, so ask teachers if they would be willing to hand out the surveys and collect them back for your students to pick up later.)

At the scheduled time, pairs of students will go to the other fifth grade classrooms
Prior to the classroom visits, have students rehearse their explanations and the directions they will give.
Students will tell the classes they visit that they are conducting research on how fifth graders feel about math.
They will briefly explain what social research is – what it tries to determine and how it is done.
They will explain the questionnaire and distribute it.
(Depending on time constraints and the classroom teacher's schedule, they can either wait while students complete it or arrange to pick it up later in the day.)

Session 4 – Taking a Look at the Data

Explain to students that they will now look at the data they've collected from the other fifth grades and determine how it compares to the results we had in our class.

Distribute the surveys among all students along with two different colored post-its
Students will look at one question at a time.
Write each question on the board, draw the line plots below it.
Students will place a post-it on the plot to represent the answers in the surveys they have been given.
Look at the data using the questions from Session 1
Discuss the results as a class recording students' responses.

Follow this procedure with all three survey questions.

Ask students if we have enough data to answer the questions
- How do fifth graders feel about math?
- Do boys feel differently from girls?
- Do we believe boys are better at math than girls?

Write out a statement, using the data to support the conclusion.

Session 5 – The Gender Gap

Materials needed:
Report card grades (most recent) from all fifth grade classes, listed according to gender, but not identified by particular classroom
PSSA scores for prior year's fifth grade, disaggregated by gender
PSSA scores from the prior year for current fifth graders, disaggregated by gender
Data recording sheet (see appendix)
Calculators

Ask students if they have ever heard the term "gender gap"?
If they have, elicit what they think they understand about the term and record on chart paper
If they have not, explain what it means, or prepare a short written description for them to read and then hold a discussion. What might be the reason(s) for this?

Ask if they think there is a gender gap among the fifth graders. On what are they basing this?

Look back at the survey results and ask if it might be possible to predict if there is a gap in the fifth grade.

Explain to students that they will be collecting and analyzing data to determine if there is a gender gap in math among the fifth grades.

Procedure:
Provide students with math grades from each classroom.
Have them find the following and record it on the recording sheet:

- mean, median, and range for each classroom
- mean, median, and range for the boys of each class
- mean, median, and range for the girls of each class
- mean, median, and range for all boys
- mean, median, and range for all girls

Complete the same process for PSSA scores (standardized test scores)

In order to display the distribution of the data in graphic form, prepare two line plots in advance. This can be done on the smart board or with overhead transparencies.
Choose a data set and prepare a line plot of the items using one color for the girls, another color for the boys. Discuss the most important features, identifying important concentrations of data, and focusing on the overall shape of the data.

Prepare a large recording sheet with the results of the work students completed.
Display the survey questions from the earlier sessions as well as the answers to the questions. alongside the data
Analyze the data.

Correlate the data with the questions. For example: Students might observe that the mean grade for boys in Room A was higher than that of the girls. They reported that they felt their skills were good and that they really enjoyed math.

Can students answer the question – Is there a gender gap in math among the fifth graders of this school?

Sessions 6 and 7

The original task was to determine if a gender gap exists in our school. Students completed an investigation of the fifth grades. At this point, their research should be extended to include the 3rd grades and the 8th grades.

They will follow the procedure outlined in Sessions 1 and 5.

Session 8

During this session, students will plan how they will represent their findings and begin work on the presentation
Some options to consider would be:
* Science fair type poster
* Power point presentation
* Create a different type of data display using an infographics website such as infogr.am.
  This is a fairly new type of data display format that can be done on line. Students will be able to create dynamic and visually compelling presentations of their research
  There are many sites, so it will be necessary to investigate and find the one most suitable for each class.

Session 9

Students will write a report on their findings.
This is an important aspect of social research- communicating what you learned with others.
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The report should detail the research process.
Ideally, the report would begin by describing the question students investigated and some background about it. It should describe the steps taken, present the data, and show/explain how these data relate to/explicate the question .Finally, the report should indicate whether or not the question was answered- what were their findings.

This work can be done over several days during literacy or math and will likely require several drafts before it is in publishable form.

Session 10

During this final session, students will share their data with the other fifth grade classrooms and the 8th grades.

Rather than read their reports, they will informally explain their question, methods, and results referring primarily to the graphic representation each created. Prior to this, students should have an opportunity to rehearse their presentations

Annotated Bibliography

Azar, Beth . "Math + culture = gender gap." *American Psychological Association Science Watch* 41.7 (2010): 41-43. Print.
Researchers have pretty much debunked the notion of a biological reason for the gender gap in math. The author takes a look at some of the other factors that keep girls lagging behind.

Bailey, Kenneth, D. *Methods of Social Research, Fourth Edition.* New York: Free Press, 1994. Print.
Bailey's introductory text on social research is an easy to read source that clearly explains every stage of sociological research.

Beilock, S.L., E. A. Gunderson, G. Ramirez, and S.C. Levine. "Female Teachers' Math Anxiety Affects Girls' Math Achievement." *Proceedings of the National Academy od Sciences* 107.5 (2010): 1860-863. Print.
This study showed that when math anxious individuals are female, as are most early elementary teachers, their anxiety carried over to their female students and resulted in negative math achievement.

Dee, Thomas. "Teachers and the Gender Gaps in Student Achievement." *Journal of Human Resources* 42.3 (2007): 528-54. Print.
The author examined the interactions between teachers and students to determine if there was any correlation between these interactions and the achievement gap in math and science.

Fryer, Roland G., and Steven D. Levitt. "An Empirical Analysis of the Gender Gap In Mathematics." *American Economic Journal: Applied Economics* 2.2 (2009): 210-240. Print.
The authors incorporated the results of a longitudinal study (ECLS-K) in their original research as they attempted to document the existence of the gender gap and explore the possible explanations for it.

Hyde, J.S., and J.E. Mertz."Gender, Culture, and Mathematics Performance." *Proceedings of the National Academy of Sciences* 106.22 (2009): 8801-807. Print.
The authors examined 3 questions – Do gender differences in math performance exist in the general population? Do gender differences exist among the mathematically talented? Do females exist who possess profound mathematical talent? They discovered that the achievement gap has all but disappeared, but that cultural factors continue to inhibit girls' performance.

Hollingsworth, Leta Stetter. " Variability as Related to Sex Differences in Achievement: A Critique." *American Journal of Sociology* 19.4 (1914): 510-30. Print.
This article, amazingly ahead of its time, is a close examination and review of the data relating to the variability hypothesis. Men were thought to have greater variability in their abilities than

women – there were more men at each end of the intellectual spectrum. This was taken (in the early nineteenth century) as a sign of men's greater intelligence. A trained psychologist, she takes the whole theory down point by point.

Kane, Jonathan M., and Janet E. Mertz." Debunking Myths about Gender and Mathematics Performance." *Notices of the American Mathematical Society*,59.1(2011):10-21. Print.
This study, using international data on school mathematics performance, successfully explodes the stereotypes about male superiority when it comes to mathematics. They found, rather, that cultural factors were more significant in determining ability.

Large, Tori. *The Usborne Illustrated Dictionary of Math.* Tulsa: EDC. 2007. Print.
This is an excellent resource about mathematics for anyone to have on hand. The author provides clear, concise explanations of some very complex math concepts and the illustrations work successfully to enhance the text.

Neuman W. Lawrence. *Social Research Methods: Qualitative and Quantitative Approaches.* Boston: Pearson. 2006.
The author provides a balanced evaluation of both approaches and illustrates how both methods, combined to provide the greatest benefit to the researcher seeking answers to complex social questions.

Niederle, Muriel, and Lise Vesterlund. "Explaining the Gender Gap in Math Test Scores: The Role of Competition." *Journal of Economic Perspectives* 24.2 (2010): 129-44. Print.
The authors examine the gender gap in math scores and suggest that current methods of testing and evaluation do not reliably represent the math skills of girls. Changing both would more accurately measure girls' abilities.

Robinson, Joseph P, and Sarah Lubienski, " The Development of Gender Achievement Gaps in Mathematics and Reading During Elementary and Middle School: Examining Direct Cognitive Assessments and Teacher Ratings." *American Educational Research Journal* 48.4 (2011): 268-302. Print.
This study suggests that the gender gap is a function of teachers' perceptions. Mistaking girls' compliance for comprehension, their abilities are misrepresented and they are shortchanged instructionally.

Rodriguez, Alberto J., and Cathy Zozakiewicz. "Using Sociotransformative Constructivism (sTc) to Unearth Gender Identity Discourses in Upper Elementary Schools." *Penn GSE Perspectives on Urban Education* 3.2 (2005): 1-13. Print.
The authors examine the patterns in classrooms as an explanation for the gender achievement gap.

Shutt, Russell K. *Investigating the Social World: The Process and Practice of Research.* Thousand Oaks: Pine Forge. 2009. Print.
This is a very student friendly textbook. It is lively, easy to read, and explains social research in the context of contemporary social issues.

Smith, Gary. "Learning Statistics by Doing Statistics." *Journal of Statistics Education* 6.3: n.pag. Print.
The author, a college professor, discussed how students learn best by engaging in activities that require them to do the work of statisticians. He has included a number of interesting projects that would work with students in different grades.

Sommers, Christina. "The Boys at the Back." *The New York* 2013: n. pag. Print.
Boys score as well as girls on standardized tests, yet they fall below in grades. The author explores the reasons behind this discrepancy. She believes it has to do with differences in non-cognitive skills – specifically behavior.

Steele, Claude M. "A threat in the Air: How Stereotypes Shape the Intellectual Identities and Performance of Women and African Americans." *American Psychologist* 52.6 (1997): 613-29. Print.
The author examines the effects of stereotypes on children's confidence and performance. Specifically, a strong stereotype may harm the stereotyped individual's performance because of the fear of confirming it.

Appendix/Content Standards

Glossary of Terms

bar graph: a chart that uses vertical or horizontal bars of equal width to represent numbers. These bars provide an easy way to compare data.

census: research which is obtained through the responses that all available members of the entire population give to questions

elements: the individual members of the population whose characteristics are to be measured

generalization/generalizability: This exists when the observation of a small group of the population informs us about the rest of the population

mean: This is an average. It is found by adding all the numbers in a set and dividing that sum by the number of addends.

median: This is another measure of central tendency (average) It's the number that falls exactly in the middle of the data when the data are arranged in order from least to greatest. Exactly half the data are lower and half are higher. To find the median, arrange the data set from least to greatest and cross out one number form each end of the list. The remaining number is the median. If two numbers remain, find the mean of the two.

mode: This is the value or values that occur most often in the set of data.

outlier: This is a data item that is much higher or much lower than all the other items.

population: the entire group of people or things that is being studied

range: This is the difference between the maximum/highest value of the set and the minimum/lowest value. To find the range, subtract the lowest value from the highest.

representative sample: a sample that looks like the population from which it was selected in all respects that are potentially relevant to the study. The distribution of characteristics among the elements of a representative sample is the same as the distribution of those characteristics among the total population
sample: a subset of a population that is used to study the population as a whole

sampling error: any difference between the characteristics of a sample and the characteristics of a population. The larger the sampling error, the less representative the sample

standard deviation: tells you how spread out the values in a distribution are from the mean. It takes into account every value of a distribution. A high standard deviation means that the values are spread out; a low standard deviation means the values are close together.

Content Standards

College-Career Ready Common Core Standards/PA Common Core

Mathematics
2.4 Data Analysis and Probability (A)
Measurement and Data
CCRS.5.MD.2

2.4 Measurement, Data, and Probability
CCRS.2.4.7.B.3

Literacy
1.4 Writing
Information/Explanatory-Organization
CC.1.4.5.C (CCRS.W.5.2)

Informative/Explanatory-Style
CC.1.4.5.E (CCRS.W.5.2)

Informative/Explanatory-Conventions
CC.1.4.5.F, L, R (CCRS.L.5.2)

Conducting Research
CC.1.4.5.V (CCRS.w.5.7)

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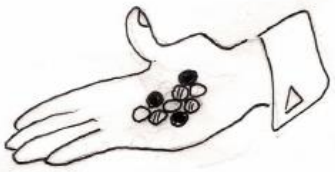
Sampling Graphic Organizer



Data Collection Spreadsheet

	Class ONE	Class TWO	Class THREE
Boys' Mean			
Girls' Mean			
Boys' Median			
Girls' Median			
Boys' Range			
Girls' Range			
Class Mean			
Class Median			
Class Range			

5th Grade Boys Mean:	
5th Grade Girls Mean:	
5th Grade Boys Range:	
5th Grade Boys Median:	
5th Grade Girls Median:	
5th Grade Girls Range:	