

The Editor's Corner



Angela Walmsley

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Happy Fall to you all; and I hope everyone has settled into their new school year by now. I'm really excited to share with you our next edition of the Statistics Teacher Network – Issue 86.

The first article is by Jeff Myers of the American Statistical Association who lets us know about the exciting “This is Statistics” campaign encouraging our students to consider statistics as a profession.

The second article is by Denis Sheeran from the School District of the Chathams in New Jersey. In this article, Denis describes how to create statistical thinkers among middle school students. He provides two lessons, “The Tootsie Pop Problem” and “M&M’s: Think Before you Eat” that can be used in middle school to promote statistical thinking.

The third article by Gregory Freeman, Associate Professor at the Baptist College of Health Sciences in Memphis, Tennessee, provides a basic overview of statistical significance and hypothesis testing. This article is great for someone new to teaching statistics or who needs a refresher on the differences between descriptive and inferential statistics in addition to hypothesis

testing. It serves as a step by step guide for generic hypothesis testing.

Our last article is from one of our associate editors, Jessica Cohen from Western Washington University around how the Standards for Mathematics Practice (SMPs) from the Common Core State Standards for Mathematics (CCSSM) apply directly to the teaching of statistics. Jessica explains that statistical literacy is different from mathematical literacy because of the different natures of the two disciplines; she then analyzes each SMP in light of how it might apply in teaching statistics specifically. In essence, she answers the question, “Are the SMPs an appropriate indicator of the ways in which students should engage with statistics, too?”

I encourage you to read all of these great articles!

We encourage our readers to write for the Statistics Teacher Network! Please send any articles or ideas you have for consideration to Angela.Walmsley@cuw.edu.

Regards,

Angela Walmsley, Editor,
Concordia University Wisconsin

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The ASA's New Statistics Toolkit

New Promotional Bundle Introduces Statistics Career Opportunities to High-School and Undergrad Students

By Jeff Meyers

If only you had handy informational materials about statistics and its many incredible career opportunities that you could have shared with students in the past who had shown an interest in the field. Perhaps, those attentive students would have gone onto college to major in or at least taken a few courses in statistics in order to better prepare for the emerging rigors of their chosen profession.

Lament no more!

The American Statistical Association (ASA), through its This is Statistics public awareness campaign, has prepared a statistics promotional toolkit replete with a variety of resources that teachers and professors can use in secondary school and college classrooms, respectively, to introduce their students to careers in statistics.

The highly impactful toolkit consists of the following helpful materials that, in addition to use in classrooms, can be used at information sessions or other events where students gather to learn about fields of study and careers:

PowerPoint presentation. This 19-slide presentation describes what statistics is and explains why it is the hottest career today; how the field is attracting females, who now comprise more than 40% of the profession; and how knowledge of statistics is growing in importance in other fields such as marketing, data science and journalism. You can deliver this presentation to your classroom to show the students just how exciting and important the field of statistics is and how it is growing.

Talking Points. These talking points closely mirror the PowerPoint presentation and can be used as an aid in delivering the PowerPoint or as a standalone speech. They take a closer look at the field of statistics and explain in easy-to-understand language why today's students should care about the profession (hint: it offers tremendous opportunity for majors and students who take statistics courses).



Fact Sheets about careers in statistics.

These **one-page** and **two-page** fact sheets feature some of the most important information about careers in statistics such as how it is a fulfilling and rewarding profession

and how a student can make a difference in society, have fun, satisfy his or her curiosity, and make money. You could post the one-pager on a bulletin board in your classroom and hand out the two-pager to students.

Video Library of This is Statistics campaign videos.

These also can be streamed on-demand at www.youtube.com/ThisisStats. The most popular of these videos—appropriately titled “Why You Need to Study Statistics” and viewed more than 22,000 times—is a compilation of interviews with several young, up-and-coming statisticians with whom your students can relate. In the video, the statisticians explain why there’s

never been a better time to study statistics and why they chose to study statistics, and why today’s high-school and college undergraduate students should, too. Other videos feature a data scientist, a government statistician, a biostatistician and other statisticians talking about how instrumental statistics is to their career success.

The ASA is excited about This is Statistics and the progress it is making in building awareness of the exciting career opportunities in statistics. By sharing the public awareness campaign’s messages about the tremendous opportunities that are available to your students, we’ll build a brighter future for them as well as the field of statistics.

You also are encouraged to share the This is Statistics Promotional Toolkit with your teacher colleagues and guidance and/or career counselors at your school.

For more information about how to use these materials, download the **Promotional Toolkit Guidance** document. [Click here to download the complete kit.](#) Contact Steve Pierson with questions. ■

Statistics in the Middle School, Concepts and Activities: Creating Statistical Thinkers

By Denis Sheeran

Find the mean. Find the median. Find the mode. Make a bar graph or pie graph. What's the probability of flipping a heads on a coin? Twice in a row?

These are the instructions and questions that encompass the complete statistical instruction many of us received in middle school, mostly with data sets of size 5 -10. Some of us who had more adventurous teachers might have even graphed bivariate data and tried to come up with our own line of best fit using completely non statistical methods, instead employing our understanding of writing an equation using two points. We live in a different world now, where large data sets are available instantly and calculation tools can organize and calculate all we need to know in less time than it takes to sharpen our pencils. So it is no longer useful to spend our time teaching arithmetic and calling it statistics. In today's classroom, the middle school teacher has the opportunity and responsibility to create statistical thinkers.

Rather than dwell on the past, let's look at the present and the future for most of us. The Common Core State Standards spell out the middle school statistical concepts we are to be teaching. What has changed for our students is that the standards no longer ask for students to calculate and find statistical values, but instead to recognize relationships, understand variability and its effect, and make predictions based on interpretation of statistical data. In short, statistics in the middle school should be based on Unanswerable Questions.

When we ask students to find the mean of the heights of the 23 students in our class, we are asking them to average some numbers together, which is a very easy question to answer and an even easier question to grade. Instead, when we ask, "how tall is the 7th grade?" our students must begin an investigation that takes them much deeper into statistics. They will discuss how to obtain the necessary information, devise a plan (one that likely won't work or is completely unrealistic), refine that plan, measure each other, standardize their measurements, find means, graph information, and they may even come across the idea of a distribution of data. And, that's all before the teacher even needs to get involved! Since up to this point in their mathematical education most questions have had numerical and final answers, the desire to try to answer an unanswerable question will continue to motivate the students to work and think and collaborate until they finally come to a point where they are satisfied with their inexact solution to the problem, therein revealing the heart of statistics: using what we know to infer about what we don't know until more information comes along and either changes our minds or gives us a reason to reopen the question.

The following are two classroom tested lessons that will help create statistical thinkers in our middle school classrooms while connecting to the concepts they already know, and paving the way to understanding the four main topics of the AP Statistics Curriculum: Exploring Data, Sampling and Experimentation, Anticipating Patterns, and Statistical Inference. Each has multiple components that can be used independently or as a whole, depending on the background of your students and time available. I have personally used each of these activities in my classes and have seen wonderful discussions and great learning come from them.

Lesson One

Exploring Data, Sampling and Experimentation, and Statistical Inference:

The Tootsie Pop Problem

The Unanswerable Question:

How many licks does it take to get to the center of a Tootsie Pop?

Begin by showing the old commercial to the students (it's on Youtube). Then, after fending off questions like, "why does the owl eat the lollipop?"; "is this some kind of fable?"; and "why isn't the boy wearing any pants?", you can get started.

The Answerable Questions:

What are the characteristics of a Tootsie Pop that we need to take into consideration?

What is a "lick" for the purpose of the experiment?

What needs to be measured, and how?

In sixth grade, students need to be able to recognize that a statistical question is one that anticipates that there will be variability in the data. The discussion associated with defining the components of the Answerable Questions introduces to them that variability exists, even in their definitions, and as such, will exist in their data. Even when they come to an agreement on definitions and procedures, they will quickly find that during the data gathering, different students are following the procedures differently. This leads them directly into the next question: What do we do with our data?



Students have enough mathematical acumen at this point to be able to make good, if not entirely correct, suggestions as to what should be done with the data, so let them. In my experience, by the third or fourth suggestion, they've come up with "average it all together," or "list it from smallest to biggest," and even "graph it." At this point, I have broken the class into teams to complete each of the different valid suggestions and report back; or depending on the focus of our previous and upcoming content instruction, I may take one of the suggestions and complete it during class.

From Common Core Grade 6

At this point, sixth graders need to be able to describe the distribution of the data using its overall shape, center, and spread and recognize that its center describes all the data at once, while the spread (variation) describes how all the data is different from each other. They also need to be able to display the data on a number line (dotplot or histogram) and describe the distribution in context.

I expect my sixth graders to be able to say: "After licking both sides of the Tootsie Pop until we reached the chocolate center, we counted the number of licks per student on each side. The mean number of licks was ##. This was more/less than I expected. When we graphed the data, the distribution was almost symmetrical except for one point which took many more licks to get to the center. The median, or middle value, was less than the mean, and I think that's because of the large number of licks it took on one Tootsie Pop. No one licked more than ## times or less than ## times before reaching the center."

Remember, the goal with sixth grade is to introduce data gathering methods, require correct statistical language, and to develop the ability to describe sets of data.

From Common Core Grade 7

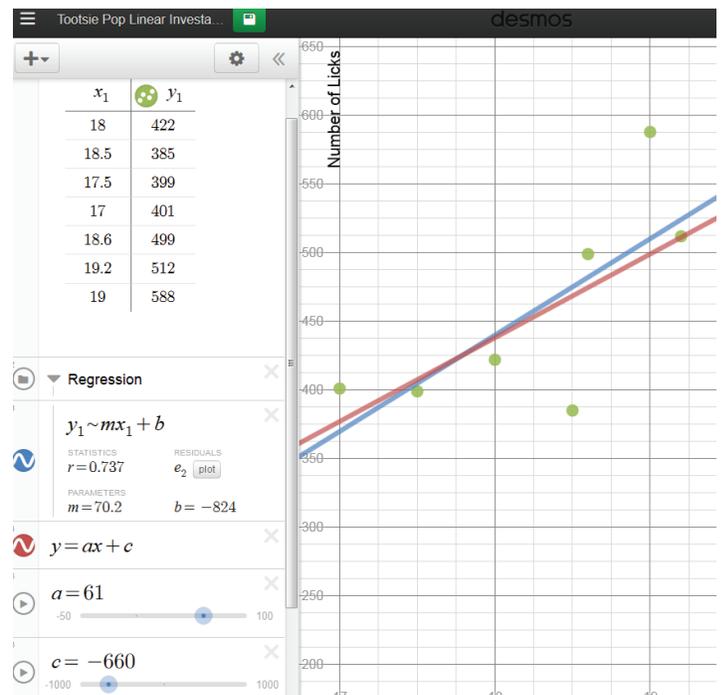
Seventh grade students are expected to begin understanding that they are gathering data from samples, and that they are doing this to make inferences about a population – not just talk about the characteristics of the sample. They should discuss whether or not the Tootsie Pops used could be called a "random sample" and what randomness is and why it is important. Probability begins to creep into the standards now, but most of that would be best taught in other activities; however, I have used our sample to ask questions like "based on our sample, what is the probability that the next Tootsie Pop will take more than ## licks to get to the center on one side?"

I expect my seventh grade students to say everything the sixth graders said, plus: "Although we don't know much about the packaging procedures at the Tootsie Pop factory, we can assume that the lollipops are thoroughly mixed and randomly put into bags. If this assumption is not true, then our sample may not actually represent all Tootsie Pops and our mean may not be a good number to use as an estimate for all Tootsie Pops." On occasion, after graphing the data, the distribution has been

bimodal, potentially due to aggressive licking procedures, or fatigue. When this occurs, I have the students decide how to divide the sample into two, discussing with them what stratification is. Then I expect them to be able to report on how the means differed and what that does to their original inference. Most often in my experience, the different means are due to male/female students. I ask them if they were paid researchers, how would they make sure they accurately measured the number of licks, and what other characteristics would they need to make sure were accounted for?

From Common Core Grade 8

The statistics standards for eighth grade focus on bivariate analysis. One of the characteristics we measured in this activity would have been the mass of the Tootsie Pop (which is represented in the x variable below). I expect the eighth grade students to be able to report on all that the sixth and seventh grade students have, as well as to make a scatterplot, construct a line of best fit using several methods, and even begin discussing the correlation coefficient, r . At this point, graphing all points by hand is tedious and can detract from the momentum of the activity and the student motivation. I suggest incorporating technology here if you have it available. I've constructed an activity on Desmos.com where students input their data, drag sliders to show a line they think is best, write the equation for the line by hand, then reveal the actual line of best fit and the correlation coefficient, followed by a discussion of similarities and differences in their choices and the actual line of best fit. ■



www.desmos.com/calculator/yx2oyxbu8a

Lesson Two

Anticipating Patterns: M&M's: Think Before You Eat

The Unanswerable Question: What Percent of M&M's are represented by each color?

This question used to be answerable, but the Mars corporation decided in 2008 to no longer post the color distribution on their website or respond to public questions about the color distribution. The latest report from the company states the following distribution for M&M's Milk Chocolate Candies: 24% blue, 20% orange, 16% green, 14% bright yellow, 13% red, and 13% brown. However, my students have begun to believe that in recent years, Orange has made a significant push for first place, with Blue falling all the way to third behind Green.

First, count out 100 M&M's for each student, letting them know that they shouldn't eat them; these are experimental candy (but I always bring more, unopened packages for them after the math is done). Tell them what Mars used to say about the distribution, and then ask them to discuss what they would expect from their sample. Then let them count and talk about experimental versus theoretical probability. Why didn't they get what was expected? Inevitably, a student will suggest totaling the class to see if it is closer, at which point a sample size discussion can follow.

I ask the students to calculate the following from what the Mars Corporation stated, and then calculate from their sample distribution using their calculators:

- a) The probability of selecting a red.
- b) The probability of selecting a green.
- c) The probability of selecting an orange.
- d) The probability of selecting a red and a blue.
- e) The probability of selecting a yellow or a green.
- f) The probability of selecting anything but a green.
- g) The probability of selecting a red or an orange or a yellow.

In the end, I cycle back to the Unanswerable Question. What Percent of M&M's are represented by each color? Has Mars changed their percentages without telling anyone? Can you prove them wrong?

That last question is the one that drives my students forward for months. Middle school students are motivated to be right, and eager to prove others wrong. Some have even come to me and learned the basics of confidence intervals and hypothesis testing because of the drive to answer the unanswerable questions. I continually try to build statistical thinkers. They will, in turn, question everything, fostering their search for answers, providing a need for statistical education – only then will they find value in the processes and procedures of statistical analysis. The study of statistics and probability has always been interesting to students, but we have a unique opportunity to now lead them to the realization that they are more than interesting, they are necessary. ■



A Basic Overview of Tests of Statistical Significance

By Gregory Freeman

Statistics, an important part of the K-12 curriculum and many undergraduate and graduate degree programs, is the study of organizing, describing, and interpreting data. Statistics used to organize and describe data are called descriptive statistics. Data are described using tools of descriptive statistics such as measures of center, measures of variability, correlation coefficients, tables, and graphs. Statistics used to interpret data are called inferential statistics. The term inferential is used because observations and analyses of a sample of data are inferred to the population from which the sample is drawn.

In most statistical studies a researcher is unable to identify or study an entire population. For example, a researcher may seek to determine if either Drug A or an exercise regimen is more effective as a weight loss program in males ages 20-25. Identifying and gaining access to every male age 20-25 is impossible. Even if the population is restricted to males in the United States or to, more specifically a given state, gaining access to all of the males for purposes of conducting a study is impractical.

Therefore, a sample (subset) of the population is used to represent the population. The sample is studied and the results are “inferred” to the population. The procedures used to infer from a sample to a population are called statistical inference or tests of statistical significance.

For example, suppose a sample of 80 males age 20-25 is selected to represent all males age 20-25. The sample is randomly divided into two groups of 40. Forty of the adult males use Drug A to facilitate weight loss, while forty adult males use an exercise regimen. The researchers find that the group using Drug A loses more weight, on average, than the group using an exercise regimen. The researcher cannot necessarily infer these results to the entire population of 20-25 year old adult males based solely on knowing that a difference exists in favor of Drug A.

The researcher must first decide if the difference in the two groups is enough to support Drug A as superior to an exercise regimen for weight loss in the population of males. A difference in weight loss between the sample groups of only 0.3 pounds might not be large enough to be convincing. Individuals' weights vary from day to day and 0.3 pounds could be attributed to normal daily variation. A difference in weight loss between the two groups of 15 pounds is large and provides stronger evidence of the effectiveness of Drug A as compared to the exercise regimen.

In general, the researcher chooses between two alternatives. The result that is observed could be attributed to chance – there is no significant difference in the two weight loss methods. Or,

the result is more extreme than could be expected by chance alone – Drug A is more effective than the exercise program. A decision is necessary because a sample cannot be expected to perfectly represent the population. The difference could have occurred for the sample as chosen, but not reflect a difference for the population. The decision of the researcher is based on probability. The decision is said to be statistically significant if the probability of the result observed is more extreme than could be reasonably expected from chance variation alone.

In general, inferential statistics involves use of a sample to represent a population. Data are collected on the sample. Descriptive statistics are calculated based on the data. The researcher uses the sample results to infer something about the population. In the previous illustration the choice is between two alternatives: 1) There is a significant difference in average weight loss between the two groups; 2) There is no significant difference in average weight between the two groups. These alternatives are called hypotheses.

Inferential statistics includes a large number of techniques for testing hypotheses. The specific technique to be used depends on the design of the experiment and the data collected. However, the basic steps involved when testing hypotheses are applicable across the various tests. Understanding the basic steps is important to reading and understanding research. The remainder of this article states and explains the basic steps.

Statement of the null and alternative hypotheses

The null hypothesis is a statement of no difference or no relationship. In the weight loss scenario previously described, the null hypothesis would state that there is no difference in weight loss between the group using Drug A as compared to the group under an exercise regimen. The null hypothesis is a general statement for the population. The alternative hypothesis is a statement of a difference. For example, the weight loss for the group using Drug A is greater than for the group under an exercise regimen.

The decision of tests of statistical significance is about the null hypothesis. The null hypothesis is retained or the null hypothesis is rejected in favor of the alternative hypothesis. A decision to retain the null hypothesis means that the difference in the groups, based on the sample data, was not convincing enough to infer the benefits of Drug A to the population. Or, the null hypothesis is rejected, in favor of the alternative which indicates Drug A was more beneficial for weight loss than the exercise regimen.

Set a significance level or alpha level

As previously stated, in tests of statistical significance a sample is used to represent the population. However, a sample cannot

be expected to perfectly represent the population. Consider the birth of ten children. Assume that for any one birth, the probability of a boy is $\frac{1}{2}$, as is the probability of a girl. The probabilities (rounded to the nearest percent using the binomial probability distribution) below correspond to the likelihood that in ten random births the given number of girls are born.

Number of girls	Probability
0	0.00 or 0%
1	0.01 or 1%
2	0.04 or 4%
3	0.12 or 12%
4	0.21 or 21%
5	0.25 or 25%
6	0.21 or 21%
7	0.12 or 12%
8	0.04 or 4%
9	0.01 or 1%
10.....	0.00 or 0%

Natural variability, or chance, makes predictions based on a sample uncertain. One does not know how many girls will be born in a random sample of 10 births. However, knowing probabilities associated with the numbers of births allows the uncertainty to be quantified. If repeated samples of 10 births are taken, the number of girls born in a single random sample of 10 births will be distributed in accordance with the probabilities shown. The birth of exactly 5 girls occurs in about 25% of the samples. The birth of exactly six girls occurs in 21% of the samples.

The ability to quantify uncertainty using probability is an important aspect of tests of statistical significance. To illustrate, suppose a program (method, drug, etc.) is devised to help increase the likelihood of a pregnancy resulting in the birth of a girl. Notice that the program claims to increase the likelihood of a girl, not guarantee the birth of a girl. The program is used with 10 couples selected at random. How many girls would have to be born to convince you that the program worked? Suppose that the decision you make will have important consequences.

The birth of five girls in ten is pretty common, so five is not statistical evidence of an increase in the rate of female births.

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The probability of six girls is 21% or .21, so the birth of six girls would not provide very solid evidence either. What about the birth of 9 girls to 10 couples? The birth of nine girls would occur by chance in only one out of a hundred samples and would provide strong support that the program works. But, 9 female births out of 10 could occur by chance 1% of the time. So, deciding the program works could be the wrong conclusion, but it is likely the correct conclusion.

You have an important decision to make. Because the evidence is based on a sample, you are unable to be completely certain that the program works. You decide the threshold of convincing evidence is the birth of 9 girls. This decision means that you are willing to take a .01 risk that the results are due to normal variability, and not the program.

This illustrates what is termed the level of significance or alpha level. A researcher must decide how much risk she is willing to take that the results are due to normal variability rather than the variable or variables of interest. In other terms, the significance level is the level of risk that the researcher accepts to reject a true null hypothesis. Significance levels are set by the researcher and are customarily set at .05 or .01. For simplicity, an alpha level of 0.05 will be used in the remainder of this discussion.

Determine specific test to be used

There are numerous statistical tests available for use. Some examples are: t-tests, the analysis of variance, and the chi-square goodness of fit test. The specific test to be used is based on a number of factors. This can be a difficult decision and is beyond the scope of this article. There are flow charts available and researchers often consult with a statistician to make sure they have chosen the correct test.

Calculate the test statistic value

Corresponding to the statistical test selected is a method or formula for calculating a number called the test statistic. The test statistic is related to the question of the study. For instance, if the question of a study is to determine if the means of two groups are different; the test statistic is a number that quantifies the difference in the means. If the question

of a study is to determine if two variables are significantly correlated, the test statistic is a number that quantifies the degree of correlation between the two variables. The test statistic is a way to distill the information in a sample down to one numerical value.

Determine the critical value(s)

The critical value for a given study is a value (or values for a two-tailed test) that serves as a numerical boundary between values of the test statistic that support the null hypothesis and values of the test statistic that support the alternative hypothesis. The critical value is related to the significance level. Critical values are determined using tables of values corresponding to the particular test being used.

Suppose that a table yields a critical value of 2.14. The value of 2.14 is the boundary between values of the test statistic that result in rejecting the null and those that result in retaining the null. All test statistic values greater than 2.14 means the data support the alternative hypothesis and all values less than 2.14 means the data support the null hypothesis.

Make decision by comparing the critical value and the test statistic

As stated, the decision of a test of statistical significance is to retain the null hypothesis or to reject the null hypothesis in favor of the alternative hypothesis. A test statistic value larger than the critical value means the data support the alternative hypothesis and all values less than the critical value means the data support the null hypothesis. The decision to retain or reject the null hypothesis can also be made by comparing a probability value called a *p*-value to the significance level. This method is not discussed in this article.

Closing remarks

The fundamentals as described in this overview are applied in different ways across the various tests; but the procedure remains constant. A deeper understanding of tests of statistical significance is gained by studying specific tests. In addition to learning to conduct tests of statistical significance appropriately, the reader should become knowledgeable of both the various tests' strengths and limitations. ■

Statistics Education and the Common Core State Standards for Mathematical Practice

By Jessica Cohen

The Common Core State Standards for Mathematics (CCSSM) indicate not only the content around which mathematics instruction should be focused in K-12, but also the ways in which students should engage with mathematics. These engagement practices, or habits of mind, are the Standards for Mathematical Practice (SMPs). The SMPs, influenced by the National Council of Teachers of Mathematics process standards and the National Research Council strands of mathematical proficiency, indicate the “varieties of expertise that mathematics educators at all levels should seek to develop in their students.” (National Governors Association, 2010)

The eight SMPs are:

- 1 Make sense of problems and persevere in solving them. Students should be able to enter into new problems, find ways to progress through problems, and consider the reasonableness of their solutions.
- 2 Reason abstractly and quantitatively. Students should flexibly work in the abstract and in contextual situations, and to choose which is helpful for their problem solving.
- 3 Construct viable arguments and critique the reasoning of others. Students should build mathematically logical arguments, justify their conclusions, communicate with others, and consider the validity of others’ arguments.
- 4 Model with mathematics. Students should choose and apply mathematics to solve real problems.
- 5 Use appropriate tools strategically. Students should select and use tools that are helpful to their problem solving.
- 6 Attend to precision. Students should use symbols precisely, calculate with appropriate precision, and use precise language when communicating their thinking.
- 7 Look for and make use of structure. Students should find the underlying structure in mathematics, including the structure of arithmetic, of algebra, and of geometry.

- 8 Look for and express regularity in repeated reasoning. Students should observe patterns through repeated actions and use those patterns to generalize.

The practices are described in some detail in the CCSSM document, with examples grounded in mathematical content. Illustrative Mathematics, a group of mathematics educators working to support implementation of the Common Core, has even drafted a publicly available “Elaborations Document” which seeks to clarify the meaning of the SMPs for elementary grades (Illustrative Mathematics, 2014)

Yet, while statistics content is part of the CCSSM at nearly all grade levels, neither the CCSSM document nor the Elaborations Document provide much insight into how the SMPs apply to statistics instruction. As the Guidelines for Assessment and Instruction in Statistics Education (GAISE) report (Franklin et al, 2005) so clearly articulated, statistics is different from mathematics, largely due to the “omnipresence of variability” in statistics. Moreover, statistical literacy is different from mathematical literacy because of the different natures of the two disciplines. This difference begs the question: Are the Standards for Mathematical Practice appropriate Standards for Statistical Practice? That is, are the SMPs an appropriate indicator of the ways in which students should engage with statistics, too?

The answer to this question is probably that it depends on one’s interpretation of the SMPs. For example, a surface interpretation might be that since statistics uses the tools and processes of mathematics, the SMPs should apply at that level. However, this doesn’t do much to indicate statistical literacy, or the degree to which students are true practitioners of statistics. The GAISE report provides some insight into the practices that should be developed in statistics students.

This report suggested a framework for statistics education that indicates the problem solving practices in which students should engage, as well as the nature of the variability students should encounter. Those problem-solving practices are:

Formulate questions. Students identify a statistical question to investigate. Anticipating variability is at the heart of formulating a statistical question.

Collect data. Students design and employ appropriate plans to collect data that can be used to answer the statistical question. These data collection plans require students to acknowledge and attend to the variability in data.

Analyze data. Students select and use the appropriate graphical and numerical methods to analyze their data. Analyzing the data is intended to account for the variability in data.

Interpret results. Students interpret the analysis and relate that interpretation to the original question. These interpretations and generalizations must allow for the variability in data.

Clearly, one can identify links to SMP 1, Make sense of problems and persevere in solving them. Students engaging in the four practices of statistics are clearly persevering in some kind of problem solving. However, making sense of problems potentially has deeper meaning for statistics students, as students are developing the ability to formulate their own appropriate questions. This level of making sense of problems goes beyond what is commonly experienced in mathematics instruction, where the student receives the problem and must interpret it. Rather, proficient students of statistics are expected also to formulate the problem or question.

SMP 2, Reason abstractly and quantitatively, refers to the ability of math students to contextualize and decontextualize. The GAISE report explicitly identifies the role of context as one of the key differences between mathematics and statistics. The data students collect and analyze in response to a question are always in a context, and therefore decontextualizing doesn't help reveal structure, as it might in mathematics. Statistics students will decontextualize when they are using mathematics in the service of statistics, like when they calculate a theoretical probability, or a correlation coefficient. However, while decontextualizing might help a student to better understand a mathematical problem, maintaining context is critical to understanding a statistical problem.

When statistics students interpret results, they are certainly engaging in a form of statistical argumentation. However, this is not exactly the type of reasoning SMP 3, Construct arguments and critique the reasoning of others, suggests. Logically sound mathematical reasoning is not interpretive. For example, a mathematics student might justify her solution by explaining why a problem is a fraction division problem, how she used a manipulative to model the division, and why her solution is reasonable. Generally, while there might be multiple ways to solve the given problem, it either is or is not a fraction division problem, and there is little room for interpretation. The types of arguments in which statistics students engage might include justifying a sampling method, or making a claim based on a graph of data collected. In both cases, one student might

reasonably make a different sampling choice or make a slightly different claim than another, and yet all of those decisions could be statistically sound. The interpretive nature of statistics means that mathematical and statistical argumentation will have fundamental differences. SMP 3 does include a brief statement that students should “make plausible arguments [about data] which take into account the context in which the data arose.” This considers one nuance of statistical argumentation, but is not sufficiently robust to address the argumentation that could and likely should occur at all stages of the statistical problem-solving process.

The process of analyzing data requires students to choose the correct statistical model to use, so SMP 4, Model with mathematics, could encompass the modeling with statistics required of statistics students. When students choose the correct statistical measure, or how to appropriately use a graph to represent their data, or identify the distribution appropriate for their data, they are making modeling decisions analogous to the decisions about mathematical models indicated in SMP 4. For example, a statistics student must recognize whether the data he has collected are categorical or numerical, and not only choose a graphical representation which can be used for those data, but also choose the graphical representation which would best tell the story of those data. He must recognize if his context may have correlation between two variables, and know how to measure and report that correlation.

SMP 5, Use appropriate tools strategically, likely applies quite well to statistics education. This practice considers students' decisions regarding when and how to use tools like a calculator, software applications, or graph paper and a ruler. This is a critical part of statistical proficiency, as well. Students have a number of tools, both traditional and technological to choose from, and the choice of an appropriate tool (i.e. using a calculator, or using Fathom) and ability to use it correctly, can have a profound impact on students' efficiency, and on the interpretation process.

Attend to precision, SMP 6, is also important for statistics. Statistics students should be precise in their calculations and in the language they use to communicate. For example, statistics students should know the difference between a histogram and a bar graph and use the terms correctly. They should carefully and accurately label graphs, and attend to scales appropriately. Reasonable interpretations hinge on students' accurate and precise analysis of the data collected.

Practices 7 and 8, Look for and make use of structure and Look for and express regularity in repeated reasoning, respectively, are often the most challenging practices to understand and distinguish in mathematics education, and this holds for statistics education, as well. SMP 7 focuses on students' understanding and use of the underlying structure of mathematics. For example, a mathematics student might know the distributive property and use it to find 24×7 by adding

20 x 7 and 4 x 7. A more advanced student might recognize that $(x - 2)^2$ will be positive for any values of x because squaring a number will always result in a positive value. Of course, the underlying structures of mathematics are important to statistics students when they are using mathematics in the service of statistics. One could argue that the underlying structures of statistics are the types of variability that arise. Students being aware of the sources and types of variability, and using that understanding to make decisions about collecting, analyzing and interpreting data could be considered the statistical analogue of understanding and making use of mathematical structures.

SMP 8 focuses on students' making generalizations and observing patterns through repeated investigations of a common problem type. For example, young mathematics students might be given a pile of shapes, told the shapes are all rectangles, and then develop a definition for rectangles based on their observations. Older students might generalize a process for factoring a trinomial after using algebra tiles to model trinomials as rectangular regions. Statistics students might consider pairs of numerical data sets in which the data points in the second set were all more than the corresponding data points in the first set by a fixed value, and, after calculating measures of center, observe the corresponding shift in the measures of center between the two sets. While the generalizations and

patterns might be in a different context in statistics, the process of observing those generalizations through repetition is very similar to what one might do in mathematics.

The SMPs aren't a perfect description of the practices in which proficient statistics students might engage, and the CCSSM articulation does not provide a clear picture of what the practices might look like for statistics students. However, when considered in conjunction with the GAISE problem-solving practices, and specifically in the context of statistics, they can provide a good indication of the ways in which statistically proficient students consider and engage with the discipline. ■

Franklin, C., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Scheaffer, R. (2005). Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K-12 Curriculum Framework. Retrieved from: www.amstat.org/education/gaise/GAISEPreK-12_Full.pdf

Illustrative Mathematics. (2014, February 12). Standards for Mathematical Practice: Commentary and Elaborations for K-5. Retrieved from: <http://commoncoretools.me/wp-content/uploads/2014/02/Elaborations.pdf>

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). Common Core State Standards for Mathematics. Washington, DC: Authors.



Teaching Statistics Through Data Investigations

New Online Course Starting March 9

www.mooc-ed.org/tsdi

Learn with colleagues near and far in this 8-week, online professional development course, designed for teachers of statistics in grades 6-12 and post-secondary contexts. This course can help you learn to teach statistics using investigations, with real data and real cool tools!

The course is **FREE** and can lead to continuing education credits.

Offered through the Friday Institute for Educational Innovation at NC State University Lead instructor: **Dr. Hollylynn Lee**, Professor of Mathematics Education



Additional resources accompanying this lesson also are posted.

Consuming Cola

Nancy Sundheim

Overview of Lesson

Students will determine if drinking cola increases heart rate. The primary purpose of the lesson is to look for extraneous variables and try to control them through focusing on experimental design.

GAISE Components

This investigation follows the four components of statistical problem solving put forth in the Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report. The four components are: formulate a question, design and implement a plan to collect data, analyze the data by measures and graphs, and interpret the results in the context of the original question. This is a GAISE Level B activity.

Common Core State Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.

Common Core State Standards Grade Level Content (High School)

S-ID. 1. Represent data with plots on the real number line (dot plots, histograms, and boxplots).

S-ID. 2. Use statistics appropriate to the shape of the data distribution to compare center (median, mean) and spread (interquartile range, standard deviation) of two or more different data sets.

S-ID. 3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points (outliers).

S-IC. 1. Understand statistics as a process for making inferences about population parameters based on a random sample from that population.

S-IC. 5. Use data from a randomized experiment to compare two treatments; use simulations to decide if differences between parameters are significant.

S-IC. 6. Evaluate reports based on data.

NCTM Principles and Standards for School Mathematics

Data Analysis and Probability Standards for Grades 9-12

Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them:

- Understand the differences among various kinds of studies and which types of inferences can legitimately be drawn from each;
- Know the characteristics of well-designed studies, including the role of randomization in surveys and experiments;
- Understand the meaning of measurement data and categorical data, of univariate and bivariate data, and of the term variable;
- Understand histograms, parallel box plots, and scatterplots and use them to display data;
- Compute basic statistics and understand the distinction between a statistic and a parameter.

Select and use appropriate statistical methods to analyze data:

- For univariate measurement data, be able to display the distribution, describe its shape, and select and calculate summary statistics;
- Display and discuss bivariate data where at least one variable is categorical.

Prerequisites

- Students will have prior knowledge of calculating numeric summaries.
- Students will have prior knowledge of constructing boxplots and histograms.
- Students will have prior knowledge of developing a hypothesis.

Learning Targets

- Students will be able to identify and construct methods for controlling extraneous variables in a simple experiment.
- Students will be able to connect a real world problem with a hypothesis to be explored.
- Students will be able to calculate numeric summaries and use

these summaries to determine if there appears to be support for a hypothesis.

■ Students will be able to construct graphical tools (boxplots and/or histograms) and use these tools to determine if there appears to be support for a hypothesis.

Time Required

Two class periods (approximately 40 to 50 minutes each)

Recommended:

■ One class period to discuss the question and carefully design the experiment

■ One class period to collect the data, analyze it, and interpret the results

Materials Required

■ Activity worksheet (page 20)

■ Stopwatches

■ Cans of cola (or other caffeinated soft drink; may also need some decaffeinated soda)

■ Worksheet (given below)

■ Pencils

Instructional Lesson Plan

The GAISE Statistical Problem-Solving Procedure

I. Formulate Question(s)

Begin by discussing recent articles about energy drinks that mention the fact that they may be a health hazard. Some possible articles are:

1. MNU News, Professor's Mission to Educate the Public about Energy Drink Dangers, Feb 2013 <https://www.mnu.edu/newsroom/article/professor-s-mission-to-educate-public-about-energy-drink-dangers>
2. Vavra, Shannon, The Tufts Daily, Health Experts Assess Risks of Long-term Energy Drink Consumption, Dec 2012 <http://www.tuftsdaily.com/health-experts-assess-risks-of-long-term-energy-drink-consumption-1.2799825>
3. Brody, Jane, The New York Times, Scientists See Dangers in Energy Drinks, Jan 2011 http://www.nytimes.com/2011/02/01/health/01brody.html?_r=0
4. Edney, Anna, Bloomberg, Energy Drinks' Health Danger Being Probed by U.S., (Nov 2012) <http://www.bloomberg.com/news/2012-11-27/energy-drinks-health-dangers-being-probed-by-u-s-regulators.html>

Several of the articles above note that the primary concern is the amount of caffeine. Furthermore, a couple of the articles point

out that the main short-term concern is the effect of caffeine on the heart rate. Since the safety of energy drinks is in question, this experiment will use soda instead of energy drinks to explore the effect of caffeine on the body. The main question is the effect of caffeine on heart rate. Some possible questions to ask:

1. What is the possible problem with energy drinks?
2. What ingredients are used in energy drinks to give that boost of energy?
3. Which ingredient seems to be the main concern? Why?
4. What can happen to some people when too much caffeine is ingested?
5. Is it likely that this can happen to all people or are there just a few that are more susceptible?
6. How does caffeine affect the body?
7. What other sources of caffeine are there in addition to energy drinks?
8. How could you explore the effect of caffeine on the body?

Tell students that they will need to identify the variables of interest in their experiment. They will also need to identify and then decide how to control any variables that are not of interest, but may affect results of the experiment. They will carry out their sampling plan, then analyze and interpret the data.

Define an extraneous variable.

Extraneous variable: A variable that is not of interest but can affect the results. Ask:

1. What can be done about extraneous variables? (take a really large sample to average out the effect of the variable (usually not the preferred method) or control those variables)
2. What if an extraneous variable is not controlled? (results are suspect because the response may be because of these variables rather than the variable of interest)
3. Is it always possible to completely control an extraneous variable? (no, sometimes extraneous variables are difficult to identify and sometimes they cannot be adequately controlled)

II. Design and Implement a Plan to Collect the Data

Break students into groups of 3 to 4 students. Give students the activity worksheet and tell them they are to design an experiment that will account for and control the extraneous variables. The next day they will collect, analyze, and interpret the data. See the worksheet for some possible ideas to consider.

Circulate through the room and give some hints or suggestions to those that seem to be stuck.

The emphasis of this lesson is on identifying and controlling extraneous variables.

After each group has completed the worksheet, direct a whole-class discussion of the proposed plans. Then select a method that ALL groups will use the next day so that all data is consistent. Things to prepare for:

1. Be sure all know how to use the stopwatch correctly.
2. Train all to take the pulse in the same manner.
3. If caffeinated and de-caffeinated cola will be used, then plans need to be made as to how to randomly select which students will get the caffeine and who won't and how this will be kept secret (this must also be done if a "drink" and "no drink" design is used).

On the second day any student who forgot and had caffeine within the 10 hours before the class needs to not participate.

Each group will proceed with data collection as planned.

[Design A]

If the class decided to control for fitness level and/or individual physiological differences by taking the pulse before and after, then use data collection sheets A (page 22). In this design all students will be drinking the caffeinated cola. This is a matched pairs design and the appropriate value to analyze is the difference in the pulse rate (after – before).

[Design B]

If the class decided to have some drink caffeinated cola and some drink decaffeinated cola, use data collection sheets B (page 23). (In this case they are assuming random assignment to the caffeinated and decaffeinated groups will assure fitness levels are equally distributed in the two groups.) In this scenario the appropriate analysis will be to compare the differences in pulse rates of the two groups. This is an independent samples design.

[Note: while drinking the cola the students can participate in a discussion of how they plan to analyze the data collected. However, they need to be sure they are accurate in the waiting time after finishing the cola and taking their pulse.]

III. Analyze the Data

The main objective of the experiment is to determine if caffeine increases the heart rate. Ask students what numbers can be calculated or what graphs can be drawn in order to help make this determination. This will depend on which design is selected (matched pairs or independent).

Design A: Matched Pairs (take pulse before and after)

■ Could look at the mean difference and the five-number summary of the differences. Depending on the background, a paired t-test can be performed. A histogram and boxplot of the differences could be helpful.

■ Here is an example data set from this design along with results:

Table 1. Example Class Data – Matched Pairs.

(Difference in Heart Rate, After – Before)

After - Before	After - Before	After - Before	After - Before
12	2	3	5
6	5	3	9
3	6	10	8
9	-1	5	4
6	6	6	6
3	5	6	8
8	2	2	

■ Have students calculate the mean and the five-number summary.

■ Have students construct a boxplot from the five-number summary.

■ Have students construct a histogram.

Table 2. Example Results from Class Data – Matched Pairs.

	Mean	Minimum	1st Quartile	Median	3rd Quartile	Maximum
After – Before	5.44	- 1	3	6	8	12

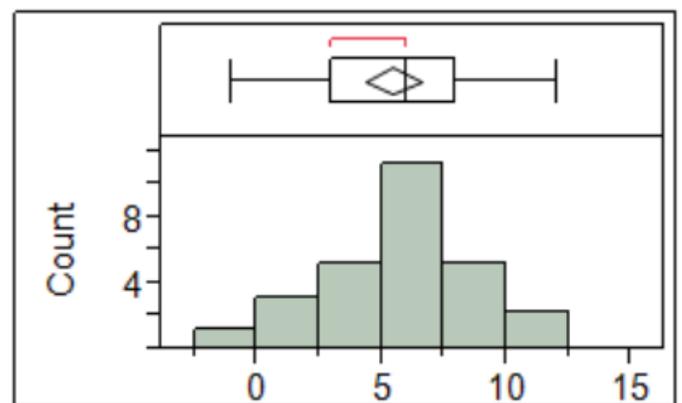


Figure 1. Example Graphs from Class Data – Matched Pairs.

Design B: Independent Samples
(caffeinated and decaffeinated groups)

■ Could compare the overall means for the two different groups and the five-number summaries. Comparative boxplots would be useful.

■ Here is an example data set from this scenario along with results:

Table 3. Example Class Data – Independent Groups.
(Difference in Heart Rate, After – Before)

Caffeinated		Decaffeinated	
2	10	3	4
13	6	0	1
5	12	-3	2
6	5	-1	5
0	6	4	-2
-1	9	1	4
5	1	-2	-1

■ Have students calculate the means and the five-number summaries.

■ Have students construct boxplots from the five-number summaries.

■ Have students construct histograms.

Table 4. Example Results from Class Data – Independent Groups.

	Mean	Minimum	1st Quartile	Median	3rd Quartile	Maximum
Caff.	5.64	-1	2	5.5	9	13
Decaff.	1.07	-3	-1	1	4	5

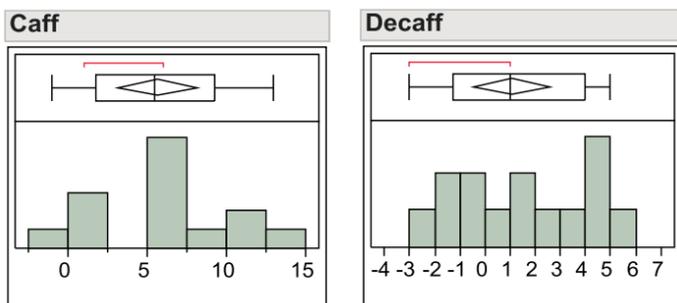


Figure 2. Example Graphs from Class Data – Independent Groups.

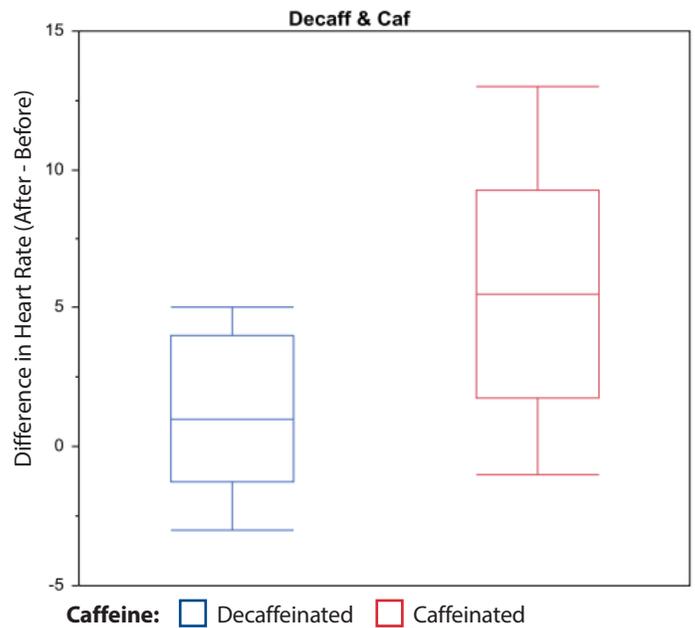


Figure 3. Example Side-by-side Boxplots – Independent Groups.

IV. Interpret the Results

Design A

■ The mean difference can be compared to zero (the difference if there was no change after drinking the caffeine).

■ If there were outliers, discuss what might have caused them.

■ Look at the Interquartile Range, $IQR = Q_3 - Q_1$, to see if zero is in the interval – what does it mean if it is not? (it is likely the caffeine did raise the heart rate if the entire interval is above zero).

Design B

■ Compare the means of the two groups – is the average difference in heart rate of the caffeinated group higher?

■ Compare the five-number summary values and ask the same question.

■ Compare the side-by-side boxplots.

Either Design

Discuss the following questions as appropriate:

■ Can the results be generalized to the public?

■ Can the results be generalized to the whole school?

■ Have all the important extraneous variables been adequately controlled? Have you thought of another extraneous variable since yesterday?

■ Can any differences seen be attributed to caffeine?

■ Can you conclude that caffeine causes the heart rate to increase? (not without a formal test, but the descriptive statistics might indicate it is possible)

■ What limitations are there from this study? (some possibilities: not certain all students had no caffeine in their bodies as many foods have caffeine that many are not aware of, this is looking at cola not energy drinks, there may be other ingredients that also affect the heart rate, etc.)

Assessment

1. Two different plant fertilizers are available. Set up an experiment to determine which will grow the largest plant by answering the following questions.

- What is the response variable?
- What is the explanatory variable?
- What are some possible extraneous variables?
- Describe how you would control any extraneous variables you mentioned.
- The data given is sample data from 10 plants with fertilizer 1 and 10 plants with fertilizer 2, paired by location. How can you compare the two fertilizers? Use the appropriate numerical summaries and graphs.

Height of tallest point, in inches

Location	1	2	3	4	5	6	7	8	9	10
Fertilizer 1	17.5	17.9	18.2	16.9	17.2	17.5	17.3	18.9	16.8	17.1
Fertilizer 2	18.4	17.9	18.2	17.6	17.6	18.8	18.1	17.4	17.8	17.6

2. A program for teaching fire safety is being evaluated. The students in this middle school come from four different elementary schools. Set up an experiment to determine if the program is effective in increasing fire safety awareness by answering the following questions.

- What is the response variable?
- What is the explanatory variable?
- What are some possible extraneous variables?
- Describe how you would control any extraneous variables you mentioned.
- The data given is sample data from 10 students with pre-scores and post-scores. How can you compare the scores? Use the appropriate numerical summaries and graphs.

Note: Setting these up as pairs would be a matched pairs design, **but for illustration purposes, the data is given as independent samples.**

Scores on Exam, out of 30 points possible

Pretest	28	14	6	24	8	13	11	11	9	4
Posttest	30	18	15	27	23	28	21	25	26	13

3. Does the use of iPads in the classroom increase the attention span, and therefore the amount of learning? Set up an experiment to determine if iPads increase test scores by answering the following questions.

- What is the response variable?
- What is the explanatory variable?
- What are some possible extraneous variables?
- Describe how you would control any extraneous variables you mentioned.
- The data given below are test scores from 10 students. Each student completed one unit of geography using an iPad and each completed another unit of geography without the use of an iPad. How can you compare the scores? Use the appropriate numerical summaries and graphs.

Test Scores, out of 80 possible points

Student	1	2	3	4	5	6	7	8	9	10
Used iPad's	78	72	50	67	73	62	69	50	58	69
No iPad's	70	67	46	69	73	60	62	39	63	70

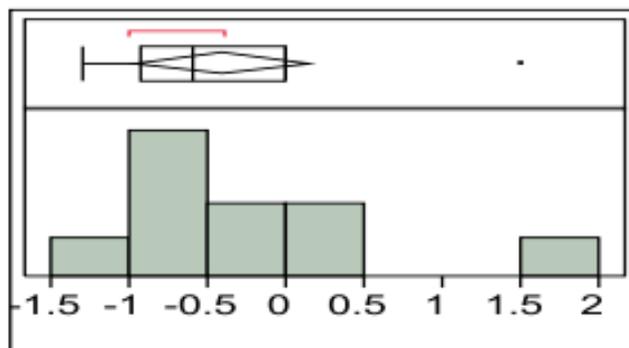
Answers:

Question 1:

- size of plant
- type of fertilizer
- temperature of the room/location, amount of sunlight per day, amount of water, time of watering, type of soil, size of plant to start with, etc.
- set plants side by side or measure temperature in various locations to ensure the temperature is the same, put pairs of plants in the same locations, carefully measure water each time and always water at the same time, use the same soil for potting both plants, select equivalent plants
- Mean and five-number summary of differences in height (inches):

	Mean	Minimum	Q1	Median	Q3	Maximum
Fert 1 -	-0.41	-1.30	-0.90	-0.60	0	1.50
Fert 2						

Histogram and boxplot of differences in height (inches):

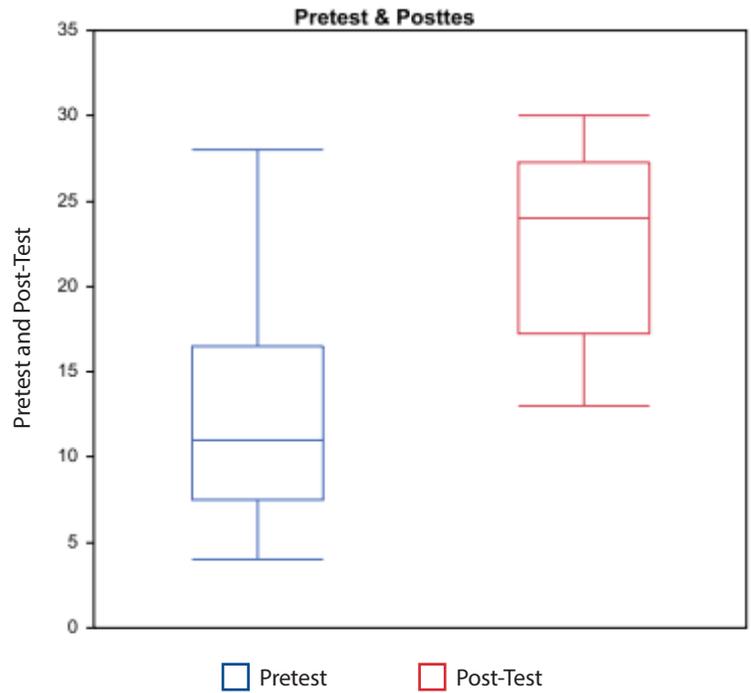
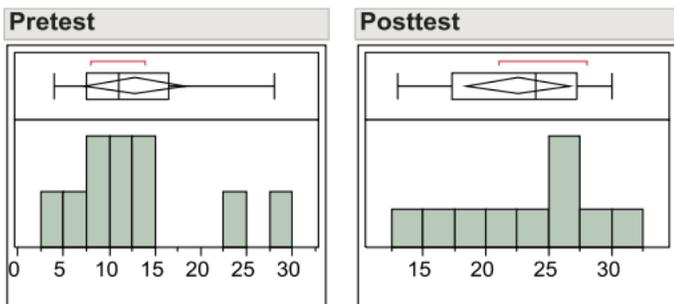


Question 2:

- a) awareness (probably measured with a test)
- b) curriculum
- c) previous instruction, life experiences (some may have dealt with fires, extent and content of TV viewing, etc.)
- d) give a pretest and a posttest and measure the difference to see how much awareness was increased
- e) means and five-number summaries of Pretest and Posttest scores:

	Mean	Minimum	Q1	Median	Q3	Maximum
Pretest	12.8	4	8	11	14	28
Posttest	22.6	13	18	24	27	30

Histograms and boxplots of Pretest and Posttest scores:

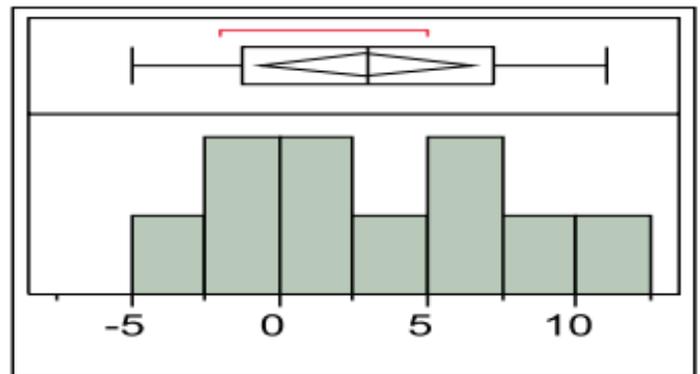


Question 3:

- a) test score at end of unit
- b) use of iPad or no iPad
- c) previous knowledge, aptitude for geography, experience with iPad, etc.
- d) have the students use iPad's on some units and not on others
- e) means and five-number summaries of differences in test scores:

	Mean	Minimum	Q1	Median	Q3	Maximum
iPad – No iPad	2.9	-5	-1	3	7	11

Histogram and boxplot of differences in test scores:

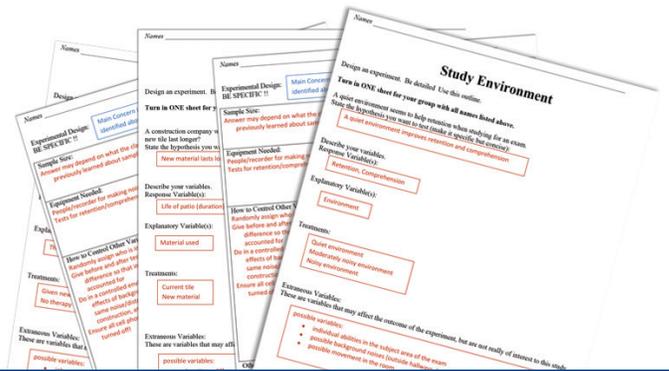


Possible Extensions

To explore extraneous variables in other settings, three additional topics are given with the original worksheet. These can be discussed without actually collecting data to apply and extend some of the concepts of controlling extraneous variables.

1. New Patio Material – explores the idea that sometimes experiments take too long so artificial methods may be used for aging and wear in some cases. How does this affect the validity of the results?
2. Therapy for Depression – explores the idea that some situations have an overwhelming number of extraneous variables and not all can be controlled

(side issues – some populations, especially populations of people, have high variation and so larger samples are necessary; using volunteers is not valid, yet it can be difficult to get a random sample).
3. Study Environment – this explores the idea that sometimes a strictly controlled environment is necessary (although, like topic 1 above, an artificial environment can bias results).



Corresponding activity sheets can be downloaded from the STEW website at www.amstat.org/education/stew.

References

1. Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report, ASA, Franklin et al., ASA, 2007
<http://www.amstat.org/education/gaise/>
2. Adapted from an activity recorded here: <http://bit.ly/1ZvP1gr>

ANNOUNCEMENTS

Mobilize: Engaging Secondary Schools in Data Science

Robert Gould, Lead Principal Investigator

Statistics teachers know that requiring students to collect data is an effective way of engaging them in data analysis. Mobilize is an NSF-funded project that has developed software which allows students to collect data using their smartphones or mobile devices, then visualize and analyze these multi-dimensional data. By engaging students in participatory sensing campaigns, students see that data – particularly their own – are a powerful tool for learning more about their own lives, communities, and the world.

The Mobilize project has developed four distinct units of curriculum. The most impactful is the year-long Introduction to Data Science (IDS) curriculum, which is a “C”, approved mathematics course in the University of California A-G requirements, which means that successful completion of IDS validates Algebra II and provides an alternative admissions

pathway to the University of California and California State University systems. The other Mobilize courses include a six-week Algebra I unit, a three-week Biology unit, and a five-week companion unit to the Exploring Computer Science curriculum.

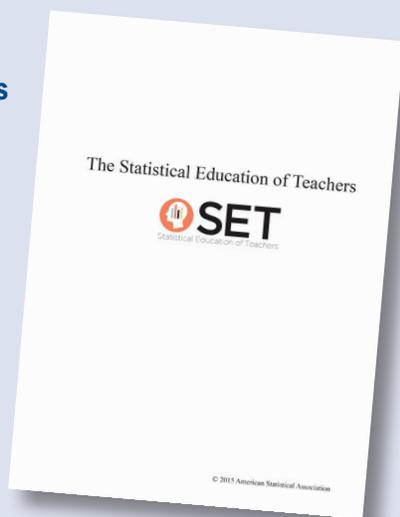
Mobilize is a partnership between UCLA’s Department of Statistics and Graduate School of Education and Information Studies, and the Los Angeles Unified School District, the nation’s second-largest school district. To date, Mobilize curricula have been taught in over 250 LAUSD classrooms. Now in its final year of NSF funding, Mobilize is interested in identifying additional schools or districts that might be interested in adopting a Mobilize curriculum. To learn more, please contact LeeAnn Trusela, Mobilize Project Director, at support@mobilizingcs.org or visit the Mobilize website at www.mobilizingcs.org

ANNOUNCEMENTS

ASA Issues Statistical Education of Teachers (SET) Report

www.amstat.org/education/set

The American Statistical Association (ASA) has issued the Statistical Education of Teachers (SET) Report, which calls on mathematicians, statisticians, mathematics educators and statistics educators to collaborate in preparing pre-K–12 teachers to teach intellectually demanding statistics courses in their classrooms. SET was commissioned to clarify the recommendations for teacher statistical preparation in the Conference Board of the Mathematical Sciences' Mathematical Education of Teachers II report. The SET report uses the ASA Pre-K–12 GAISE Framework as the structure for outlining the content and conceptual understanding teachers need to know in assisting their students develop statistical reasoning skills. The report facilitates the understanding of key topics such as what sets statistics apart as a discipline distinct from mathematics, the difference between statistical and mathematical reasoning, and the role of probability in statistical reasoning. SET is intended for everyone involved in the statistical education of teachers, both the initial preparation of prospective teachers and the professional development of practicing teachers.



PROJECT-SET

Project-SET is an NSF-funded project to develop curricular materials that enhance the ability of high-school teachers to foster students' statistical learning regarding sampling variability and regression. All materials are geared toward helping high-school teachers implement the Common Core State Standards for statistics and are closely aligned with the learning goals outlined in the Guidelines for Assessment and Instruction in Statistics Education: A Pre-K–12 Curriculum Framework (GAISE) report. For more information, visit <http://project-set.com>.

CHANCE Special Issue on Nurturing Statistical Thinking Before College Part 1 Available

The first of the two part (Nurturing Statistical Thinking Before College) CHANCE special issue is now out and available on the web at <http://chance.amstat.org/2015/09/28-3-editors-letter>. Some articles are freely available while all articles are available

through ASA Member's Only. Not yet an ASA K-12 Teacher Member? You can start your free one-year trial online at www.amstat.org/membership/K12teachers.

Significance Opens Archives

Significance magazine has opened its 10-year archives for access by the public. The magazine's volumes 1 through 10 are available to read, free of charge, at www.statslife.org.uk/significance/back-issues. Further, all magazine content will be made freely available one year after its initial publication. Editor Brian Tarran believes open access will demonstrate the importance of statistics and the contributions it makes in all areas of life. Royal Statistical Society and ASA members and subscribers will continue to enjoy exclusive access to the latest magazine content.

Data-Driven Mathematics

Data-Driven Mathematics is a series of modules funded by the National Science Foundation and written by statisticians and mathematics teachers. Intended to complement a modern mathematics curriculum in the secondary schools, the modules offer materials that integrate data analysis with topics typically taught in high-school mathematics courses and provide realistic, real-world data situations for developing mathematical knowledge. The copyrights have been transferred from the original publisher to ASA. Scanned copies of these books are freely available to download at <http://www.amstat.org/education/publications.cfm>.

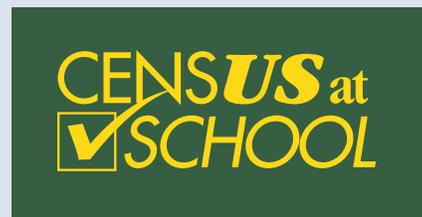
Episode 15 of STATS+STORIES is Available

Episode 15 ("Screening and intervention for substance abuse") of S+S is now available. S+S guest, Nick Horton, Professor of Statistics at Amherst College, joined the Stats+Stories regulars to talk about substance abuse and studies of interventions to reduce this abuse. To listen now, please visit www.statsandstories.net. You can subscribe to the Stats+Stories podcast on iTunes.

Census at School Program Reaches More Than 37,000 Students

The ASA's U.S. Census at School program (www.amstat.org/censusatschool)

is a free, international classroom project that engages students in grades 4–12 in statistical problem solving. The students complete an online survey, analyze their class census results, and compare their class with random samples of students in the United States and



ANNOUNCEMENTS

other participating countries. The project began in the United Kingdom in 2000 and now includes Australia, Canada, New Zealand, South Africa, Ireland, South Korea and Japan. The ASA is seeking champions to further expand the U.S. Census at School program nationally. For more information about how you can get involved, see the article online at <http://magazine.amstat.org/blog/2012/02/01/censusatschool-2> or email Rebecca Nichols at rebecca@amstat.org.

Explore Census at School Data with TuvaLabs

TuvaLabs provides free, real data sets, lessons, and visualization tools to enable teachers to teach statistics and quantitative reasoning in the context of real-world issues and topics. The ASA has provided TuvaLabs with a clean Census at School data set with 500 cases and 20 attributes that is now freely available in TuvaLabs for students and teachers to explore online with their visualization tool and Census at School–adapted lesson plans. Start exploring Census at School data with TuvaLabs at https://tuvalabs.com/datasets/census_at_school_clean_data. Other TuvaLabs data sets and lessons are available at www.tuvalabs.com.

ASA 2015 Poster and Project Winners Announced

The ASA is pleased to announce the winners of the 2015 poster and project competitions at <http://magazine.amstat.org/blog/2015/08/01/2015-poster-project-competition>. The competitions offer opportunities for students to formulate questions and collect, analyze and draw conclusions from data. Winners were recognized with plaques, cash prizes, certificates and calculators, and their names were published in Amstat News. To view the winning posters and projects or for more information, visit www.amstat.org/education/posterprojects.



2016 Poster and Project Competitions

Introduce your K–12 students to statistics through the annual poster and project competitions directed by the ASA/NCTM Joint Committee on the Curriculum in Statistics and Probability. The competitions offer opportunities for students to formulate questions and collect, analyze and draw conclusions

from data. Winners will be recognized with plaques, cash prizes, certificates and calculators, and their names will be published in Amstat News. Posters (grades K-12) are due every year on April 1. Projects (grades 7-12) are due on June 1. For more information, visit www.amstat.org/education/posterprojects.

Albert Einstein Distinguished Educator Fellowship Program now accepting applications for 2016-2017 Fellowship Year Due November 19, 2015

The Albert Einstein Distinguished Educator Fellowship (AEF) Program provides a unique opportunity for accomplished K-12 educators in the fields of science, technology, engineering, and mathematics (STEM) to serve in the national education arena. Fellows spend 11 months working in a Federal agency or U.S. Congressional office, bringing their extensive classroom knowledge and experience to STEM education program and/or education policy efforts. Program applications are due November 19, 2015, and must be submitted through an online application system. Information about the Albert Einstein Distinguished Educator Fellowship Program, including eligibility requirements, program benefits, application requirements, and access to the online application system can be found at <http://science.energy.gov/wdts/einstein>.

Useful Websites for Teachers of Statistics

The ASA currently hosts a listing of websites useful for teachers of statistics. The list has recently been updated, though is still a work in progress. Please visit the site at www.amstat.org/education/usefulsitesforteachers.cfm. If you have recommendations of additions, please contact rebecca@amstat.org.

Online Community for ASA K-12 Teacher Members

A new online community for ASA K-12 Teacher Members will allow participation in online discussions and sharing resources with other members. More information is available at <http://community.amstat.org/faqs>. Not yet an ASA K-12 Teacher Member, you can start your free one-year trial online at www.amstat.org/membership/K12teachers.

LOCUS

LOCUS (<http://locus.statisticeducation.org>) is an NSF Funded project



focused on developing assessments of statistical understanding across levels of development as identified in the Guidelines for Assessment and Instruction in Statistics Education (GAISE). The intent of these assessments is to provide

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teachers, educational leaders, assessment specialists, and researchers with a valid and reliable assessment of conceptual understanding in statistics consistent with the Common Core State Standards (CCSS).

CEMSE Seeks Field Testers for Online Tools

The Center for Mathematics and Science Education (CEMSE) at the University of Chicago is seeking interested students and teachers to participate in a field test of two interactive online tools.

Data Workshop is a web-based data exploration environment intended to help users understand elementary experiment design and subsequent analysis. Users can enter their own raw data, collect data via surveys, or design simulations such as coin flips and dice tosses. Both raw data and results can be shared with other Workshop users. Data Workshop has all the features needed for a probability and statistics course for pre-service teachers and for students in any grade interested in the principles of experiment design. For more information, please go to <http://dataworkshop.cemseprojects.org> or send a message to dataworkshop@cemseprojects.org.

The Number Stories project is a collection of dynamic mathematics activities organized in a searchable online platform. All the activities are based on real-world contexts. The problems are designed to motivate the use of mathematics to solve problems in various professional or other everyday life situations. Number Stories support individual users with targeted feedback and are useful in many situations such as home-schooling, vocational training, or to enrich classroom mathematics. For more information, please go to <http://numberstories.cemseprojects.org> or send a message to numberstories@cemseprojects.org.

Science Ambassador Scholarship Deadline December 1, 2015

Do you have any women students who plan to study statistics as an undergraduate during the 2016-2017 school year? Please encourage them to apply for the Science Ambassador Scholarship, which is a full tuition scholarship for a woman seeking an undergraduate degree in statistics or another science, engineering, or math field, funded by Cards Against Humanity. The ideal candidate will be an ambassador for their field—someone passionate about discovery who shares their excitement with others. Video applications are due by December 1st, 2015. For more information, please visit www.scienceambassadorscholarship.org.

Free Online Videos and Courses for Statistics Teachers

Teaching Statistics Through Data Investigations

What: Free Online Course

Register: Sept 28-Nov 9, 2015; However, registration is still open and course will remain open until December 14, 2015.

When: Spring 2016 dates TBD

More information: go.ncsu.edu/tsdi

Learn with colleagues near and far in this 6-week, online professional development course, designed for teachers of statistics in grades 6-12 and post-secondary contexts. This course can help you learn to teach statistics using investigations, with real data and real cool tools! The course is FREE and can lead to continuing education credits. Offered through the Friday Institute for Educational Innovation at NC State University

Lead instructor: Dr. Hollylynne Lee, Professor of Mathematics Education

YouTube Videos on Descriptive Statistical Concepts

<https://www.youtube.com/user/profdstangl/playlists>

Need assistance in teaching your students statistical thinking? Through funding from Duke University and the American Statistical Association, Dalene Stangl, Kate Allman, Mine Cetinkaya-Rundel, and a group of Duke students have created a set of 52 videos to help you understand and teach basic descriptive statistical concepts. The videos are organized into five units. Within each unit there are videos covering core concepts, pedagogy, JMP software, and applet demonstrations. Unit one covers data and explains the structure of the videos. Unit two covers one variable descriptive statistics, transforming a variable, and the normal curve. Unit three covers description of relationships between two categorical variables (contingency tables) and between one categorical and one numeric (side-by-side boxplots). Unit four covers description of relationship between two numeric variables using correlation and regression. Unit five pulls all the concepts together in review videos. We hope you find them useful. Enjoy!

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Videos from Data to Insight free on YouTube

Chris Wild's "Data to Insight: An Introduction to Data Analysis" is a free, online, hands-on introduction to statistical data analysis. The videos which make up most of its "teaching content" have been made conveniently accessible on YouTube. While "Data to Insight" prototypes a next-generation introductory statistics course, many of its videos are immediately useful for current high school and lower level university statistics courses. The videos are indexed at <https://www.stat.auckland.ac.nz/~wild/d2i/4StatEducators> together with an outline of their content and the course-design philosophy (see also the YouTube channel "Wild About Statistics").

But for those actually want to learn about statistics, "materials" is only one part of the story. As we know from your own teaching, what learners do (activities) is more important than what they simply see. The course itself starts formally on 19 October and runs for 8 weeks. However, it is self-paced and can be joined at any time till mid-December at <https://www.futurelearn.com/courses/data-to-insight>.

Against All Odds: Inside Statistics

<http://www.learner.org/courses/againstallodds/index.html>

Against All Odds is a free video series teaching introductory statistics concepts in context of real-life applications. This is an updated video series developed by Annenberg Learner (the producers of the original version in the 1980's) and contains videos, a glossary, teacher guides and student guides.

ASA K-12 Statistics Education Webinars Now on YouTube

The ASA offers free webinars on K–12 statistics education topics at www.amstat.org/education/webinars.

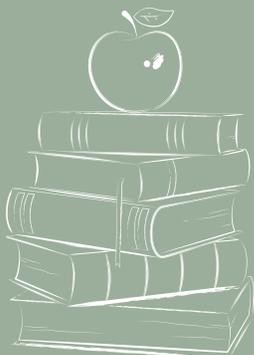
The ASA offers free webinars on K–12 statistics education topics at www.amstat.org/education/webinars. The ASA K-12 Statistics Education Webinars are now also on YouTube at https://www.youtube.com/channel/UCfFPk_3D_JTn1T674Kgu_ZA. We hope you will subscribe. This series was developed as part of the follow-up activities for the Meeting Within a Meeting Statistics Workshop (www.amstat.org/education/mwm). The Consortium for the Advancement of Undergraduate Statistics Education also offers free webinars on undergraduate statistics education topics at www.causeweb.org. The ASA/American Mathematical Association of Two-Year Colleges (AMATYC) Joint Committee also offers free statistics webinars through AMATYC at www.amatyc.org/?page=Webinars.

K-12 TEACHERS! GET YOUR

FREE!

ASA TRIAL MEMBERSHIP

This special offer is tailored for K-12 educators so you can enhance your students' statistical education.



Members receive:

Access to professional learning community teaching resources, including webinars, peer-reviewed lesson plans (STEW), Census at School, and publications such as the *Statistics Teacher Network*, *GAISE: A Pre-K-12 Curriculum Framework*, *Bridging the Gap Between Common Core State Standards and Teaching Statistics*, and *Making Sense of Statistical Studies*.

Information about upcoming events and services for K-12 teachers and students, including workshops, student competitions, data sources, and publications.

Access to the **ASA Community's K-12 discussion group**, where like minds share ideas, questions, and resources.

Subscriptions to *Amstat News*, the ASA's monthly magazine, and *Significance*, a magazine aimed at international outreach and statistical understanding.

Members-only access to the ASA's top journals and resources, including online access to *CHANCE* magazine, the *Journal of Statistics Education*, and *The American Statistician*.

Activate your free trial membership at www.amstat.org/k12trial.

Free trial membership is valid for new ASA members only.



HELP US RECRUIT THE **NEXT GENERATION** OF STATISTICIANS

The field of statistics is growing fast. Jobs are plentiful, opportunities are exciting, and salaries are high. So what's keeping more kids from entering the field?

Many just don't know about statistics. But the ASA is working to change that, and here's how you can help:

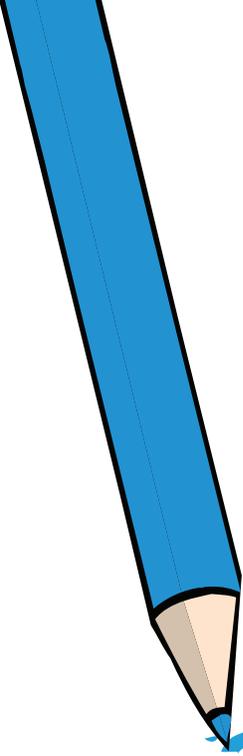
- Send your students to www.ThisIsStatistics.org and use its resources in your classroom. It's all about the profession of statistics.
- Download a handout for your students about careers in statistics at www.ThisIsStatistics.org/educators.



If you're on social media, connect with us at [www.Facebook.com/ThisIsStats](https://www.facebook.com/ThisIsStats) and www.Twitter.com/ThisIsStats. Encourage your students to connect with us, as well.

The site features include:

- Videos of young statisticians passionate about their work
- A myth-busting quiz about statistics
- Photos of cool careers in statistics, like a NASA biostatistician and a wildlife statistician
- Colorful graphics displaying salary and job growth data
- A blog about jobs in statistics and data science
- An interactive map of places that employ statisticians in the U.S.



Statistics Education Web

STEW



Lesson Plans Available on Statistics Education Web for K–12 Teachers

Statistics Education Web (STEW) is an online resource for peer-reviewed lesson plans for K–12 teachers. The lesson plans identify both the statistical concepts being developed and the age range appropriate for their use. The statistical concepts follow the recommendations of the *Guidelines for Assessment and Instruction in Statistics Education (GAISE) Report: A Pre-K-12 Curriculum Framework*, *Common Core State Standards for Mathematics*, and *NCTM Principles and Standards for School Mathematics*. The website resource is organized around the four elements in the GAISE framework: formulate a statistical question, design and implement a plan to collect data, analyze the data by measures and graphs, and interpret the data in the context of the original question. Teachers can navigate the site by grade level and statistical topic. Lessons follow Common Core standards, GAISE recommendations, and NCTM Principles and Standards for School Mathematics.

Lesson Plans Wanted for Statistics Education Web

The editor of STEW is accepting submissions of lesson plans for an online bank of peer-reviewed lesson plans for K–12 teachers of mathematics and science. Lessons showcase the use of statistical methods and ideas in science and mathematics based on the framework and levels in the *Guidelines for Assessment and Instruction in Statistics Education (GAISE)* and *Common Core State Standards*. Consider submitting several of your favorite lesson plans according to the STEW template to steweditor@amstat.org.

For more information, visit www.amstat.org/education/stew.





FREE international classroom project to engage students in statistical problem solving

Teach statistical concepts, statistical problem solving, measurement, graphing, and data analysis using your students' own data and data from their peers in the United States and other countries.

Complete a brief online survey (classroom census)

13 questions common to international students, plus additional U.S. questions
15–20-minute computer session

Analyze your class results

Use teacher password to gain immediate access to class data.

Formulate questions of interest that can be answered with Census at School data.

Collect/select appropriate data

Analyze the data—including appropriate graphs and numerical summaries for the corresponding variables of interest

Interpret the results and make appropriate conclusions in context relating to the original questions.

Compare your class census with samples from the United States and other countries

Download a random sample of Census at School data from United States students.

Download a random sample of Census at School data from international students (Australia, Canada, New Zealand, South Africa, and the United Kingdom).

International lesson plans are available, along with instructional webinars and other free resources.

www.amstat.org/censusatschool

For more information about how you can get involved,
email Rebecca Nichols at rebecca@amstat.org.

Bridging the Gap

Between
Common Core State Standards
and Teaching Statistics



Twenty data analysis and probability investigations for
K–8 classrooms based on the four-step statistical process as defined by the
Guidelines for Assessment and Instruction in Statistics Education (GAISE)

www.amstat.org/education/btg



MAKING SENSE OF STATISTICAL STUDIES



Making Sense of Statistical Studies consists of student and teacher modules containing 15 hands-on investigations that provide students with valuable experience in designing and analyzing statistical studies. It is written for an upper middle-school or high-school audience having some background in exploratory data analysis and basic probability.

www.amstat.org/education/msss