Exploring the Information around You

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INTRODUCTION

Master teacher Marilyn Burns has stated that “probability is an important area of mathematics that can motivate students’ interest, stimulate their mathematical thinking, and reinforce their application of number skills” (65). It’s also the area, aside from basic computational skills, that can have the most impact on a student’s daily life. To ensure that this topic impacts *all* of my students, I’ve created a unit that keeps the topic firmly rooted in my students’ lives. By bringing the outside world in, my students will be able to retain their knowledge far past the end of school, the end of summer, and the end of their educational careers.

This curriculum unit is about the probabilities and statistics of our everyday lives, numbers and factors that we usually pay no attention to and rarely take into account -- at least in a truly mathematical sense. Can we replace "maybe" and "I think" with "65% chance" and "3 out of 5 times"? Can we replace uncertainty and ambivalence with confidence and interest? Can we put more math into our lives and still enjoy them? The answer is yes.

I like math, and I like using math in my real life, but I’m a math teacher; it’s to be expected. Most people are not math teachers, and many of them do not like math. For some, it’s a lack of aptitude. For others, math feels like “all work and no play.” Still, for others, the repetition needed to properly learn a skill turns them off. Whatever the reason, as a math teacher I often feel like I’m engaged in siege warfare, trying to battle against all of the walls my 12-year-old students have already put up. So, aside from making myself personally engaging, the key to success in a math classroom is to make the topic engaging as well.

Why Probability?

I was drawn to this seminar on probability and statistics because I’ve always liked the subject, probably because it is so open-ended and versatile. Like geometry, it’s an area of math that gives the mathematician (or at least, the novice mathematician) a chance to manipulate numbers and immediately see results, a chance to tinker around with math – to get personal pleasure from it and not just solve someone else’s problems or learn an abstract skill. It’s a chance to analyze data for fun, to learn more about each other and develop critical thinking skills at the same time. In short, it is the perfect way to get my students fully engaged in math class.

Most of my students are minorities, come from low-income families, and are generally unprepared for the 7th-grade curriculum. Some students can’t subtract properly, some still count on their fingers, and many have difficulty with multiplication facts and procedures. By the time they get to my class, many feel like putting forth effort in math class is not worth their time because they will never get ahead. Too many failures have piled up behind them, and they see no way out of their present situation. Before I can teach them any math, I must first teach them that they can be successful in math. One-on-one or small group tutorials, parent phone calls, classroom pep talks -- whatever it takes to make sure they succeed -- but getting them engaged in class is key.

A good probability and statistics unit not only provides knowledge and skills but also provides a forum for increased independent thought in the math classroom. I'm hoping that by coupling the pure math aspects of probability and statistics with real-world experimentation and examples, I can use this unit to capture my students' attention and cram some math into their heads while they're not looking. They will think, they will talk, they will go out on a limb, and they won't even know what hit them.

CURRICULUM BACKGROUND

For a true mathematician "statistics…is not a method by which one can prove almost anything he wants to prove" (Blaylock 3). Instead, statistics should merely be used to describe or infer about events (Bradley 3). Statistics is also the branch of mathematics students will use most often after leaving the world of academics and entering the job market. In short, they need to know this subject to be successful. The Texas Education Agency understands this, and that is why they address it as early as possible.

Texas students begin to study the manipulation of data in Kindergarten, probability in 3rd Grade, and statistical tools such as mean, median, mode and range in 6th Grade. In the 7th Grade, it is my job to show these students that probability and statistics are much more versatile than they ever thought possible. The key to unlocking these great secrets, and making sure that the students internalize them, is to use data close to their hears: data about them or data on variables they have chosen to collect.

Classroom Examples

Flipping coins and rolling dice are excellent ways to introduce probability topics. They're stored easily, fun to manipulate, and can generate experimental data very quickly. However, no probability and statistics unit should ever stop there. We rarely need to use our knowledge of coin flipping or dice rolling in the real world, so to allow the topic to fully soak in and be applicable to my students' lives, I need to give them examples they can relate to. Sadly, the topics that first come to mind are crime statistics and reasons for curfew laws, but I think using data like this can give concrete arguments to policies adolescents tend to rebel against. On the flip side, using Billboard music charts, data from fast-food restaurants, and TV ratings can engage just as well. Math tends to get too much of a doom and gloom reputation, anyway.

Some great web resources to use for on-the-fly stats are:

- The McDonald's BagaMcMeal flash application (app.mcdonalds.com/bagameal), which lets users put together a meal of their choice from McDonald's menu items to discover just how nutritional their meal choice is. The application covers all basic information, from calories to saturated fat to protein, both in grams and percent daily value. This would also make a great homework assignment by requiring each student to find the nutritional information for their favorite meal at McDonald's. The following class period could be used to compare student data and find the central tendencies for the class.
- Billboard.com's Top 100 chart. Each album is listed with current place value, weeks on the chart, and highest place value occupied -- all great numbers to use to find the mean, median, mode, and range of a data set. You can even compare current data with data from a month ago, or give each student group a different week's data and then compare the mean, median, mode, and range of each.
- Your police department's neighborhood crime report. For Houston, these reports are organized by region and then by beat geographically, to make for an easy search. Using this data you can compare crime concentration based on time of day, type of crime, season of the year ("Neighborhood Crime Statistics").

HTI Influences

The most important thing I have been able to take away from this HTI seminar is a new wealth of real-life examples. I have included a list of these resources in the supplementary sources section of the bibliography, so that you can investigate them yourself when you (or your students) need a little food for thought, such as using data to better target Nazi submarines, finding cures for mysterious diseases, Java applets on the web that demonstrate statistics topics, or ESP experimentation. There is a wide world of statistical knowledge to bring into our classrooms and all we have to do is find it. It seems that no matter what you or your students find interesting, there is a statistical story that goes with it as long as you can do a little digging. The following are a few examples discussed during our seminar that I found quite intriguing.

Cancer Rates

Thanks to comprehensive studies done by the American Cancer Society, I now know that tobacco products are not only the major cause of lung, throat, and mouth cancer, but of pancreatic and urinary bladder cancer as well. Their studies of cancer cases per hundred thousand people are organized by state and cancer type, allowing for some startling (and some expected) observations. West Virginia and Kentucky having the highest instances of lung cancer and Washington, DC having the highest instance of prostate cancer allow for great induction-based discussions, as well as the fact that Utah has the lowest cancer death rate (per 100,000) of all the states. What is Utah doing that states such as Alabama and Maryland are not? My students, especially, will also be curious as to why Mexico has lower cancer rates than the United States. This topic, which some might find depressing, can also shed some hope on lives at this impressionable age. Even if cancer is happening all around us, there are ways to prevent it and the American Cancer Society has given us the numbers to prove it. When discussing this data in class, the goal should be to promote inference and inquiry instead of absolutes, leaving "correct" or "incorrect" to the cold, hard crunch of numbers.

The Probability of Coincidence

Diaconis and Mosteller published a fascinating article using probability to "debunk" the mysticism of a coincidence. While their mathematics are a little too complicated and subject matter a little too depressing for the average 12-year-old (Diaconis proposes that there are no coincidences and all events can be reasoned out mathematically), many of their examples and concepts can be reconfigured to suit the needs of middle school students with great results.

One easy example to use is student birthdays, as they all have them and know them quite well. With 12 months in a year, and a class size of *X,* students will be able to find how many students should have the same birth month as they do and compare their theoretical results with the true (experimental) ones. The experiment could even be expanded, polling other classes to see how close the experimental data can come to the theoretical, and how the data varies from class to class. On a more specific level, with 365 days in a year, and *Y* students in the school, students can determine how many students at school should have their exact birthday. A fun homework assignment could even be to find one of these other students at school that shares their birthday. An assignment that takes more guts than penmanship, I feel it could be a truly life-changing experience for students struggling with math, helping them to realize that all these numbers and symbols actually have a basis in reality. According to Diaconis (858), there's a 50% chance that one match will happen right in the classroom!

The power of probability can also be shown in a quick card-guessing game. By picking cards and having students try to guess the suite, you can show that while matches may seem special, they are bound to happen one in four times. While at first one student may seem especially gifted, with enough trials their success rate will resemble the theoretical probability.

Opinion Polls

An article from *Wikipedia* gives an excellent foundation for discussion on the various biases associated with opinion polls. The first known scientifically based survey was conducted by George Gallup in 1936, and despite continued efforts of polling organizations across the world to develop bias-free questionnaires, errors can still occur. To be 95% accurate in your results, you must poll at least 1000 people. This is harder than it seems, and could take thousands upon thousands of polling attempts to get 1000 complete responses. At a school, this would either be impossible to achieve, or require virtually the entire school to participate. In this regard, the fewer questions you include in your poll, the better.

Once you get your responses, you must consider a few areas of bias as well. How would those who chose not to participate have voted? Was there a trend to the type of people who refused, or did it seem to be a random selection of the population? If they did not care to let their opinion be known, will they care if the outcome of the poll is not what they wanted? For those that did answer, could their responses have been colored by fear of what other students might think of them? Did the pollster reveal any bias in the way they asked the questions that might have influenced a student to respond with the "popular" answer instead of their own? Did the respondents see the answers of those who responded before them? Any of these things could skew results and contribute to unsatisfactory findings.

To combat bias in a poll, it is important to set ground rules before allowing students to ask questions. Make sure students have all written down the same questions, and the same answer choices if applicable. Practice reading the questions together, so that all students can pronounce the questions correctly. Discuss the wording of the questions in-depth, so that students know exactly what they are asking. Stress objectivity to the students, and discuss ways to limit personal bias from their questioning techniques. Explain the importance of questioning students one at a time, so that peer pressure does not influence their responses. Allowing respondents to write their answers down instead of verbalizing them is another way to reduce stress about their response.

Once responses are in and have been tabulated, work with the school newspaper or another source to make sure that these results are published. If it is an area of great school importance, sending a team of student ambassadors to discuss the results with the principal would allow students the chance to let their work truly affect their school and teach them that there is a point to all of this "mathematical silliness."

The Misrepresentation of Statistics

From 4 out of 5 dentists to 50% chance to 99% accurate, inaccurate statistics are produced and regurgitated at an alarming level every day. Even worse, they are usually accepted by the general public without a second thought. The key to gaining control over statistics is to understand what statistics can and cannot do for you, and learning to look for the loophole that allows an untruth to exist or even flourish.

For example, the prevailing thought among Americans is that the normal (i.e. average) body temperature is 98.6 degrees Fahrenheit, when it is actually 98.2 (Paulos 139). The original scientist conducted his research in degrees Celsius and sensibly rounded his results to 37 degrees. This rounding was forgotten when converted to Fahrenheit and we have been left with our inaccurate average ever since.

Many times, misleading statistics can be used to urge the reader towards a certain viewpoint or emotional response. One such example, the claim that 1 in 8 women will develop breast cancer is true but quite misleading. Only 1 out of every 2500 women will contract the disease by the age of 30, only 1 out of every 50 women by the age of 50, and only 1 out of every 9 women by the age of 85 (Paulos 138). Most women do not even live to the age of 85, and while 1 in

2500 is too many women to have to live with this disease, the actual mortality rate is a fraction of these numbers.

Even more shocking is the truth behind so-called 99% accurate tests, be they for pregnancy, disease, or what have you. Paulos reports that if a disease affects 1 out of every thousand people, then out of a sample of 100,000 people only 100 would actually have the disease and 99 would test positive (136). Out of the 99,900 healthy people, 1% inaccuracy results in 999 wrongly-positive tests, which means that only 9% of the people who test positive actually have the disease. When looked at in the correct light, this test is not very accurate at all, and shows just how powerful statistics can be. "If they have numbers to back it up, it must be true." Not quite, and this example stands as a powerful lesson that we cannot take everything the "experts" say for granted.

Classroom Success

Our seminar participants had great discussions based on these topics, many of which led me to further questions and study of my own. I believe the same will be true for our students. Middle-school students like "weird" stuff, and topics like blowing up submarines and telepathy (please reference Körner's book *The Pleasures of Counting*) seem to get their brains moving faster than you could ever think possible.

By weaving these examples into our in-class experiments and discussions, we will hopefully produce a few extra experiments along the way, depending on which examples the class finds most compelling. Outside of the classroom, students will be completing a data collection and interpretation project that will enhance and solidify their learning in an even more personal way.

I hope to see great success in my students from this unit, but the success will be contingent on two factors:

a) will my students be able to examine a data set and analyze it for themselves, and
b) will my students realize how important knowledge of probability can be for their lives?

Curriculum Covered

To stay consistent with Texas Education Agency standards, TEKS covered during this unit will be:

- 7.10: Probability and statistics. The student recognizes that a physical or mathematical model can be used to describe the probability of real-life events.
- 7.11: Probability and statistics. The student understands that the way asset of date are displayed influences its interpretation.
- 7.12: Probability and statistics. The student uses measures of central tendency and range to describe a set of data.
- 7.13: Underlying processes and mathematical tools. The student applies Grade 7 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school.
- 7.14: Underlying processes and mathematical tools. The student communicates about Grade 7 mathematics through informal and mathematical language, representations, and models.
- 7.15: Underlying processes and mathematical tools. The student uses logical reasoning to make conjectures and verify conclusions.

Covering objectives 10-12 in the context of objectives 13-15 will allow me to deliver true math skill along with an understanding of how mathematics pertains to my students' lives and the critical-thinking skills my students will need to address these topics for themselves in the future.

TOPIC BACKGROUND

"Students' previous experiences have led them to conclude that math problems usually have answers that can be figured out exactly" (Burns and Humphreys 79). Because of this, going against conventional teaching methods can have impressive results as "a new and exciting area of exploration is brought into lessons when the teacher doesn't have the answer or is not totally certain about what will occur" (Burns and Humphreys 79). From previous classroom experience, I know this to be true. There seems to be an air of excitement when students have completed an on-the-spot example and they're waiting to see if I come to the same conclusion they did. It almost feels like Christmas, a feeling I hope to transfer to this unit as a whole.

My students need to learn about probability and statistics, but they also need to learn that math exists outside of the classroom and that they can actually have fun with numbers instead of cringing from them. With my curriculum unit, I hope to accomplish all three of these goals. I want students to not only become proficient in finding probabilities and using statistics, but also to develop probabilities of their own, make mathematically-sound choices based on evidence presented, and gain mastery over the numbers of their world.

Classroom Application

Each day we must all make choices based on the chance that a certain event might occur. We informally estimate probabilities of events by using statistical data, past experiences, other people's opinions, and the like (Brutlag 28). I want my students to take their concepts of choice and chance past unconscious "hunches" and into the realm of true-life reasoning. In class and out, I will use examples and exercises that students are interested in: the NFL draft, Billboard music charts, clothing designers, television, dating, and, of course, the students themselves. I will call their attention as to where they are receiving their information and how information looks from other sources. I will make them think about their own choices and if the way that they go about their lives really is the best for them. But above all else, they must learn to think critically in every situation.

During the curriculum unit, we will concern ourselves with both descriptive (organizing the data) and inductive (making inferences about the data) areas of statistics, but I feel that my students need much more practice with inductive reasoning so we shall concentrate most of our efforts there. "Inductive statistics is based directly on probability theory" (Blaylock 5), so by combining the two topics into one unit, we can provide a rational, deductive base for our inferences and ground probability theory in real-world application.

In class, we will couple experimentation with discussion, and then analyze the data in different ways each day. Sometimes we will review the same data, sometimes completely new data, and sometimes amended data (yes, the numbers can change). As a review, we will start with mean, median, mode, and range, and then move into probability, compound probability, and the difference between all of these analysis methods. Towards the end of the unit, students will choose their own method of analysis and will have to justify this choice. Upon presentation of results, we will debate which method provided the most applicable results and why, based on the application, this method will not always be the same.

School Support

To fully realize the potential of this unit, it will also be important for me to get the support of other teachers in the building. I need their support because I'll be disrupting their classrooms at least once or twice during the unit to collect data. A class of 30 can yield decent results, statistically, but for more reliable probabilities, you need at least 200 subjects to survey. By allowing student representatives to gather data from other classrooms around the building, I will not only expose them to methods of sampling but also to acceptable sample sizes and the ways in which statistics can change depending on how much data you have to draw from. By picking teacher's names randomly out of a hat, I also open a discussion on why statisticians prefer random samples and what might occur regarding the data if you were able to choose your survey subjects.

If a teacher does not seem receptive to students interrupting their lesson, an alternative would be to ask the teacher to collect the data and send the results back to the class when he or she has finished. This option is less appealing to me, as I feel it's important for the students to experience the data collection process as much as possible before they attempt their unit project. The students will at least have data to work with, and we could take the time to hone our inferential skills by trying to predict how the teacher would collect the data, based on what we already know about the teacher's behavior.

Student Products

As we collect new data, students will organize and represent their data with stem plots, histograms, scatter plots, bar graphs, box-and-whisker plots, and circle graphs. They need to see that the same data can look decidedly different based on how you choose to graph it. Using these graphs, we will examine, analyze, justify, and compare until true statistical thought has become second-nature to my students. Once I see that my students have a firm grasp on the topics, they will be unleashed on the real world with two tasks to complete.

Task 1

A. For two weeks, observe a recurring phenomenon in your life that is out of your control.
   Ex. What does Mom prepare for dinner? Does Suzie buy an ice cream at lunch? How late is the bus that picks you up in the morning?
B. Record and collect your data as you observe.
C. Organize your data, and display it graphically in the form of your choosing.
   Ex. bar graph, histogram, pie chart.
D. Create three probabilities based on an observed event occurring the next time you experience this phenomenon.
   Ex. The bus was 5 minutes late on 3 out of the 10 school days observed, so there is a 30% chance the bus will be 5 minutes late to pick me up for school tomorrow.

For me, the key to this task is their analysis of the data after they've organized and graphed and crunched the numbers. What do these numbers really mean? How can these numbers help the student or the student's subject? Knowing what they do now, how can the students affect the world around them to change it for the better? Discussion of appropriate visual aids will also help students really "wrap their heads around" the data. By having to explain why a bar graph is the best choice for Jaime's observations but a stem and leaf plot is best for Connie's observations makes the students interact with the data on a higher cognitive level than they really want to – which is our true goal as teachers. If we are stretching brains with this unit, we are doing a good thing.

Task 2

A. Choose five variables to observe in a chosen population.
   Ex. gender, hair color, number of children.
B. Observe a public location for one hour (make sure to have a guardian present).
   Ex. grocery store, mall, street corner.
C. Record and collect your data as you observe.
D. Organize your data, and display it graphically in the form of your choosing.
   Ex. Bar graph, histogram, pie chart.

E. Create probabilities based on three compound events occurring.

Ex. One person out of thirty had on a red shirt, and fifteen out of thirty were women, so there is a 15/900 (or 1.7%) chance that the next person through the door will be a woman wearing a red shirt.

The variables chosen could be as simple as the person's sex or as complex as what model car he or she drives. After students present their data, they will be expected to analyze the data in several ways. This analysis will center around what the data shows about that particular location, that particular day, that particular time, and those particular variables. How can perception be skewed by variable, time, or place selection? Does the student feel like the data accurately portrays the chosen location? And perhaps most importantly, if the student could do it all over again, what would he or she have done differently?

MATERIALS NEEDED

- clear playing cards for the overhead and regular playing cards
- clear dice for the overhead and regular dice of varying sizes
- coins, marbles, colored cubes and other objects that can be manipulated and quantified
- graph paper
- chart or butcher paper for presentations
- access to a computer lab

LESSON PLANS

The unit requires eight 90-minute “block” periods to complete. If your classes are shorter than this, do not worry because none of the activities take longer than 45 minutes to do. Each of my lessons incorporates a warm-up problem that the students solve during the first seven minutes of class and an exit ticket, a way for students to collect their thoughts, that is completed during the last five minutes of class. Depending on your time frame to complete the unit, some aspects of the unit could be incorporated into a warm-up activity, homework assignment, or the like. Please use your discretion, as discussion of the elements is key for maximum learning potential. Of the eight unit lessons, I shall cover the first three in detail and create outlines for the remaining five.

Lesson 0

Before starting the unit, I will pass out the unit project to each student. We will talk a little bit about project expectations and ideas presented within the unit. The main goal of passing the project out early is to give the students enough time to gather the data and analyze it before the presentation is due. We will discuss possible long-term study subjects and basic data collection methods, and then the students will have about 15 minutes of quiet time to decide what they would like to study. The exit ticket for this lesson will be the discussion of a few student examples to make sure that all students have a good understanding of what makes a good topic for the project.

Lesson 1

Students were introduced to probability and ratios in the 5th grade, and reinforced in the 6th grade, so my goal for the first day of this unit is to get my students refreshed and fully confident in their probability skills.

I will start the lesson by asking my students, “What is probability?” We will discuss this for a few minutes – I usually take a few volunteer answers and ask a few students at random – and then move into a note-taking mode where I provide the “official” definition of the term and step-by-step instructions for finding the probability of a certain event. We will try a few example together, and then I will let the students (coupled with their step-by-step instructions) tackle a few on their own.

When picking examples, I try to choose events that have some connection to the students in my class; events that explicitly involve the students are even better. "What is the probability that the next student I pick to answer a question will have Air Jordan shoes on?" almost serves as a wake-up call to those students who couldn't care less how many red marbles I have in a bag. To get easy numbers (1 out of 4 instead of 1 out of 30) like the bag problems usually provide, you can center your probability on only the students near the windows, in the front row, etc. It is definitely okay to get creative in math class!

After we have checked our answers and I have checked for student comprehension, we shall use the same examples but now solve for the probability of that event NOT occurring. A good discussion of the relationships (yes + no = 1, which probability would they bet on) between the probabilities here and in our first series of examples is crucial for the development of their probability brains, so make sure that above all else this discussion becomes part of your lesson plans as well.

These same class examples can be used to introduce compound probability – or the chance that two events will happen simultaneously – as well. I would use a central event (*ex. shoe color*) with several different other events (*shirt color, gender*) to guide students through the step-by-step instructions for finding compound probability. Once the concept is clear, we will gather a little more information about the class and then the students will try to determine several compound probabilities on their own. Make sure to discuss student answers, answer any lingering questions, and make connections to previous activities after students have completed their problems.

Students will end the class with an "Exit Ticket" – a way to reflect on the day's learning and focus on the central themes of the unit. On day one, my exit ticket will consist of two questions: "What does probability mean to you?" and "How can knowledge of probability affect your life for the better?" These questions have no correct answer, but students are expected to put thought and effort into their responses.

I believe homework is essential for mathematical proficiency, especially in a block scheduling situation. Homework for day one will center around examples of the skills learned in the day's lesson, making sure to include a few critical thinking questions to spice things up.

Lesson 2

The second lesson will focus on sample spaces for single and compound events, approximate probability through experimentation, and selecting different models to simulate an event. To do this, my class will meet in the computer lab. If you have access to a class set or even a half-class set of programmable calculators, you may choose to use those instead.

The class will warm up with the questions: "What is the probability that a randomly chosen student in this room is sitting at a computer?" and "What is the probability that a randomly chosen student in the room is you?" My computer lab has only enough computers to accommodate half of my class at one time, so if your lab has enough computers for all students, you may either change the first question or use it as an opportunity to talk about certain (100% probable) events.

Once the warm-up has been discussed, I will introduce the term "sample space" -- all of the possible outcomes of an event. We will discuss several events' sample spaces (*shirt color, math period, wake-up time*) and then center the discussion on the sample space on a coin flip. Its incredibly small sample space makes it an ideal candidate for early experimentation, and we will do so in two groups. One half of the class will be flipping a real coin while the other half will be flipping a simulated coin online. Each student will make a prediction as to how many heads they will get in 10 flips, and then flip their coins. We will compare the experimental data with the logical probability of ½, or five times and see, on average, how far off the mark we were.

If time permits, this is also a good time to discuss the sample space of their guess -- any number between 0 and 10, or eleven unique outcomes -- and what the probability was that their guess would be true. This discussion will most likely produce incredulity from the students, as a guess of 4-6 is much more reasonable than a guess of one or two. Fortunately, inferences based on pure probability and previous data can lead to increased success. Unfortunately, flipping a coin is still a random event and our inferences will not always pay off. This may not "sink in" with the students at the moment, but they will experience the phenomenon enough times to recognize it as truth once the unit is completed.

After the coin outcomes have been discussed, the groups will switch places, and we will repeat the process with a six-sided die. Due to the increased complexity of a die over a coin, we shall roll the die 20 times instead of 10. Make sure to explain why you have increased the sample size, and have the students infer as to how many 6's they think they will roll. Have students roll the dice and compare their results with the mathematical probability of rolling a 6.

For the final phase of the experiment, students will pair up -- one with a die, the other with a coin -- to see how many times they have to roll/flip to get an outcome of heads on the coin and 6 on the die. $1/2 \times 1/6 = 1/12$, so check to see if the students are guessing accordingly. If not, please ask "why" to stimulate thought in all students. Have students collect their data and again compare the class average with the mathematical probability of the compound event occurring.

For an exit ticket, ask the students why they think some people might prefer to use a computer simulation instead of the real event. For an extension, you can ask the students to think of another way to model a coin toss besides actually flipping it or using a computer simulation. Please make sure to save the student-generated data as it will be used in lesson three and can be used for further analysis later in the unit.

Lesson 3

Lesson three will serve to review mean, median, mode, range, and the various graphical models used to most commonly represent statistical data. While many of these concepts have been introduced in previous years, it is important for my students' confidence and mathematical autonomy that we make sure these skills are fully honed before they get into the "meat" of their projects.

We will begin by copying down the class data from the previous lesson into three charts, one for each experiment. While it may seem time consuming at first, I assure you it will increase work speed throughout the rest of the lesson. Once each student has a copy of the data in hand, introduce the concepts one by one, finding the answer for one set of data together, allowing the students to find the answers to the other two sets of data by themselves, and then checking their results together. For example, first I would introduce the definition of mean and give a few examples, then we would, step-by-step, find the mean of the number of "6 rolls" together, the students would use those same steps to find the mean of "heads tosses" and "heads-6 rolls," and then we would check to see if their answers were valid.

This process should be repeated for median, mode, range, bar graph, circle graph, and scatter plot. Repetition may seem boring, but input/output and format changes keep the students engaged, learning, and successful. Students that seem to require more time may finish the assignment at home.

For an exit ticket, show the students a bar graph with a y-axis that starts at 5 instead of 1. Ask them if this is a valid way to display the data, and why or why not. Depending on student responses, this example may need to be followed up on in lesson four.

Lesson 4

This lesson will center on how statistical data can be influenced by outside factors: the when, where, why, how, and who of asking questions. The day will start off by collecting written responses to the question, "Who is your favorite musical artist?" We will then ask the same question out loud and give oral responses to see how peer pressure can skew data. We will then examine how data can deceive us through clever questioning by examining differences in responses to "Do you enjoy *John Doe's* music?" and "Do you prefer other music to *John Doe's*?"

Lesson 5

This lesson centers on finding probabilities of recurrence using statistical data. Each student will be given the same two questions to ask the entire class, and the first part of class will be spent surveying. When comparing data, we will be able to discuss operational error and strategies to account for it as some data will most likely be inconsistent with the rest of the class'. Once collected, we will analyze the data using MMMR (Mean, Median, Mode, Range) and finding singular and compound probabilities for certain answer choices. The students will end the day by modeling the data graphically in the form of their choice.

Lesson 6

Students shall start the lesson by presenting their graphical models of the previous class' data. We will discuss model choices, collect data on which models were used the most, and try to come up with a consensus as to which choices were most appropriate. Then, given a set of data, students will construct graphical models of the data in several formats before determining which form is most appropriate and why. It is the "why" that is key, and the main point of our closing discussion.

Lesson 7

Student project presentations begin today. Audience members must take notes that they will use in the post-presentation discussion. Participation (at least two valid comments) in the discussion will be part of their project grade as well.

Lesson 8

The class will start with a review discussion of all the concepts we have learned thus far in the unit. Once the students are refreshed, they will be given a series of questions that will allow them to analyze and think critically about their projects. How effective were their collection methods, what implications does this data hold, what would they do differently if they were to try the same project again? After self-analysis, students will trade projects with another student in class and perform similar analysis on that student's project. This analysis, coupled with the two project tasks, will serve as the assessment for the unit.

CONCLUSION

This curriculum unit has been designed not only to educate, but also to empower and show that paying attention can pay off. By using information dear to students' hearts, I hope to quickly break down negative math barriers and develop dynamic math thought. By working together, discussing and debating each issue that arises, by experimenting with the information instead of passively ingesting it, my students will learn to think critically and scholarly about numbers. They will learn that they have power over these numbers as well, that they can create this information as well as control it.

I hope that this unit helps open students up to the joy of tinkering with numbers, and of taking control over the numbers in their lives. I hope this unit empowers students to study and analyze numbers in order to better their lives instead of just going along with the status quo. I hope that this unit allows them to study their lives, period -- to realize what patterns exist and how to change those patterns for a better tomorrow. Statistics is the only time in mathematics when we really get to explore and create our own answers. Let's use this opportunity to explore something meaningful to our students, so they'll realize that math has meaning in their lives as well as ours.

APPENDIX

Included are sample rubrics for the unit project Tasks 1 and 2.

Probability and Statistics Task 1

Due _____________

Complete all 5 parts for full credit.

A. For 2 weeks, observe a recurring phenomenon in your life that is out of your control.
Ex. What does Mom prepare for dinner? Does Suzie buy an ice cream at lunch? How late is the bus that picks you up in the morning?

B. Record and collect your data as you observe.
Ex. Journal, data table.

C. Organize your data, and display it graphically in the form of your choosing.
Ex. bar graph, histogram, pie chart.

D. Create 3 probabilities based on an observed event occurring the next time you experience this phenomenon.
Ex. The bus was 5 minutes late on 3 out of the 10 school days observed, so there is a 30% chance the bus will be 5 minutes late to pick me up for school tomorrow.

E. Collect your data, graphic organizer, and probabilities together so that they may easily be shared with the class.
Ex. Poster board, folder, PowerPoint presentation.

<u>Rubric for Grading Task 1</u>

14 Observations: *14 points*
Data Recorded Legibly: *5 points*
Data Organized by Date: *5 points*
Graphic Organizer Shows all Data: *10 points*
Graphic Organizer Scaled Correctly: *10 points*
Graphic Organizer Choice Fits Data: *10 points*
Graphic Organizer is Visually Pleasing: *6 points*
3 Probabilities Included: *10 points*
Math Shown on 3 Probabilities: *10 points*
Math Correct on 3 Probabilities: *10 points*
Project is Collected Neatly: *5 points*
Collected Project is Easy to Follow: *5 points*
Project Turned in on Time: *10 points*

Total: 110 points

Probability and Statistics Task 2

Due _____________

Complete all 6 parts for full credit.

A. Choose at least 3 variables to observe in a chosen population.
Ex. gender, hair color, number of children.

B. Observe a public location for one hour (make sure to have a guardian present).
Ex. grocery store, mall, street corner.

C. Record and collect your data as you observe
Ex. Journal, data table, tally sheets.

D. Organize your data, and display it graphically in the form of your choosing.
Ex. Bar graph, histogram, pie chart.

E. Create probabilities based on 3 compound events occurring.
Ex. One person out of 30 had on a red shirt, and 15 out of 30 were women, so there is a 15/900 (or 1.7%) chance that the next person through the door will be a woman wearing a red shirt.

F. Share your findings with the class in a 2-5 minute presentation.
Ex. Lecture, PowerPoint presentation, video.

<u>Rubric for Grading Task 2</u>:

3 Variables Chosen: *10 points* *(each extra variable recorded is + 5 points)*
Data Recorded Legibly: *5 points*
Data Organized by Time: *5 points*
Data Spans 1 Whole Hour: *5 points*
Graphic Organizer Shows all Data: *10 points*
Graphic Organizer Scaled Correctly: *10 points*
Graphic Organizer Choice Fits Data: *10 points*
Graphic Organizer is Visually Pleasing: *5 points*
3 Probabilities Included: *10 points*
Math Shown on 3 Probabilities: *10 points*
Math Correct on 3 Probabilities: *10 points*
Presentation Lasts 2-5 Minutes: *10 points*
All Aspects of Project Presented: *5 points*
Presentation Engaging to Audience: *5 points*

Total: 110 points

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"Opinion Poll." 2006. *Wikipedia*. 17 March 2006. <http://en.wikipedia.org/wiki/Opinion_poll>.
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Supplemental Sources

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This site provides a list of single-gene genetic traits that will allow students to compare classroom data with Mendelian genetic probability.