Expect the Unexpected With Math®

A Program of The Actuarial Foundation

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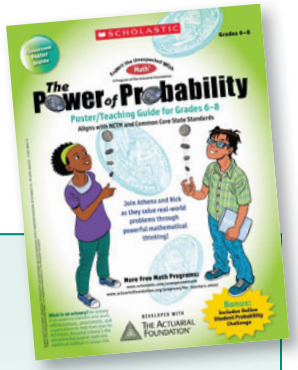
The Power of Probability

Classroom Guide for Actuaries



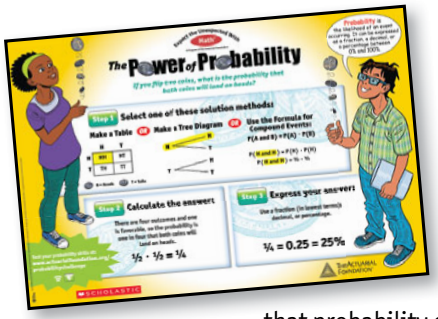
This guide is designed to help actuaries conduct in-school visits in conjunction with the grades 6–8 program **The Power of Probability**, developed by The Actuarial Foundation with Scholastic.

Like other programs in the "Expect the Unexpected with Math®" series, this program is designed to provide skill-building lessons and worksheets that use math in the real world. This guide is designed to help you, the actuary, bring some of your experience to students to help them see the real-world relevance of math, as well as to provide them some insight into how math is used in the professional world and what an actuary does.

Includes:

1. **Overview of *The Power of Probability***
2. **Actuary Classroom Activity** on **probability** to support the lessons
3. **Preparing for Your Visit:** Pointers for coordinating with teachers and planning a classroom presentation
4. **Ideas for Real-World Math Applications to Present to Students**

1 Overview of *The Power of Probability*



This program is designed to help students grasp key concepts encountered in the study of **probability** for grades 6–8. Mastery of these concepts will help them be successful, not only when they take high school and college-level mathematics, but also when they use mathematics in their careers and their everyday lives.

Some of the key concepts or "big ideas" addressed in the materials include:

- *depicting probability as a decimal, percentage, or fraction*
- *strategies for identifying favorable and total outcomes*
- *simple probability/compound probability*
- *sampling and proportions*

The story line running through the materials chronicles the adventures of Athena and Rick, two middle school students who use mathematics to solve everyday problems. The worksheets and their accompanying illustrations engage students to follow along with the duo and solve problems by applying mathematical skills and a logical, systematic approach. Components include:

- A **poster** that provides students with a definition of probability; explains that probability can be expressed as a decimal, fraction, or percentage; and reminds students of strategies they can use to calculate probability. The poster gives teachers a tool to reach visual learners during the lessons and will help reinforce concepts for students as they complete the worksheets.
- **Three lessons**, each accompanied by a **reproducible student worksheet** that enables students to practice the knowledge and skills learned in the lessons. In addition, the program contains **a reproducible bonus worksheet**, which gives students an additional opportunity to apply what they have learned in the lessons. *(These materials are found on the back of the poster/teaching guide provided in the program.)*

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Here is an overview of the content of these materials:

Lesson 1

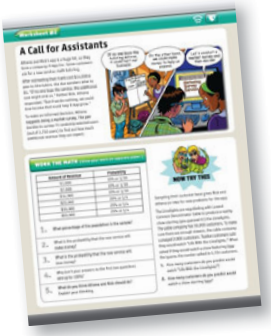
Probability Basics:

Uses the example of a coin toss to instruct students on how to use strategies like tree diagrams, tables, and the fundamental counting principle to calculate probability; also demonstrates how probability can be expressed as a fraction, a decimal, or a percentage.

- Worksheet 1—"Smartphone Test Prep": Students solve Rick and Athena's sample problems by using tree diagrams, tables, and the fundamental counting principle to calculate probability.

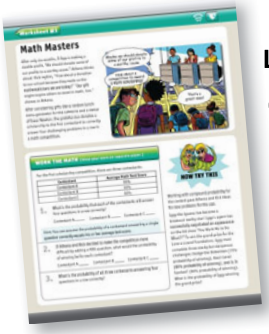
Lesson 2

Simple Probability and Sampling:



Shows how proportions can be used to make predictions about a population based on a sample; identifies the difference between outcomes and events; and shows how to add the probabilities of the outcomes that are part of an event to determine the probability of an event.

- Worksheet 2—"A Call for Assistants": Students help Rick and Athena decide whether or not to expand their business by studying responses from a survey of a sample of their customers.



Lesson 3

Compound Probability:

Shows students how to use a tree diagram to derive the formula for compound probability, and directs students to use this formula to calculate the probability of multiple independent events.

- Worksheet 3—"Math Masters": Students use the formula for compound probability to calculate the likelihood of different contestants winning a math competition.
- **Bonus Worksheet—**"Mind Your Own Business!": Students use probability to examine various investment options and choose the best investment for Rick and Athena.

2 Actuary Classroom Activity

Title: "Rocking & Rolling Over Probability"

Ties in with the "Probability Lab" Online Activity at:
www.actuarialfoundation.org/probabilitychallenge/

Objectives: Students will be able to:

- identify the difference between experimental and theoretical probability.
- indicate that experimental probability tends toward theoretical probability as the number of attempts increases; in other words, when we perform a probability experiment, our actual results generally come closer to the expected results when we increase the number of trials in our experiment.

Materials:

- dice—one die for each group of students doing the basic lesson, two dice for each group doing the advanced lesson
- paper and pencils for recording results

Procedure:

Prior to the lesson, ask the teacher whether the basic or advanced version of the lesson would be more appropriate for the class. Also, ask the teacher to have students placed in groups of two or three for this activity.

1. Show the class a die and ask: What is the probability of rolling a "six"? Note that 1/6, 16.66%, and $0.16\overline{6}$ are all acceptable answers. 1/6 or 1 out of 6 is a precise answer while 16.66% and $0.166\overline{6}$ are close approximations. If the class is not familiar with the concept of repeating decimals, it might be necessary to show how 1/6 converts to $0.166\overline{6}$ by dividing 1 by 6 on the board.
2. Ask: How many times would you expect to roll a "six" if the die were rolled 12 times? Take the time to show on the board how the correct answer of 2 is calculated (1/6 x 12 rolls). It is critical to ensure that the students clearly understand that in the calculation 1/6 x 12 = 2, the 1/6 is the number of faces with "six" divided by the total number of faces on the die. Be sure the class understands that 1/6 or 1 out of 6 is the *theoretical probability* of rolling a "six." Ask the class what the *theoretical probability* of rolling, say, a "four" would be to ensure that they understand the concept.
3. Make sure the students understand that the actual results of our experiment is called the *experimental probability*, which could range from 0% ("six" rolled zero times) to 100% ("six" rolled all 12 times).
4. Indicate to the class that they will be conducting a probability experiment. Each student will roll a die 12 times and record the number rolled each time. To expedite the collection of data in steps 5 and 6, on the board, draw a template of the data table the students should use to summarize how many times "one" was rolled, how many times "two" was rolled; etc. Distribute the die and indicate to the class that they should begin the experiment.

5. When the students have finished, chart the results of the experiment on the board, i.e., each group should indicate how many times they rolled a "one," how many times they rolled a "two," etc. Discuss that while the *experimental probability* equaled the *theoretical probability* in a number of cases, in other cases, it did not.
6. Add up the results of the entire class and calculate the *experimental probability*, i.e., the total number of times "six" was rolled for the class divided by the total number of rolls. Point out that while individual groups might have had results with fewer or more than 2 "sixes," the *experimental probability* using class results was closer to the *theoretical probability* of 1/6 than many of the individual experiments.
7. If time permits, have the class perform another round of the experiment and calculate the *experimental probability* of that round and of the two rounds combined. Point out how the *experimental probability* tends to the *theoretical probability* as the number of rolls increases. In other words, when we perform a probability experiment, our actual results generally come closer to the expected results when we increase the number of trials in our experiment.
8. If time permits and it's technically feasible to do an online class demonstration, you could also show this idea at work at the "Probability Lab" online activity located at **www.actuarialfoundation.org/probabilitychallenge/**
9. Relate the results of the experiment to the work performed by actuaries, e.g., it isn't possible to predict whether or not an individual home or a small town will suffer damage from a severe storm, but when looking at a large number of homes, it is possible to make reasonable predictions about the number of homes in a state or nationally that will suffer damage from severe storms.

Advanced Version:

1. Ask the students to determine the *theoretical probability* of rolling two dice and having the sum of the rolls equal, say, "three." Ask for students to volunteer answers and explain their thinking. By the end of the discussion, students should understand that the *theoretical probability* is 1 out of 18 (reduced from 2 out of 36) because there are two ways to have a sum of "three" (1 and 2, 2 and 1) and 36 possible outcomes (six sides times six sides).
2. Ask the students to calculate the *theoretical probability* of rolling other sums ranging from "two" to "twelve." Compare answers to ensure that all students agree on the *theoretical probability* of each sum.
3. Hand out the dice and indicate to students that they are going to conduct a probability experiment, the results of which will be termed the *experimental probability*. Draw a template of the table students should use to record results.
4. Ask students to roll the two dice 36 times and record their results on their data tables.
5. Compare the *theoretical probability* and *experimental probability* obtained from the experiment as in step 5 of the basic lesson above.
6. Complete steps 6 through 9 from the basic lesson above.

3 Preparing for Your Visit

Since actuaries, like most adult professionals, know their profession but may not have teaching experience or have interacted with a group of young teenagers before, this section is designed to help you ensure that you gear presentations at the right level for the grades 6–8 student.

- Contacting the classroom teacher by phone or email prior to your visit can provide valuable information as you plan your presentation. In addition to finding out when and where to report, you should also ask about the availability of projection equipment if you expect to use it and other details about the space in which you will be presenting. It would also be a good idea to find out what the class does and doesn't know about the mathematical and financial topics you plan to present.
- Students in grades 6–8 bridge the gap between young children in elementary school and young adults in high school. In planning a presentation to this group, it can be a challenge to strike the right balance so that the presentation isn't too complicated (and boring) or too simple (and condescending). The best approach may be to simply be you. Students will appreciate your sincerity.
- Remember that a lecture is generally considered to be one of the least effective ways to present information. Try to encourage student discussion and participation whenever possible. Consider kicking off your presentation with a thought-provoking question, by asking students for their opinion on a relevant issue, or by asking what they already know about your topic. Try to use real-world examples that would appeal to the real world of middle school kids.
- Be aware that most students have never heard of actuaries and probably have little detailed knowledge of topics like insurance, pensions, and possibly even investments.
- When preparing, it's a good idea to remember that less can be more. Students may end up learning very little if you try to cram too much information into a limited amount of time. At the same time, it's a good idea to have something in reserve in case you finish your presentation before the allotted time is over.

4 Ideas for Real-World Math Applications to Present to Students

What is an Actuary? One effective way to open this part of your presentation is to simply ask students what they think an actuary does. In addition to providing some potentially humorous moments, it will give you a quick read on what the

class already knows. Explain in simple terms what an actuary does, and some of the "big issues" that actuaries deal with and how they use math to solve questions.

Note: The program materials contain the following definition of an actuary, which you may want to refer to: "An actuary is an expert in statistics who works with businesses, governments, and organizations to help them plan for the future. Actuarial science is the discipline that applies math and statistical methods to assess risk."

Be aware that many terms used by actuaries may have limited relevance to the 6–8 grader. For example, "premium" to the middle schooler may mean "premium" gas or a "premium" edition of something. Likewise, the term "insurance" may not have meaning to all middle schoolers. Keep in mind that your primary goal in the classroom should be to expand students' financial literacy, build math skills, and bring real-world relevance to math. This will go a long way in helping to bolster students' overall math proficiencies.

Other Real-World Math Examples: Help students understand how important math is in the careers and everyday lives of adults. Some examples:

- Insurance company employees, such as Actuaries, use their knowledge of probability and other mathematical concepts to make predictions about future events to set rates for insurance policies. (Program content areas: simple and compound probabilities, investments)
- Meteorologists use their knowledge of probability when they forecast the weather. (Program content areas: simple and compound probability)
- Nurses calculate intravenous drip rates and check the reasonableness of dosages prescribed for their patients. (Program content area: proportions)
- Accountants generate, organize, and/or review the financial records of individuals, companies, and other organizations. They use mathematics to make estimates and calculate profits, interest, taxes, and other critical financial measures. (Program content area: simple probability, investments)
- Bankers use interest formulas when deciding whether or not to make a loan to a customer or setting the interest rate for savings accounts. (Program content areas: simple and compound probabilities, investments)
- Conservationists and wildlife managers use proportions, probability, and statistics to determine the populations of endangered species. (Program content areas: proportions, simple probability)
- Factory workers and managers use statistical sampling to make sure that the products they produce are reliable and work as intended. (Program content area: proportions, simple probability)
- Advertising agency employees make extensive use of data analysis, in addition to their creative skills, to design an advertising campaign. (Program content area: proportions)
- Chefs use proportions when working with recipes. (Program content area: proportions)

In the unlikely event that your career does not require a solid understanding of mathematics, you will still need it for everyday things such as deciding whether to buy or lease a car, choosing the right cell phone plan, or making the right investment choices!