Take a Chance!

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Overview

This unit on Probability and Chance is for students in grades 3-5. Math concepts in the classroom are endless and often remain "untapped." Probability is one math topic that is usually found at the end of a math textbook and covered when there is extra time at the end of the school year. Additionally, teaching probability and statistics is not easy for mathematics teachers. Primary and secondary level mathematics teachers frequently lack specific preparation in statistics education (Godino and Batanero, 2001). However, children can understand concepts of chance in the earliest grades (Andrew, 2009). This unit will bring probability to the forefront of math instruction and make it interesting and applicable to students in grades 3-5.

Rationale

Probability and Statistics are included in the State's standards for math education in elementary school through high school. Many universities also require students to take basic statistics courses. This can be a foreign world for students who are not properly exposed to the concepts and theories at a young age. In Pennsylvania, there are two math standards out of eleven that address statistics and probability:

> PA State Standard 2.6 – Statistics and Data Analysis (Collecting and reporting data, analyzing data)
>
> PA State Standard 2.7 – Probability and Predictions (Validity of data, calculating probability to make predictions)

Many times elementary problems of statistics and probability are presented in ways that are extremely obvious for students and do not provide a challenge or any real need to conduct a hands-on experiment. Results can be predicted and problems have a weak use of experimental probability (Andrew, 2009). One specific activity, tossing a paper cup in the air and letting it land on the floor, not only has 3 different outcomes (landing right side up, upside down, or on its side), but also provides a more powerful example of experimental probability because there is no real way to predict what the probability will be without actually trying it out with paper cups (Andrew, 2009).

One important connection for students to make with dealing with chance and probability is that there is a connection between the experimental probability and theoretical probability. When students conduct an experiment on a small scale, they may not see the connection. However, when individual student outcomes are combined with their classmates to create a class-wide representation of all outcomes, they will more easily make this connection. Multiple experimental approaches help students see that there is an ideal probability that can be calculated without actually conducting the experiment, resulting in a theoretical probability (Andrew, 2009).

Many times, at the elementary level, students have a difficult time with the concepts of fractions, ratios, and percents. However, throughout this unit, it will become obvious that experimental probability is connected to number sense and different representations of numbers such as percent, decimals, ratios and fractions (Andrew, 2009). Therefore, many other PA State Standards in math will be addressed and reinforced. Students will be able to make real-life connections between actual situations and the use of fractions, decimals, percents and ratios. Probability might also help students overcome any fears of fractions because situations of chance represented as a fraction help them realize how the numerator and denominator are compared and what that means in real-world situations (Andrew, 2009). A goal of this unit will be to have students represent their outcomes in the following manner: the chance of a coin landing on heads is 'one out of 2', the chance of a cube landing on the number 5 is 'one out of 6', etc. (Edwards and Hensien, 2000).

Mathematical Background

The origins of probability date back thousands of years. It is difficult to track when the concepts of statistics and probability began being used, but a more formal creation of these principles can be noted in the 14th Century in France when a man by the name of Giovanni Villani created a history of France that included statistical information on population, ordinances, commerce and trade, education, religion, and many other topics. From there, probability developed into other areas and also became common in experiments.

In the 20th Century, there have been several notable statistical experiments that have brought to light to mistakes and errors that can occur. One of these errors occurred in 1954 when there was a field trial for a Polio vaccine conducted by a Dr. Salk (http://wps.aw.com). Due to selection bias and diagnostic bias, the data and findings were skewed and thus inaccurate.

Strategies

To prepare myself for writing this unit, I researched the basic concepts behind probability and chance. I created a vocabulary list and a list of basic concepts necessary to solve many probability situations. The vocabulary includes likely, unlikely, certain, possible, impossible, outcomes, theoretical probability and experimental probability. Students will learn these terms through the creation of flashcards for each term using definitions, examples, and visual representations. They will practice the terms by answering questions using their flashcards, gathering data using the proper vocabulary, and consistent and repetitive review of these terms.

Concepts that are important to a basic foundation for probability include what outcomes are possible, how many outcomes are possible, how to count possible outcomes, how to express probability as a fraction, percent, or ratio, and the difference between experimental and theoretical probability. I will also collect a plethora of problems and situations that can provide students with practice. The concepts will be taught using a multitude of different strategies. This unit will include age-appropriate experiments and simulations that will help students practice determining probability. The teacher will incorporate technology, hands-on activities, and cooperative learning to excite students and keep them involved. The unit will incorporate important vocabulary covered using graphic organizers and flashcards. Connections will be made between simulations and actual mathematical equations. Students will work as a class and independently to conduct experiments and problem solve. Literature based on real-life situations that provide insight into probability will be shared with students.

Classroom Activities

Lesson 1 – What is Probability and Chance?

Objectives – Students will become familiar with basic vocabulary used with probability. Students will answer probability questions using the terms Possible, Impossible, and Certain. Students will predict the outcome of spinning on a spinner 50 times. Students will use a spinner and graph their results in a bar graph.

Materials – Probability PowerPoint, Index Cards, Spinner/Bar Graph, Paper clips

Procedure – I will define probability for students (the chances/odds of a specific action occurring) and explain that there are some commonly used words when working with probability. A PowerPoint presentation will introduce each word with its definition, examples and synonyms. Students will write each word on an index card and write the definition, synonyms, examples and any visual representations on the back. These words will include certain, possible, impossible, outcome, likely, and unlikely.

After students have created their "flashcards," situations will be provided from the PowerPoint where students must hold up the term that relates. For example: what are the chances that you can see your shadow in the dark? Answer: Impossible; what is the probability that it will rain on Sunday? Answer: Possible; what is the probability that the sun comes up in the morning? Answer: Certain; what is the probability that a fire is hot? Answer: Certain; what is the probability that a cat has wings? Answer: Impossible; what is the probability that a bird can talk? Answer: Impossible/possible (a conversation might arise about parrots).

A spinner with 8 numbers and matching bar graph will be given to each student for a spinner experiment. The spinner will be discussed and outcomes will be predicted. Students will then use a pencil and paperclip to spin 40 times and record their results in a bar graph.

Lesson 2 – Games of Chance

Objectives – Students will review basic probability terms and review their Spinner Experiment. Students will answer questions regarding the outcome of their Spinner Experiment. Students will play a Lucky Duck game to determine the probability of several situations using the terms Certain, Likely, Unlikely, and Impossible. Students will learn that probability can be expressed as a fraction and make the connection between these two concepts.

Materials – Spinner/Graph outcomes, Lucky Duck Activity Sheet, *It's Probably Penny* book (Leedy, 2007)

Procedure – I will review the basic vocabulary and previous predictions for the Spinner Experiment. Students will then have the spinners returned to them with 10 questions attached and a Lucky Duck activity sheet. As a class, results from the Spinner Experiment will be shared and the term 'outcome' will be discussed as it pertains to the activity. Students will work independently to answer 10 questions about their spinner experiment:

"40 Spins" Spinner Experiment and Probability

1. What is the MODE of your graph (which number was landed on the MOST)?_____
2. What is the total number of outcomes on this spinner? _____
3. What outcomes are MOST possible? _____
4. What is an outcome that is IMPOSSIBLE on this spinner? _____
5. What outcome was landed on the LEAST? _____
6. Draw a spinner that has 4 different outcomes.
7. Draw a spinner that has 6 different outcomes.
8. Draw a spinner where the chance of spinning the number 8 is IMPOSSIBLE.
9. What are the chances of it raining today? (Certain, possible, or impossible)_____
10. What are the chances of a fire drill today? (Certain, possible, impossible)_____

As a class, we will examine the Lucky Duck game. There are 12 ducks numbered from 1-12 on the bottom. They are floating in the water and you are trying the pick the duck that will be a winner. Different scenarios are given and students must determine whether their chances are Certain, Likely, Unlikely, Impossible. *For example: What is the probability that you will choose a duck with wings? Answer: 12/12 – Certain. What is the probability that you will choose a duck with a number greater than 3? Answer: 9/12 – Likely.* During this activity, students will be introduced to the fact that probability and chance can be represented as fractions or ratios. The teacher will then share the book *It's Probably Penny* with the class (Leedy, 2007).

Lesson 3 – Spinner Coloring/A Very Improbable Story

Objectives – Students will practice using fractions, ratios, and percents to represent probability while creating spinners of chance. Students will learn about everyday situations that involve probability and chance.

Materials – Spinner Coloring paper, crayons/colored pencils, *An Improbable Story* (Einhorn, 2008).

Procedure – Students will review the previous activities, including the Spinner Experiment, Lucky Duck Activity, and various probability terms. Representing chances or odds as fractions and ratios will also be reviewed. Students will then be given 8 blank spinners. With teacher guidance, students will divide 2 spinners into 4 equal parts, 1 spinner into 6 equal parts, and another into 8 equal parts. They will then follow directions for creating 8 different spinners:

Spinner Coloring

1. Make the probability of landing on blue equal to ¼. Make the probability of landing on red ¼. Color the rest of the spinner yellow. What is the probability of landing on yellow? (Answer: 2/4 or ½) What is the probability of *not* landing on yellow? (Answer: 2/4 or ½).
2. Cut the spinner into eighths. Color 3 spaces green, 2 spaces orange, 2 spaces yellow, and 1 space blue. Which 2 colors are equally likely? (Answer: orange and yellow) What is the probability of landing on green? (Answer: 3/8)
3. Cut the spinner into 6 equal parts. Make the probability of landing on blue equal to ½. Make the probability of landing on red 1/6. Color the rest of the spinner green. What is the probability of landing on green? (Answer: 2/6 or 1/3) What is the probability of landing on either green or blue? (Answer: 5/6) What is the probability of landing on green, red, or blue? (Answer: 6/6 or 1).
4. Cut the spinner into four equal parts. Color 1 part blue, 1 part yellow, 1 part green, and 1 part red. What is the probability of landing on red? (Answer: 1/4 or 25% or 1 out of 4) What is the probability of *not* landing on red? (Answer: ¾ or 75% or 3 out of 4) What is the probability of landing on white? (Answer: 0)
5. Make red the more likely color to spin. Make yellow the less likely color.
6. Make green and blue equally likely. Make red less likely.
7. Make blue least likely. Make red most likely. Include 2 other colors, too.
8. Make red more likely than blue. Make red less likely than yellow.

While students are coloring the spinners, the book *A Very Improbable Story* will be read aloud by the teacher (Einhorn, 2008). This book involves many situations of chance and also represents these situations as ratios and fractions.

Lesson 4 (2 days) – Super Spinners

Objectives – Students will analyze spinners to compare the theoretical probability of each spinner outcome with the experimental probability from their trials. Students will use fractions and percents to represent probability. Students will determine the difference of the theoretical and experimental probabilities. Students will draw conclusions about the accuracy of the experimental probability data in relation to the number of trials completed.

Materials – Super Spinner packets, Paper clips, calculators

Procedures – I will start by explaining the difference between the Theoretical Probability and Experimental Probability. Theoretical Probability is the mathematical chance that something SHOULD happen. Experimental Probability is the result obtained by actually completing a number of trials of an event. For example, if a spinner section takes up one half of a circle, then the Theoretical Probability would be ½ or 50%. However, upon completing a certain number of spins, a student may come up with an Experimental Probability that differs (but is usually close to) the Theoretical Probability.

Each student will be given a Bug Super Spinner packet and a paper clip. As a class, we will determine the Theoretical Probability for all 3 spinners and record them in the table as a fraction and a percent. Then students will spin 50 times on each spinner. They will record their outcomes with tallies on the table under Experimental Probability. Once all 3 Spinner Experiments have been completed, students will work independently to calculate the fraction and percent for each outcome. I will then explain how the difference between the Theoretical and Experimental probabilities can be calculated. As a class, we will discuss the numerical and conceptual differences.

Each student will then be given the Sports Super Spinners to repeat these procedures independently. Once they have been completed, individual data will be collected and combined to create class-wide data. Students will see that the more times an experiment is attempted, the closer the Experimental Probability compares to the Theoretical Probability.

Lesson 5 (2 days) – Likely Letters

Objectives – Students will use experimental probability to determine the letters with the highest frequency of use in written English. Students will differentiate between theoretical and experimental probability, make predictions, collect and organize data, and analyze their results to discover which letters of the alphabet are used the most.

Materials – Reading materials (books/magazines), calculator, Likely Letters packet with Data Entry Sheet, www.superkids.com for an educational game of hangman

Procedures – I will write a Hangman game on the board and students will guess the word by calling out letters. Students will then be given the Likely Letters packet with the Data

Entry Sheet. As a class, we will discuss the probability of each letter in the alphabet being used in written English and how this differs from the obvious probabilities that the students have worked with so far (for example, the probability of a word having the letter "e" is NOT 1/26). Additionally, each letter does not have equal probability of being chosen because some letters are used more often than others in written language. For instance, the letter Z is not used in many words. On the Data Entry Sheet, each student will predict which 5 letters they think are used most often in writing. I will then refer the class to a board where I have posted the 5 most commonly used words COVERED, to be revealed after the investigation.

Each student will obtain a reading passage (each student will use something different). The first 100 consecutive letters will be recorded in the Likely Letters packet. Using the Data Entry Sheet, the students will write in the number of each letter found in their written English sample of 100 letters (Example – A: 9, B: 3, C: 0, etc.) After all data has been recorded, students will then turn this raw data into percents. Students will rank the top 10 letters that were found in the passage and record these 10 numbers in order into their Likely Letters packet.

As a class, we will combine all individual data and create a grid of class data on their Data Entry Sheet. We will record raw data, percents, and then ranking of the top 10 letters. The most frequently used letters (according to a study by Meyer and Matyas in 1982, are, in order, ETAOI NSRHL DCUMF PGWYB VKXJQ Z.

After revealing the outcome of the experiment and the actual top 5 letters, students will conclude with a discussion. I will ask the following questions:

1. Who might actually use these results, which show the letters used most often in written English? (Answer: game players, code breakers, billboard/marquee sign users, typesetters)
2. How did the results change as more data was collected, combining individual data into class data? (The results will probably get closer and closer to the expected probability as the sample grows.)
3. Will your results become more accurate as your data sample becomes larger? Why? (Yes, the results should become more accurate as a larger, more representative sample is used.)
4. Which five consonants would be the most useful when playing Wheel of Fortune? (The five consonants are T, N, S, R, H or others that were in the students' top 5 consonant letters.)
5. What percentage of all the letters surveyed by the class were vowels? Consonants?
6. In the game of Scrabble, why do you think the letters Q, Z, and X have higher point values? (These letters have a higher point value because they are harder to use and appear less in words.)
7. What were the five LEAST-USED letters according to the classroom data?

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Appendix: Content Standards

This unit is intended for students in Grades 3-5.
The Objectives of the unit will include the following:

2.5.5 Mathematical Problem Solving and Communication

2.6.5 Statistics and Data Analysis

2.7.5 Probability and Predictions