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TOPIC: Probability, Igba-ita (Nigerian game)

NCTM STANDARDS: Data Analysis and Probability, Algebra, Connections

GOALS:

- Students will learn the meanings of the mathematical terms: probability, experimental probability, theoretical probability, trial, outcome, frequency, equally likely, and random.
- Students will use a calculator to perform a series of trials using randomly generated numbers.
- Students will relate probability to proportion and ratios through the Nigerian recreational game, Igba-ita.

INTRODUCTION:

Igba-ita is a Nigerian recreation game using their traditional form of currency, cowrie shells, which were often used in the marketplace. The name Igba-ita means "pitch and toss" which is basically what occurs in this game. The game is traditionally played as a type of gambling or betting game played by men, where the players are aiming to win a pot of cowrie shells after a certain number of rounds or trials.

The cowrie shell is a significant symbol all around Africa, not just Nigeria. However, the cowrie shell was used as a form of currency more recently, as well as in ancient times, in Nigeria, while other African countries used the shells as currency throughout ancient times. These shells can mostly be found in the Indian Ocean, and even once were adopted as a form of currency in ancient China, first by using the shells and later making shells of bronze or copper. More recently, these shells have become part of African jewelry.

ACTIVITIES:

- Part 1. Probability lesson introduction. Students will be introduced to important probability terms. They should take notes on these terms so that they can refer to them at a later time, including the other activities.
- Part 2. Calculator Cowrie Shell (or coin) Toss. The students will individually perform the calculator shell/coin toss using their graphing calculators. Using the list and random number generator functions, they can determine long term probabilities of tossing shells/coins. They will also create a scatter plot to be able to visualize the proportion of shells/coins which land a specific way.
- Part 3. Igba-ita game. Students will be in pairs for the Igba-ita activity. Each student will need 4 shell-shaped macaronis (or pennies) and a copy of the rules and score sheet. They will perform 15 rounds of the game and then tally up their scores.

ASSESSMENT:

After completing the activities, the students will be given the *Igba-ita Probability Discovery* worksheet. This worksheet will guide the students through determining probabilities related to ratios of different parts of the Nigerian game, Igba-ita.

Introduction to Probability Scoring Rubric:

Activity	Points per Activity	Points Received
Correct Scatter Plot on Calculator	5	
Igba-ita Score Sheet	5	
Igba-ita Probability Discovery Worksheet	20	
TOTAL POINTS	30	

RESOURCES:

Jackson, I. Cowrie shell history. Retrieved September 22, 2006, from http://www.ifama.com/page7.html.

McIntosh, T. & Carroll, S. (2006). Igba-Ita. Retrieved September 12, 2006, from Queen's University connect-ME family math activities: http://www.educ.queensu.ca/~fmc/december2006/3.htm.

Murdock, J., Kamischke, E., & Kamischke, E. (2002). *Discovering algebra: An investigative approach.* Emeryville: Key Curriculum Press.

WCET, Cincinnati Art Museum, & Association of the Advancement of Art Education. Igba-ita. Retrieved September 21, 2006, from Cincinnati Art Museum's math games at http://www.behindtheglass.org/africaresources/igba.asp.

Part 1. Probability Lesson Introduction Teacher class outline

Have you heard someone use the phrase "chance of" or how likely something is to occur? Where have you heard these phrases (help give examples if none are mentioned- weather, sports, games- lottery, card games, dice games, etc)

The mathematical term for the chance that something specific will happen is called the **probability** of that occurrence.

The probability or chance of something is often given in a percentage, with the percentage being ranging from 0% to 100% (Why can't the probability of something be less than 0% or greater than 100%?). The probability can also be rewritten as a decimal or fraction, where the percent amount is divided by 100% to get the ratio of the chance that something will occur to the entire number of possibilities that could occur (100% of the time).

Or think of the probability as: $\frac{\text{\# ways (or times) outcome will occur}}{\text{Total \# of ways (or times) under consideration}}$

which would give you the proportion (or the percent if you multiply that number by 100)

Trial: performing a specific task (one time)
Example- flipping a coin one time

Outcome: result of a trial
Example- when flipping a coin you can either get a head or a tail, so if you flipped a coin and got a head, the outcome of that trial would be a head

Experimental (observed) Probability: collected data from a set amount of trials
Example- We could flip a coin ten times and get HHTHTTTHTT, where we had 4 outcomes of a head and 6 outcomes of a tail. This means that 4 out of 10 times we got a head, or 4/10 = 2/5 of the times we got heads. Then the experimental probability of getting a head was 2/5 = 0.4.

Frequency: number of times a specific result occurs through a series of trials
Example- Like in our experiment where a coin was flipped ten times, the frequency of getting a head would be 4, since we got a head 4 out of the ten times.

Theoretical (actual) Probability: estimated probability based from data
Example- If we were to keep flipping coins for a much larger and larger amount of trials, our experimental probability would become closer and closer to the theoretical probability.

Equally Likely (fair): results are considered equally likely when they have the same theoretical probability of occurring
Example- A penny is generally very evenly weighted with two sides resulting two possible outcomes, heads or tails. Since it is evenly weighted (as long as it has not been damaged or altered to remain fair) it is considered that getting a head is as equally likely as getting a tail.

Random: when the outcome of a trial cannot be predicted
Example- when we flip the coin, we cannot predict beforehand if the outcome will be a head or a tail

Part 2. Calculator Cowrie Shell (or Coin) Toss

Students will use their graphing calculators, preferably with the assistance of a projected calculator by the teacher. The instructions given are based on a TI-83 or TI-83 plus graphing calculator.

We assume that it is equally likely for a cowrie shell to be rolled so that the open side is facing up or the closed side is facing up (theoretical probability of either outcome is .5 or 50% of the time). The calculator can only use numbers, so we will use the number 0 to represent the open side landing upward and the number 1 to represent the closed side landing upward.

Before beginning this activity, make sure the students have the lists (at least 1-4) in their calculators cleared out [STAT, 1:Edit, Highlight L_1 with cursor, CLEAR, ENTER]

Follow the steps to complete the calculator cowrie shell toss:

1. Enter the sequence of integers from 1 to 100 in L_1. These are the numbers of rolls or trial numbers.	1. With the cursor highlighting L_1, 2nd LIST OPS 5:seq(x, x, 1, 100, 1) ENTER
2. Enter 100 randomly generated 0s and 1s into L_2. These numbers designate the outcomes of the rolls.	2. With cursor highlighting L_2, MATH PRB 5:randInt(0,1,100) ENTER
3. Display the cumulative sum of L_2 in L_3. This shows the total number of shells which have landed closed side upward before and including that particular flip.	3. With the cursor highlighting L_3, 2nd LIST OPS 6:cumSum(2nd L_2) ENTER
4. Show the ratio of L_3 to L_1 in L_4. This will display the observed probability of a shell landing closed side upward.	4. With the cursor highlighting L_4, 2nd L_3 ÷ 2nd L_1 ENTER
5. Create a scatter plot using the roll number (L_1) as the x-values and the observed probability of closed side upward (L_4) as the y-values. Set the window appropriately to view the scatter plot.	5. From the main screen, 2nd STATPLOT 1:Plot 1 On ENTER Type: (dots- first choice) Xlist: L_1 Ylist: L_4 WINDOW Xmin = 0 Xmax = 100 Xscl = 1 Ymin = 0 Ymax = 1 Yscl = .1 GRAPH
6. Enter the theoretical probability of rolling a shell to land closed side upward in Y_1 on the Y= screen. Graph this line on the same screen as the scatter plot.	6. Y = Y_1 = .5 GRAPH

Part 3. Igba-ita game

Igba-ita is a Nigerian recreation game using their traditional form of currency, cowrie shells, which were often used in the marketplace. The name Igba-ita means "pitch and toss" which is basically what occurs in this game. The game is traditionally played as a type of gambling or betting game played by men, where the players are aiming to win a pot of cowrie shells after a certain number of rounds or trials.

Below are instructions to play our modified version of Igba-ita:

1. Each player has four cowrie shells to be used in the game.
2. A player must be chosen to go first (this could be done by flipping a shell and one player calling either open or closed, where open and closed are the names for which side is facing up).
3. The chosen player goes first, tossing their four shells on the table.
4. a) If all of the shells are facing the same way, then the player gets a score of 4 and gets to roll again.
   b) If half (2) of the shells are facing one way and the other half (2) another way, then the player gets a score of 2 and gets to roll again.
   c) If anything else is rolled, the player gets a score of 0 for this round and it is now the other player's turn.
5. Continue playing for 15 rolls total, and then add up all of your scores. Person with the largest score wins Igba-ita!

Score Sheet: Keep the tally of your score in the table below
(mark through any rounds you do not play)

Round	Score
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
Total	

Name: _____ Date: _____

Igba-ita Probability Discovery

1. When rolling a single shell, what are the possible outcomes?

2. Assuming the shells are equally distributed (the shells are fair) what is the theoretical probability of each of the outcomes when rolling a single shell?

3. If rolling a single shell, what should the observed probability of rolling a shell open side upward over a long period of time be? (think back to the scatter plot)

4. Fill in all of the possible rolls below with an 'O' for open side facing upward or a 'C' for the closed side facing upward:
   (*note the series OOCC is different than OCOC)

Shell 1	**Shell 2**	**Shell 3**	**Shell 4**

5. How many total possibilities of shell combinations are there?

6. How many of these times are all shell openings facing upward?

7. How many of the total possibilities include all of the closed sides of the shells facing upward?

8. How many different ways can you get all the shells facing the same way out of all of the possibilities?

9. What is the theoretical probability of getting all of the shells facing the same way in one roll?

10. What is the theoretical probability of half of the shells facing one way and half of the shells facing the other way?

11. What is the probability that a player playing Igba-ita would get to roll the next round as well as the round they are about to roll?

12. What is the probability that a player would get a score of 0 for a round?

13. What was your experimental probability of rolling all shells facing the same way?

14. What was your experimental probability of rolling a second time? (If you rolled three times in a row, then you had two second time rolls)

15. If the theoretical probability of an occurrence was unknown, describe how you could find it.

Name: Answer Key Date: _____

Igba-ita Probability Discovery

(20 points total)

1. When rolling a single shell, what are the possible outcomes?
   Open side up, closed side up
   Open side up, open side down
   (1 point)
2. Assuming the shells are equally distributed (the shells are fair) what is the theoretical probability of each of the outcomes when rolling a single shell?
   Open side up: ½ or .5
   Closed side up, open side down: ½ or .5
   (1 point)
3. If rolling a single shell, what should the observed probability of rolling a shell open side upward over a long period of time be? (think back to the scatter plot)
   Over a long period of time the observed probability of a shell landing open side upward should be close to ½ or .5.
   (1 point)

4. Fill in all of the possible rolls below with an 'O' for open side facing upward or a 'C' for the closed side facing upward:
   (*note the series OOCC is different than OCOC)
   (4 points)

Shell 1	Shell 2	Shell 3	Shell 4
O	O	O	O
O	O	O	C
O	O	C	O
O	C	O	O
C	O	O	O
O	O	C	C
O	C	O	C
C	O	O	C
O	C	C	O
C	O	C	O
C	C	O	O
O	C	C	C
C	O	C	C
C	C	O	C
C	C	C	O
C	C	C	C

5. How many total possibilities of shell combinations are there?
   16 total possible shell combinations **(1 point)**

6. How many of these times are all shell openings facing upward?
   1 time (OOOO) has all of the shell openings facing upward **(1 point)**

7. How many of the total possibilities include all of the closed sides of the shells facing upward?
   1 time (CCCC) has all of the closed sides of the shells facing upward **(1 point)**

8. How many different ways can you get all the shells facing the same way out of all of the possibilities?
   2 ways (OOOO and CCCC) have all of the shells facing the same way **(1 point)**

9. What is the theoretical probability of getting all of the shells facing the same way in one roll?
   The theoretical probability of getting all of the shells facing the same way is 2 ways out of 16 ways which equals 2/16 = 1/8 = .125 **(1 point)**

10. What is the theoretical probability of half of the shells facing one way and half of the shells facing the other way?
    6/16 = 3/8 = .375 **(1 point)**

11. What is the probability that a player playing Igba-ita would get to roll the next round as well as the round they are about to roll?
    8/16 = 1/2 = .5 **(1 point)**

12. What is the probability that a player would get a score of 0 for a round?
    8/16 = 1/2 = .5 **(1 point)**

13. What was your experimental probability of rolling all shells facing the same way?
    Various answers accepted: verify with results of score sheet **(1 point)**

14. What was your experimental probability of rolling a second time? (If you rolled three times in a row, then you had two second time rolls)
    Various answers accepted: verify with results of score sheet **(1 point)**

15. If the theoretical probability of an outcome was unknown, describe how you could find it. Through a very large number of trials, the experimental probability should be a good approximation of the theoretical probability. **(3 points)**