PBS Mathline®

The Elementary School Math Project

Chances Are — Part 1

Talking Probability

A Class Over Time (Probability)

Objective

Students will be able to describe events that are certain, impossible, likely, and unlikely to occur. Students will determine the likelihood of an event occurring using a probability scale.

Overview of the Lesson

Students are introduced to the idea of probability by discussing the likelihood of events occurring. Students focus on the "language" of probability as they use their life experiences to recall events that are certain, impossible, likely, and unlikely to happen. These events are recorded through the use of graphic organizers that relate to a current unit of study. Students are introduced to a probability scale, ranging from 0 - 1. They are encouraged to evaluate the chance of given events occurring and assigning the event a position on the probability scale. The activity immerses the students in experiences that promote discourse about probabilistic notions.

Materials

Teacher

- Ribbon approximately 10 feet in length
- Three 9" by 12" cards with the following titles: 1 - CERTAIN; 0 - IMPOSSIBLE; 1/2
- Toy basketball hoop and foam basketball
- Graphic Organizers

TALKING PROBABILITY

A. The Orioles will win the World Series.

B. The next baby born in Baltimore will be a girl.

C. You will watch television some time today.

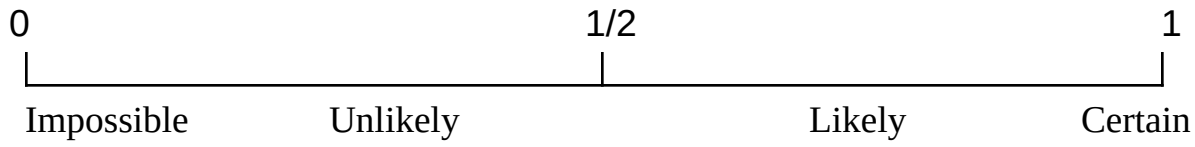
D. It will snow in your area during the month of August.

E. You will read at least four books this month.

F. It will be sunny tomorrow.

G. Make up a sentence of your own.

Walk-on Probability Line



Each Group of Four Students

- Large probability scale (24 inches long)
- Sticky dots labeled A,B,C,D,E,F
- Activity Sheet: Talking Probability

Procedure

Show the class a toy basketball hoop and ball and ask them to describe your chances of making a basket on the first try from a distance of 10 feet. Focus the discussion on vocabulary such as likely, unlikely, probably, maybe, certain, impossible, and highly unlikely. Ask students to compare your chances of making a basket with the chances of a professional basketball player like Michael Jordan.

Introduce the term, "probability," to the class and discuss its meaning. Probability can be defined as the chance of an event occurring. Ask students to name the instances that they have heard the term used in their everyday lives.

Tell the class that probability can be expressed on a probability scale. Place a long piece of ribbon on the floor representing the scale. Ask the students to name a number that would best represent an event that is impossible. (0) Choose a student to stand at this position on the scale and hold a card marked, "0 IMPOSSIBLE". Ask students to name events that are impossible. List student responses on a graphic organizer.

Now ask students to name a number that would best represent an event that is certain. (1) Have a student stand at this position on the scale and hold the card marked, "1 CERTAIN". Challenge students to name events that are certain and record their responses on a graphic organizer. It would also be helpful to mark 1/2 on the scale and have a student stand halfway between 0 and 1 and hold the card, "1/2." Ask the students to make a prediction about the weather for that day. For example, they may discuss the chances that it will snow in their town today. Encourage them to come up to the walk-on probability scale and stand in the position that best represents their ideas. To promote discourse, students need to explain their reasons for standing at a particular spot. Elicit other students to come up and take a place on the scale.

Divide the class into groups of three to four students and give each group a set of sticky dots labeled A,B,C,D,E,F and a large probability scale, about 24 inches long. Give each student a copy of Activity Sheet: Talking Probability. Students will work in groups to evaluate the likelihood of the six events occurring. They will place the sticky dot representing a given event on the probability scale. They may record their personal answers on their individual sheets and then come to a consensus in their group to choose one position on the group scale for each event.

Students may then share their answers and use the class walk-on probability scale to show the likelihood of each event occurring. Have students brainstorm words related to probability that they used in their discussions. Write the words on a poster to be used for enrichment vocabulary or possible spelling words.

Collect the individual probability scales as well as the student Activity Sheets to assess student understanding of the concept of probability.

Mathematically Speaking. . .

Probability concepts are found in almost every aspect of every day life. Young children are very aware of probability in the context of games where they often informally evaluate the probability of winning and even determine if a game is truly "fair." As they mature, they will come to realize that weather reporting, highway planning, television programming, medical treatment options, and insurance policies all depend on probabilistic notions.

Probability can always be expressed by a number between 0 and 1. 0 denotes an event that is impossible, while a 1 represents an event that is absolutely certain to occur. Often the frequency of an event's occurrence is expressed as a ratio such as one out of two, 1/2, .5, or 50%. Probability is useful in predicting outcomes from a given set of circumstances. It will help students to make decisions, simple and complex, as they go through life. For example, if the probability of rain is high, then the student may wish to carry an umbrella or wear a raincoat.

Extensions & Connections

Have students keep a daily diary for several days noting all of the times that they encountered instances involving probability.

Weather prediction can be easy or challenging depending on geographic conditions. Have students listen for probability mentioned in weather forecasts as in probability of precipitation. Then have students give a weather forecast for the class or school over the intercom or on a large calendar that can be posted in the hall.

Students could survey parents, grandparents, neighbors, and friends as to ways probability is part of their daily occupations.

Resources

Exploring Probability: Quantitative Literacy Series. (1987) Dale Seymour Publications. Palo Alto, California

Making Sense of Data: Addenda Series, Grades K-6. (1992) National Council of Teachers of Mathematics. Reston, Virginia. ISBN 0-87353-318-6; #449E1B

Ideas for Online Discussion

(*Some ideas may apply to more than one standard of the* ***NCTM Professional Standards for Teaching Mathematics.)***

Standard 1: Worthwhile Mathematical Tasks

- What are some of the significant mathematical ideas posed in this lesson with third grade students?
- What number sense concepts are contained in the probability number scale?
- Do you feel probability should be part of the elementary curriculum?

Standard 2: Teacher's Role in Discourse

- The teacher remarked that this was a teacher-oriented lesson because of introducing new concepts. In follow-up lessons, she wants to engage the students more. Suggest activities that could be used to build on today's lesson.
- As discussion evolves around the group probability scale, the teacher noted additional vocabulary being used. What technique does she use to reinforce the new vocabulary? How do you introduce precise terminology to your students?

Standard 4: Tools for Enhancing Discourse

- What concrete materials, techniques or strategies does the teacher use to promote communication about probabilistic ideas such as certain, probable or impossible events?
- What examples do the students offer from their experiences to show that they understand impossible and certain, and how are they recorded? How do you record student answers?

Standard 6: Analysis of Teaching and Learning

- What comments did the teacher make to show she is analyzing her teaching style and the student learning that is taking place?
- How did the assessment influence the next day's lesson? Suppose the feedback indicated that half the students did not grasp the concept. How would this influence the lesson you are teaching the next day?

TALKING PROBABILITY

A. The Orioles will win the World Series.

B. The next baby born in Baltimore will be a girl.

C. You will watch television some time today.

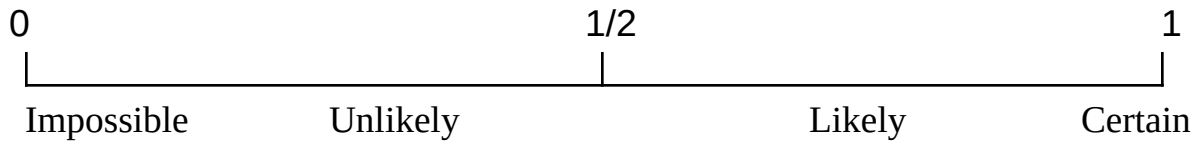
D. It will snow in your area during the month of August.

E. You will read at least four books this month.

F. It will be sunny tomorrow.

G. Make up a sentence of your own.

Walk-on Probability Line



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The Elementary School Math Project

Chances Are — Part 2

It's a Mystery to Me

A Class Over Time (Probability)

Objective

Students will be able to name all of the possible outcomes of a given event and predict the likelihood of an event occurring based on a data set.

Overview of the Lesson

Students extend their understanding of basic probability concepts as they learn to name all of the possible outcomes of an event as well as ways to express the likelihood of such an event occurring. Students use large number cubes and oversized playing cards as they explore ways to express probability. These ways include ratios such as one out of four or 1/4. Computer software that simulates the rolling of a number cube 1,000 times in a few seconds is used to stimulate student inquiry. Students are then actively engaged in a probability experiment where they must collect, organize, display, and interpret data concerning thirty spins on a "mystery spinner." At the conclusion of the lesson, students are given opportunities to share their data displays with others and encourage classmates to predict what their "mystery spinner" might look like based on the data collected. Students then compare their predictions with the actual spinner.

Materials

Teacher:

- Deck of large playing cards
- Ice cube in a dish
- Large foam number cube
- Large spinner

- Computer software, Interactive Mathematics, Silver Burdette or similar software

Each student:

- Individual marker board or mini-chalkboard
- Markers or chalk, and eraser
- Activity Sheet: Mystery Spinners

Each group:

- "Mystery Spinner" concealed in an envelope. (These could be teacher-made using a paper clip and fastener or commercially produced spinners)
- Large chart paper
- Markers or crayons

Procedure

Show the students a small dish with an ice cube. Ask students to describe the probability that some of the ice cube will remain by the end of the math lesson. Review concepts from the previous lesson using probability vocabulary such as likely, unlikely, certain, etc. Students may wish to refer to the vocabulary chart made in the previous lesson. To provide further review of the previous lesson, ask students where they would place the event on the probability scale.

Show the class a large set of playing cards. Pick two queens, a seven, and a ten. Ask the students to name all of the possible outcomes if you were to shuffle these four cards and pick only one of them. Introduce the term, "outcomes" to the students. Ask students to describe the chances of picking a seven. Focus the discussion on ways to express the probability of choosing a seven. (one out of four, 1/4, .25, 25%) Student answers will vary as to their personal experiences with expressing probability. Continue the discussion by describing the chances of picking a queen. Have students name ways that they could improve their chances of picking a queen. (Add more queens. Take other cards away.)

Display a large foam number cube that has numbers 1-6 on it. Ask students to name all of the possible outcomes that they could roll. Have students record their answers on individual marker boards or mini chalkboards. Ask students to determine if one number has a better chance than another where rolled. Encourage students to give reasons for their answers. Use a computer software program that can simulate the rolling of a number cube. Display the software program so that students can look at 1,000 rolls of a number cube and analyze the results.

Next, show the class a spinner which is divided into quarters. Have students color one-half one color, and each of the remaining quarters in different colors. Ask the students to name all of the possible outcomes. Students will record their responses on marker boards and then share their answers. Have students predict what color the spinner is most likely to land. Students should justify their responses. Divide

the class into groups of three students each. Give each group a "mystery spinner" in a secret envelope. Tell the students that these are top secret and that they may not show the spinners to anyone outside of their group. Give each student a copy of the Activity Sheet: Mystery Spinners. Instruct the students to spin the spinner 30 times and record the results of their spins on the frequency table. There is also a place on the Activity Sheet for students to predict the results of the experiment. After students complete the probability experiment, have them make a bar graph displaying their results on large chart paper.

Each group then shares the results of their probability experiment. Based on the data presented, the remainder of the class will predict what they think the group's mystery spinner looked like. Encourage discourse among students. The group then unveils their mystery spinner for all to see! Discuss the results.

Collect and evaluate the Activity Sheets for student acquisition of the objectives.

Mathematically Speaking. . .

There are many experiences in our daily lives involving chance outcomes. These involve a variety of situations for which we do not know the outcome in advance, but we may be able to list all of the possible outcomes and make predictions based on prior knowledge. Numbers can be used to represent the chances of the events occurring. These numbers can be expressed in a variety of ways. For example, if a spinner is divided into four equal regions and the regions are colored white, yellow, red, and blue, then the chances of spinning yellow could be expressed as one out of four, 1/4, .25, or 25%.

Extensions & Connections

Students may design a board game in which play is advanced through the use of number cubes or a spinner.

Have students explore all of the possible outcomes when rolling two number cubes that are numbered 1-6. Use computer software that can simulate and graph thousands of rolls of the cubes. Have students construct and explain a bar graph depicting the rolling of two number cubes and then make a comparison with the rolling of one number cube.

Resources

Elementary Quantitative Literacy, Dale Seymour Publications (To be published).

Guidelines for Teaching Statistics K-12, American Statistical Association. (1990) Dale Seymour Publications. Palo Alto, California.

Computer Software: Interactive Mathematics, Silver Burdette or similar software.

Making Sense of Data: Addenda Series, Grades K-6. (1992) National Council of Teachers of Mathematics. Reston, Virginia. ISBN 0-87353-318-6; #449E1B.

Ideas for Online Discussion

(*Some ideas may apply to more than one standard of the* ***NCTM Professional Standards for Teaching Mathematics.)***

Standard 1: Worthwhile Mathematical Tasks

- As the teacher builds on the notions of probability from the previous day's lesson, what mathematical concepts are being reinforced in this lesson? Which are new? Hoe do you determine how much new material should be introduced on a given day?

- How do the connections to the previous lesson aid students in learning new concepts?

Standard 3: Students' Discourse

- What techniques do students use to reason, make connections, solve problems and communicate?

- What particular value will students gain from viewing the graphs constructed on mystery spinner outcomes, and from predicting what the spinner looks like?

Standard 5: Learning Environment

- Over the 2-day period of this probability unit, the teacher has allowed students to grapple with a range of concepts concerning probability. How has she sequenced the skills over time? How might this be changed?

- In this classroom learning environment, what evidence do you see that students are displaying a sense of mathematical competence?

Standard 6: Analysis of Teaching and Learning

- How does the teacher assess the students' understanding of probability?

- As the lesson has evolved over this 2-day period, what evidence shows that the teacher is continuing to plan for short-term and long-term learning of probability?

MYSTERY SPINNERS

1. Look at your spinner. List all of the possible outcomes.

2. **PREDICTION**

If you spin the spinner 30 times, how many times will it land on each of the outcomes?

LIST OUTCOMES	**PREDICTED FREQUENCY** (How many times will it land on the color?)

3. **EXPERIMENT**

Take turns spinning the spinner 30 times. Record your results in the chart below.

LIST OUTCOMES	**FREQUENCY**

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Chances Are — Part 3

OH NO! Look Out Below for a UFO

A Class Over Time (Probability)

Objective

Students will predict and simulate the likelihood of an event occurring.

Overview of the Lesson

Students are introduced to the idea of using simulation to explore and express the probability of an event occurring. Using an inflatable globe of the earth, students simulate where a UFO would impact with the surface of the Earth. Will the UFO hit land or water? Students are encouraged to make predictions based on prior knowledge of the earth's geographical features. Students toss the globe one hundred times and catch it with open hands. The position of their right index finger represents the landing location of a UFO. Students then use the data that they have collected to evaluate and make predictions on where a UFO will impact the earth.

Materials

Teacher

- One or two inflatable globes of the world
- Red markers
- Resource Sheet: Exploration Centers

Procedure

This lesson can easily be integrated with a language arts unit on mysteries. Have students read Cam Jansen and the Mystery of the UFO by David Adler. Begin the lesson with a short review of the book and a brief discussion of UFO's. Explain to the class that many UFO's that people report are merely space junk or meteorites that have fallen in the Earth's atmosphere. Invite students to pretend that a UFO has just been spotted entering the Earth's atmosphere. Ask the students to predict whether the UFO will most likely hit land or water. Encourage students to give reasons for their predictions.

Since collecting real data concerning UFO's would not be feasible, tell the class that they are going to set up an experiment to **simulate** this event. Introduce the term, "simulation," and discuss its meaning. Students hold up their right index finger and the teacher places a red dot at the end of their fingers with a red marker. Tell the students that the red dot represents the UFO.

Divide the class in half. Have students form two large circles. This activity works very well outside on the playground. Choose one student in each group to record the data and another student to count the number of trials. Students toss an inflatable globe around the circle. When they catch the globe, they note where their right index finger lands, water or land, and report the results to the recorder. After each group makes 50 tosses, the data from both groups are added together making a total of 100 trials.

Discuss the results after a few trials. Encourage students to observe patterns that emerge as the number of simulations increase. Assist students in understanding that increasing the number of trials helps them make a more accurate prediction.

Have students analyze the data and compare the experimental results with their predictions. Students can research the actual percentages of land and water on Earth. (Earth is approximately 71% water and 29% land so we would expect the UF0's to hit water around 70 times and land around 30 times.) Students compare their experimental results with the actual percentages of land and water.

Have students write notes to Cam and Eric, the two main characters of Cam Jansen and the Mystery of the UFO, telling them what they have learned about probability from doing this simulation. They may offer advice to Cam or Eric about the potential dangers of a UFO or a meteorite striking their house. Remind students that their letters should have words and numbers in their explanations.

Collect students' notes and evaluate them for understanding of simulation and probability.

Mathematically Speaking. . .

Simulation is a method of exploring more complex processes involving probability by doing repeated trials and experiments that resemble the actual situations. Simulation is used to gather data that is impractical if not impossible to observe in real-life situations. It is most useful in predicting results of different strategies for various solutions to real-world problems.

Simulations help to make distinctions between the important concepts of experimental probability and theoretical probability. Suppose we had a spinner divided into four equal regions and the possible outcomes of the spins would be white, yellow, blue, and green. We could find the experimental probability of landing on blue by spinning the spinner fifty times and recording the number of times it landed on blue. We could then express this as a ratio such as 15/50 or 3/10 (read 3 out of 10). However, to find the theoretical probability we would need to divide the total number of **possible** outcomes, (4), by the total number of favorable outcomes. (1) Thus, the theoretical probability is 1/4 or 25%.

Extensions & Connections

Have students use simulation to explore the possibilities of a meteorite striking North America. Students may research the actual land mass of each of the seven continents as well as the area covered by oceans and seas.

Students could use a coin to simulate an event that has two outcomes. Tell students they are going to take a test. Have students number from 1 - 10 on their papers. Toss a coin. If it is heads write "True", if it is tails, write "False". Have students number from 1 - 10 again. Give a question on something students are studying and have the answer True or False. Compare the results from the two instances.

Have students participate in a series of centers to review probability. See Resource Sheet: Exploration Centers.

Resources

Elementary Quantitative Literacy: Book 1. (1997) Dale Seymour Publications. Palo Alto, California.

World Almanac.

Cam Jansen and the Mystery of the UFO, by David Adler (1991) Puffin Books USA, Inc. Penguin Group, New York, New York. ISBN: 0-14-034672-4.

Making Sense of Data: Addenda Series, Grades K-6. (1992) National Council of Teachers of Mathematics. Reston, Virginia. ISBN 0-87353-318-6; #449E1B.

Ideas for Online Discussion

(*Some ideas may apply to more than one standard of the* ***NCTM Professional Standards for Teaching Mathematics.)***

Standard 2: Teacher's Role in Discourse

- Throughout the three days, the teacher consistently asks for students to discuss concepts taught in lessons. What ways do you use to review mathematical concepts?

- Building probability concepts over the three day period increases the amount of student discussion. What factors account for the increased discussion?

- How does the teacher become involved during learning center time?

Standard 4: Tools for Enhancing Discourse

- What concrete materials have you found useful in teaching probability?

- In the lesson, the teacher has students record the number of boxes of cereal "purchased" so they can later construct a stem and leaf plot. What other data displays can be used with these lessons?

- How could the calculator be incorporated into probability lessons?

Standard 6: Analysis of Teaching and Learning

- In the opening of this lesson, the teaching team is meeting to coordinate their curriculum. What are they concerned about in terms of learning, and their role as teachers?

- What concrete assessment piece does the teacher have to evaluate student learning? What do you use?

- How would you adapt these lessons for your students?

- Consider what probability concepts were taught over this 3-day period. Reflect on what was done, and what you might do differently.

EXPLORATION CENTERS

Mathesnackers

Materials:

- Number Cubes
- Activity Sheet: Mathesnackers

A new snack called Mathesnackers is putting a free math puzzle in every box. The company puts an equal amount of six different math puzzles in their products. Students simulate how many boxes of Mathesnackers the typical person would need to buy to collect all six different puzzles. Students conduct this simulation with an Activity Sheet and one number cube. Students put their data on a class chart so that later in the week the class results can be graphed and analyzed.

A Tacky Investigation

Materials:

- Thumbtacks
- Activity Sheet: A Tacky Investigation

Students investigate the probability of whether a tossed tack will land point up, point down, or on its side. After they have collected the data, they analyze the results. They also analyze the structure of the tack to determine if all outcomes were equally likely.

Design a Board Game

Materials:

- Spinner or Number Cube

Students design their own board game that advances play with a spinner or number cube. They are required to analyze the game for fairness. They also design an advertising campaign to sell their product.

Computer Center

Materials:

- Computers and software, Silver Burdette Interactive Math or similar software
- Construction paper, crayons, markers, scissors

Students use software programs, such as Silver Burdette Interactive Mathematics, to further explore probability concepts. Students predict the outcomes of the rolling of two number cubes. Through the use of the software, they can roll the number cubes 99,999 times in seconds. The program will then graph the results. Students can conduct similar investigations with a variety of spinners.

4. How do your results compare with your prediction?

5. Use large chart paper to make a bar graph to display your data.

6. Write a paragraph describing the results of your probability experiement. Also tell what you have learned about probability by doing this experiment.

A Tacky Investigation

Experiment	 Lands Up	 Lands on Side	 Lands Down
1			
2			
3			

Which way did it land most often? _____