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Title of Lesson: Introduction of “Experimental p-value” utilizing basics of probability theory

Discipline Focus: Scientific Research - Project 2061 Benchmarks NAS Science Standards or NCTM Standards supported by this activity:

Grade 11 – 12

Category: Scientific Inquiry

Students develop scientific habits of mind as they use the processes of scientific inquiry to ask valid questions and to gather and analyze information. They understand how to develop hypotheses and create and evaluate a variety of conclusions. Students are also able to demonstrate the ability to communicate their findings to others.

Benchmark A: Make appropriate choices when designing and participating in scientific investigations by using cognitive and manipulative skills when collecting data and formulating conclusions from the data.

Grade 11

Doing scientific inquiry:

5. Summarize data and construct a reasonable argument based on those data and other known information.

Grade 12

Doing scientific inquiry: 2, 5.

2. Derive simple mathematical relationships that have predictive power from experimental data (e.g., derive an equation from a graph and vice versa, determine whether a linear or exponential relationship exists among the data in table).
5. Use appropriate summary statistics to analyze and describe data.

Category: Scientific Ways of Knowing

Benchmark A: Explain how scientific evidence is used to develop and revise scientific predictions, ideas and theories.

Grade 11.

Nature of Science: 1, 2.

1. Analyze a set of data to derive a hypothesis and apply that hypothesis to a similar phenomenon (e.g. biome data).
2. Apply scientific inquiry to evaluate results of scientific investigations, observations, theoretical models and the explanations proposed by other scientists.

Grade 12.

Nature of Science 4.

4. Analyze a set of data to derive a principle and then apply that principle to a similar phenomenon (e.g., predator-prey relationships and properties of semiconductors).

Purpose: What should students know, or be able to do, by the end of the lesson?

Student should understand the basic concept of probability and be able to predict the outcome of suggested events.

Context: (Background information for teacher):

Are there any common misconceptions related to this topic?

Are there any pre-requisite student knowledge needed for this lesson?

Does this lesson fit within a series or strand of lessons?

The Probability lesson will be an introductory lesson for the statistical analysis and hypothesis testing lessons.

Planning Ahead: What does the teacher need ahead of time (e.g., materials to gather/prepare, activity sheets, student E-sheets).

- 1) One big dice with clear plastic pockets on each side, that allow changing the side number by inserting prepared cards with numbers.
- 2) Set inserts for the pockets with numbers 1 through 6.
- 3) Additional set with numbers 1 through 3, and last set with numbers 1 and 2.
- 4) Puzzle made from a picture cut on 9 pieces.
- 5) Lego constructor blocks: 10 pieces of 5 colors, two of each. Each student gets a brown bag with identical set of logo pieces.

Websites: Are there any that are central to the lesson?

Motivation: Can you suggest a short activity/discussion to elicit students' thinking about the ideas behind the lesson, to determine any misconceptions, or to explicitly create a sense of purpose for the entire lesson?

Student will be introduced to the idea that statistical data analysis can have an acceptable level of error. There is some percentage of experimental data that can be attributed to chance and may not reflect actual recorded data.

Lesson Description

Puzzle example: Ask Students to determine the probability that a piece of a puzzle taken from a pile that contains 9 pieces will be an outer corner piece. Repeat question substituting the object pieces as a central piece and again as the outer sidepieces. Explain to students how these probabilities could be calculated.

Dice example:

- 1) Insert number 1 through 6 in the pockets of the dice and ask students to calculate possible outcome for any number.
- 2) Change numbers 4, 5, and 6 with the second set of 1, 2 and 3. Now numbers 1, 2, and 3 appear on the dice twice. Ask students to calculate possible outcome for any of these 3 numbers.
- 3) Change the numbers on the dice so that die has number 1 on 3 sides and number 2 on the other 3 sides. Ask students to predict outcome for any of these 2 numbers.

Lego example:

- 1) Students are given a pre-prepared brown bag that has 10 Lego pieces.
- 2) Each bag will have 2 pieces in each of 5 colors.
- 3) Students are asked to find the probability that the first piece of Lego taken out of the brown bag will be red.
- 4) After students calculate the probability, each of them should take out one piece and verify the color.
- 5) Students should leave this piece on the table.
- 6) Ask students to calculate the probability that the second piece they withdraw will be red.
- 7) Have the student explain why there are two correct answers to this question.

Assessment: Suggestions for assessing student learning?

Students will be asked to determine what is the probability of drawing a red Lego piece from the imaginary set of 100, that has only 1 red piece. Repeat the same example for 5, 10 and 95 pieces. This helps students to link fractional probability values to percents and p value in following lessons on hypothesis testing.

Extensions: Ideas for further exploration?