Title: Understanding the Odds: The Relationship Between Statistics and Gambling
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Purpose: A mini lesson designed to introduce teacher candidates to the statistics involved with different games and gambling, and how they can use these types of games in inquiry-based activities throughout the secondary mathematics curriculum.

Materials:

- "Understanding the Odds: The Relationships Between Statistics and Gambling" Slideshow
- 1 pair of large, foam dice
- Circus music (https://www.free-stock-music.com/alexander-nakarada-circus-theme-ragtime-version.html)
- 3 baskets
- tokens (2 each + some in the bank)
- Google forms (https://forms.gle/qVmd4jzH6jaazQzbA)
- dice (2 per participant)
- Plastic Sandwich bags
- Laptops/Cell phones (internet access for Google form, google dice) (1 per participant)
- Google dice (https://www.google.com/search?q=dice&rlz=1C1CHBF_enCA876CA876&oq=dice+&aqs=chrome.0.69i59j0i67i650j46i175i199i512j0i433i512l2j0i131i433i650j0i433i512j69i60.771j0j7&sourceid=chrome&ie=UTF-8)
- Number Chart (1 per participant)

Activity

1) Hook: Over Under (5 min)
    - set up: place a basket for tokens at the front of the room, and 1 at each side of the room (empty) (3 total). Have one instructor hand out 2 tokens to each student. Put the signs "over" and "under" on the side walls by the baskets, and the sign "seven" on the front wall. Instructors will hold large foam dice. Have students remain seated while instructors explain rules.
    - Over-under rules: The object of the game is to correctly guess whether the dice will roll a total that is either less than 7, greater than 7, or equal to 7. You can bet a single coin on one of the three possibilities. If your guess was correct, you can double or even quadruple your original bet!
        - If the sum of the two dice is less than 7 – rewards are 1:1

        - If the sum of the two dice is greater than 7 – rewards are 1:1
        - If the sum of the two dice is equal to 7 – rewards are 4:1
    - activity: students will place bets by moving to stand by one of the signs: “over”, “under” or “seven”. Instructors will give foam dice to two students to roll (one from over, one from under), students will roll, then students will take/return the tokens accordingly. Play 3 rounds.
    - wrap up: ask the question “Who here thinks they have the most money?” polling the class to see who did the best. Bring up the point that we, the house, won the most money.
2) Experimental Classwide Over-Under (3 minutes)
    - Set up: Give each table a plastic sandwich bag containing 1 number chart/person, and 2 dice/person. Set-up the histogram on the main projector. Have students connect to the google forum. Load the circus music to play while the activity is going on.
    - instructions: The goal is to figure out which number is most probable to be rolled. Explain that students will be rolling dice and entering their responses on their personal devices, and that the classes collective results will be displayed in live time on the board. Encourage students to do as many individual trials as possible.
    - Activity: Play the circus music. Students will roll dice and enter responses for 2 minutes.
3) Compare Experimental vs. Theoretical Over-Under (2 min)
    - Set up: Pull the slideshow to be half of the screen, and the results of the experimental classwide over-under (a histogram) on the other half of the screen.
    - Activity: What’s the most probable number? Seven! Does our experimental match our theoretical?
    - Explanation for theoretical: there are 36 total possibilities to roll. 6/36=1/6 are rolling a 7, and so forth with the other probabilities of rolling each number 2, 3, …, 12.
4) Inquiry Over-Under (3 min)
    - Set-up: students will each need a number chart (given in the experimental classwide over-under) and a personal device to access google dice (type “dice” into the search browser).
    - Instructions: In table groups, students will decide collectively on a set of dice to use for this activity - for example, 2 6-faced die and 1 4-faced die. The group will form a hypothesis of which number is most probable to be rolled. Each student will roll the google dice on their own device and tally the results on their own number chart. At the end of the activity, students will compile their data (number charts) to find out which number was rolled most. Did their theoretical hypothesis match their experimental results?
    - The answer to any groups combination of dice: take the maximum roll and the minimum roll with the chosen dice and input into this expression to get the most probable number: [(max-min)/2] + min
        - if the number is a whole number, that is the most probable number
        - if the number is 3.5 (for example), the 2 most probable numbers are 3 and 4 (equally probable)

5) Conclusion (2 min)
    - These activities matter because…
      – As outlined by Wathall (2016), 3 strategies to captivate students are creating a social learning environment, using appropriate inquiry-based activities, and differentiating. These activities support the creation of a social learning environment as they give students the opportunity to collaborate and get creative, while further developing their mathematical fluency in the process. These activities can be delivered in an inquiry-based manner (as with our introduction of new dice), and therefore allow students to develop conceptual knowledge and apply that knowledge to new scenarios. Game-based statistics activities can be differentiated appropriately by allowing student choice (each student will naturally be interested in different games) and by introducing games of varying complexity.
      – Game-based statistical activities introduce students to where statistics apply in the real world, and have the potential to peak student interest as the activities are engaging and applicable to their daily lives.
      – There is a common notion that math is boring, but by introducing activities that incorporate collaboration, creativity, and real-world application in an engaging and up-beat manner, mathematics teachers can fight back against this notion to show students that math can be fun!
- What can teachers do in their own classrooms? Some ideas:
    - have students create their own games with accompanying statistics, and have a game night afterwards
    - teachers can provide games, students calculate the statistics
    - Students could research a game of their choosing and share the game and the accompanying statistics with the class
- What outcomes does this apply to?
    - The outcomes are outlined in a concept map. This illustrates that statistical games can be added to lessons in a variety of classes. The outcomes were accessed from the SK curriculum website (https://www.edonline.sk.ca/webapps/moe-curriculum-BB5f208b6da4613/) and are accurate as of March 27, 2023.
    - The outcomes are:
        - Mathematics 9
            > SP9.3 Demonstrate an understanding of the role of probability in society. ([C, CN, R, T])
        - Foundations of mathematics 20
            > FM20.1 Demonstrate understanding of the mathematics involved in an historical event or an area of interest. ([C, CN, ME, PS, R, T, V])
            > FM20.2 Demonstrate understanding of inductive and deductive reasoning including: analyzing conjectures, analyzing spatial puzzles and games, providing conjectures, solving problems. ([C, CN,PS, R, V])

> FM20.7 Demonstrate understanding of the interpretation of statistical data, including: confidence intervals, confidence levels, margin of error. ([C, CN, R])

- Foundations of mathematics 30

> FM30.2 Demonstrate understanding of inductive and deductive reasoning including: analysis of conditional statements, analysis of puzzles and games involving numerical and logical reasoning, making and justifying decisions, solving problems. ([C, CN, ME, PS, R])

> FM30.3 Demonstrate understanding of set theory and its applications. ([CN, PS, R, V])

> FM30.4 Extend understanding of odds and probability. ([C, CN, ME])

> FM30.5 Extend understanding of the probability of two events, including events that are: mutually exclusive, non-mutually exclusive, dependent, independent. ([CN, PS, R, V])

> FM30.8 Research and give a presentation of a current event or an area of interest that requires data collection and analysis. ([C, CN, ME, PS, R, T, V])

- Workplace and apprenticeship mathematics 10

> WA10.2 Analyze puzzles and games that involve spatial reasoning using problem solving strategies. ([C, CN, PS, R])

- Workplace and apprenticeship mathematics 20

> WA20.2 Demonstrate the ability to analyze puzzles and games that involve numerical reasoning and problem solving strategies. (C,CN,PS,R)

>WA20.11 Extend and apply understanding of representing data using graphs including: bar graphs, histograms, line graphs, circle graphs. (C, CN, PS, R, T, V)

- Workplace and apprenticeship mathematics 30

> WA30.1 Analyze puzzles and games that involve logical reasoning using problem-solving strategies. ([C, CN, PS, R])

> WA30.9 Extend and apply understanding of measures of central tendency to solve problems including: mean, median, mode, weighted mean, trimmed mean. ([C, CN, PS, R])

> WA30.11 Extend and apply understanding of probability. ([C, CN, PS, R])

References

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Circus music:
https://www.free-stock-music.com/alexander-nakarada-circus-theme-ragtime-version.html