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Hypothesis testing for a binomially-distributed random variable (Biostatistics)

- Opening: What is the binomial distribution?
    - **Open discussion:** What are examples of binomially-distributed random variables?
    - **Open discussion:** Suppose the probability of success is given by $p = 0.5$, can we calculate the likelihood of observing 8 successes out of 10 trials? What about the likelihood of observing 8 *or more* successes out of 10 trials?
    - **Open discussion:** If the probability of success is given by $p$, what is the likelihood of observing $x$ *or more* successes out of $n$ trials?
        - **Advantage:** Could help to get ideas from more people in the class, as the questions can be technically challenging for students with less mathematical backgrounds
        - **Pitfall:** Could require more scaffolding from the instructor to help students arrive at the correct answers
    - **Calling for Response:**
        - Helps kick off the class with student interaction and group discussion as an entire class; also establishes safe space for sharing all perspectives
        - Could require the instructor to give a few more concrete examples with made-up numbers to sufficiently illustrate how the equation and calculation works
- Middle: How do we test a null hypothesis for a random variable that is binomially-distributed?
    - **Individual writing:** What is the standard null hypothesis when conducting a statistical test on a binomially-distributed random variable?
    - **Individual writing:** Suppose that for a binomially distributed random variable X, we perform 10 trials and observe 7 successes. Is this enough evidence to reject the null hypothesis?
    - **Individual writing:** Suppose that for another binomially distributed random variable Y, we perform 100 trials and observe 70 successes. Is this enough evidence to reject the null hypothesis?
    - **Individual writing:** Notice that the rate of success was the same for both X and Y. Why do you think that the results are different when we perform 100 trials instead of 10 trials?
        - **Advantage:** Students have a chance to individually work through the concepts previously introduced and practice doing the calculations for themselves

        - Last question gives students a chance to reflect internally on the intuitive workings of the mathematical concepts introduced in the lesson
        - **Pitfall:** Could again be difficult for some students to successfully answer questions by themselves if they find it challenging to grasp the technical aspects of the lesson
    - **Using the clock:**
        - Keeps the lesson plan on track in terms of time, and limits the amount of "wasted time" for students that are unable to solve the questions individually
        - Can budget time after individual writing for students to share amongst themselves, allowing students who could answer the questions to teach those who could not
- Close: How can we use the binomial distribution to conduct a statistical test on the results of a sexual selection experiment using guppies?
    - **Small groups:** Why is the binomial distribution appropriate for this experiment? Can you think of circumstances under which it wouldn't be appropriate?
    - **Small groups:** What is the null hypothesis for this experiment? What does the null hypothesis mean biologically?
    - **Small groups:** Conduct a statistical test on the data. What can we conclude from the results of the experiment?
        - **Advantage:** Students work together to think critically about a biological application of the statistical methods introduced
        - **Pitfall:** Students could collectively reach an incorrect conclusion if everyone is making the same mistakes with the mathematical calculation or using the incorrect null hypothesis