Date ________________________

In Class Activity

The Binomial Distribution

Group Member Names: ____

Part One – Introductory Scenario

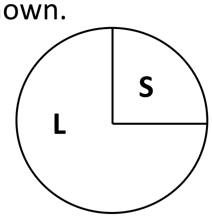
Perform a close reading of the following paragraph below:

> The retirement of baby boomer nurses will impact the nursing shortage, forcing hospitals to turn to new graduates to staff their beds and provide patient care. New nursing graduates are now the largest source of registered nurses available for recruitment in the nation, facing difficult psychological and intellectual challenges as they adapt to their new careers. Graduates face new emotional stressors, such as navigating a new environment and working overnight shifts, which contribute to increased turnover in the first year. New graduate nurses often lack the skills to transition quickly to the bedside role. They also are more likely to resign than experienced hires; **75%** of new graduate nurses leave their job within the first year, with estimated turnover cost per nurse of $22,420- $77,200 (Nursing Executive Center, 2005). In an effort to combat this high turnover, Nursing Residency Programs (NRPs) were designed to establish a smooth transition from student life into professional life.

[Welding NM (2011) Creating a nursing residency: decrease turnover and increase clinical competence. *Medsurg Nursing* **20**, 37–40]

Part Two – Conduct an Experiment to Collect Data

For this activity, you should have a paper plate and **at least ten** pieces of candy. Draw a right angle on your plate so that the vertex of the angle is in the center of the plate. Label the smaller sector of the plate **S**, for "stayed at the job," and label the larger sector **L**, for "left the job," as shown.



1. Drop one piece of candy on the plate. Where did it land? _______________

2. What is the probability that it lands in the "left the job" part of the plate?

   ____

   We will refer to one candy dropping on the plate as one ***trial***.

3. Individually, drop one candy, record its location ("Left" or "Stayed"), remove it from the plate, drop another candy, record its location, and continue this until you have dropped ten candies total and recorded their locations in the table below. (You can use an **L** or an **S** to indicate "left" or "stayed" respectively.) This simulates the hospital hiring 10 new nurses, and recording whether they had left or stayed after one year. We will refer to the set of ***10 trials*** as one ***experiment***.

Trial Number	1	2	3	4	5	6	7	8	9	10
Example	L	L	L	L	S	S	L	L	S	L
"Left" or "Stayed"										

4.

DEFINITION An experiment is said to be a **binomial experiment** if:

- The number of trials (n) is fixed.
- Each trial is independent.
  (The outcome of one trial will not affect the outcome of another.)
- Each trial represents only one of two outcomes: success or failure.
- The probability of success (p) is the same for each trial of the experiment.

Let's examine if this candy drop experiment meets the conditions of a binomial experiment.

a. Is the number of trials fixed? Why or why not? If so, what is the value of n?

b. Is each trial independent? Why or why not?

c. Does each trial result in one of two possible outcomes? Why or why not? If so, describe the two possible outcomes. Is it OK to label the outcome that a nurse left the job a "success"?

d. Is the probability of "success" ("left the job", in this case) the same for each trial? Why or why not? If so, what value is p?

5. Look at your table (from number 3) that recorded the candy drops. Define the random variable ***X*** as **the number of nurses that left the job (L)**. What your value for X for that experiment? ______

6. Each person in your group did this experiment, which simulates several hospitals each hiring 10 nurses and seeing how many left. We will assume that each hospital's attrition is independent of one another, and that the nurses' decisions to leave or stay are also made independently.
   Did all the members of your group get the same value for X? _________________Why or why not?

7.

> **DEFINITION**
> If ***X*** counts the **number of "successes"** (as defined by the researcher) in a binomial experiment, then ***X*** is a **binomial random variable**.

For our example, is *X* a binomial random variable? ____________________Explain.

8. What are *all* of the possible values for *X* in this experiment?

____

9. What value of *X* has the highest probability? ______________ Why?

10. Repeat *three more times* your experiment of dropping 10 candies on the plate and recording whether the candy landed in the "Left" or "Stayed" part. This should give you a total of 4 repetitions of the experiment – that is, 4 hospitals. Since you have already completed Experiment 1, just copy the results for that first hospital (from number 3 on page 34) in the table below. Then, record the outcomes for repetitions 2 through 4 of the experiment. At the end of each row, calculate the value of *X* (the number of times the candy dropped in the large part of the plate).

Trial Number	1	2	3	4	5	6	7	8	9	10	Value of *X*
Example	L	L	L	L	S	S	L	L	S	L	7
Experiment 1 (L or S)											
Experiment 2 (L or S)											
Experiment 3 (L or S)											
Experiment 4 (L or S)											

11. Each member of your group should have four values of *X* from the last column of the table on number 10. Tally up all the *X* values for your group in the corresponding column in the table below, and then total up the tallies and write the frequency for each value of *X* for your **GROUP**.

Possible Values of *X*	0	1	2	3	4	5	6	7	8	9	10
Tally (running count) for each value of *X* for your **GROUP**											
Frequency (total) for each value of *X* for your **GROUP**											

12. Now, combine your **GROUP** results (from number 11) with the other groups in the **CLASS**, copying from the table on the board. Record the data for the entire **CLASS** in the table below.

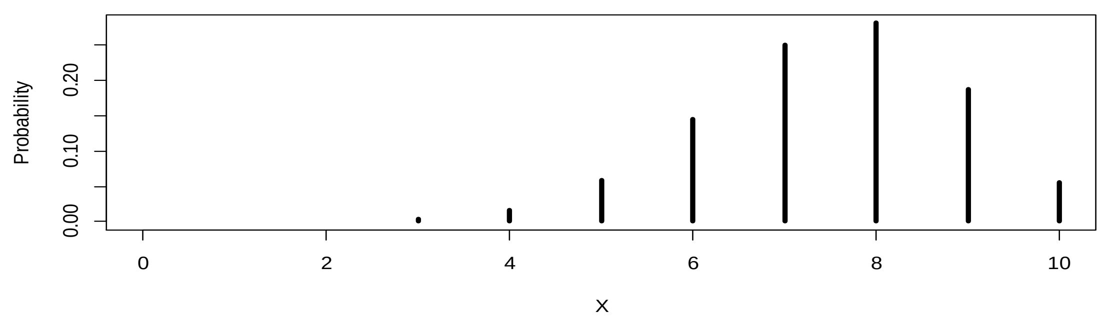
Possible Values of *X*	0	1	2	3	4	5	6	7	8	9	10
Frequency (total) for each value of *X* for the **CLASS**											
Relative Frequency (Probability) for each value of *X* for the **CLASS** (write as fraction and as decimal to 4 places)											

Part Three – Analyze the Data and Draw Conclusions

1. Here are the ***theoretical*** probability values for *X* in a table and in a graph. Notice that the height of the lines in the graph correspond to the probabilities of the different values of *X*. Compare these to the relative frequencies (from number 11) that you observed for the whole **CLASS**.

Values of *X*	0	1	2	3	4	5	6	7	8	9	10
Probabilities	.0000	.0000	.0004	.0031	.0162	.0584	*	.2503	.2816	.1877	.0563

**Note: The probability of getting 6 successes is omitted in the table because you will be asked to calculate it later.*



2. If you hired 10 nurses, what is a plausible number of nurses leaving in the first year? ___________
Explain your answer.

3. Using the theoretical chart (from number 1), calculate the following probabilities.
   a. The probability of exactly 6 nurses leaving after one year, which can be written as $P(X = 6)$ ___________________
   (Show your work)

   b. The probability of getting at most 6 nurses leaving after one year, which can be written as $P(X \leq 6)$ ___________________
   (Show your work)

   c. The probability of getting more than 6 nurses leaving after one year, which can be written as $P(X > 6)$ ___________________
   (Show your work)

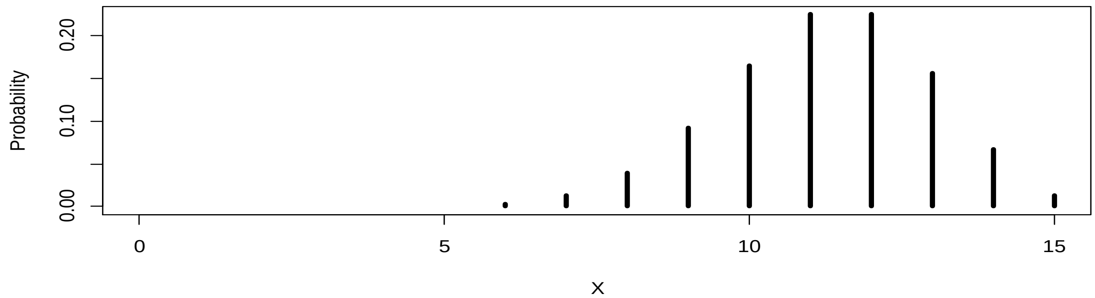
4. Suppose a larger hospital hired 15 nurses rather than 10. Would the number of nurses leaving after one year still be a binomial random variable? What value would *n* be, and what value would *p* be?

5. Suppose a hospital offers better perks and pay, and so is able to attract more experienced nurses, whose probability of leaving in the first year is lower – let's say that typically only 50% leave the first year. In this year, the hospital hired 10 new nurses. Would the number who leave within a year still be a binomial random variable? What value would *n* be, and what value would *p* be?

6. The following graphs show binomial distributions for different values of *n* and *p*. Which of them describes the situation in number 4, and which describes the situation in number 5?

(Hint: Notice the *x*-axis and think about the probability of success.)

Write the number beneath the letter of the graph choice. One graph will not be selected.

<table>
<tr><th>Graph Choice</th><th>Corresponding Graph of the Binomial Distribution</th></tr>
<tr><td>A
______</td><td>
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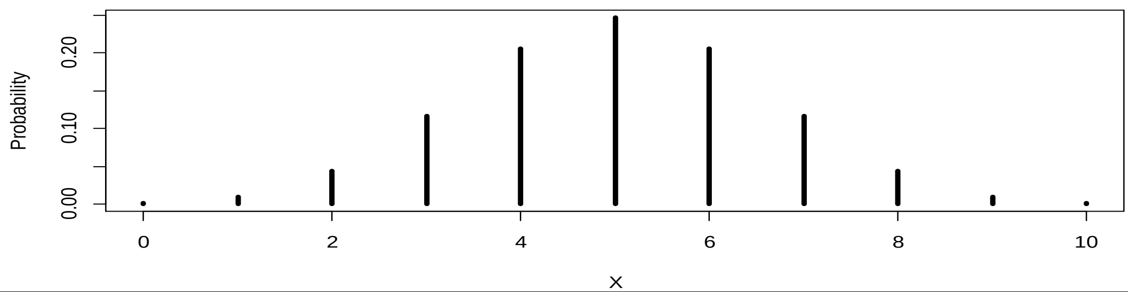
______</td><td>
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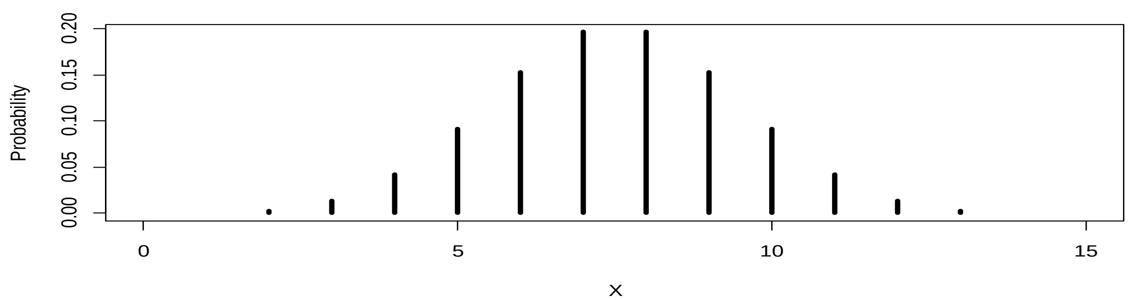
______</td><td>
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MAIN IDEAS: List the Main Ideas for Today's Lesson