This worksheet will be an introduction to statistics and will focus on probability.

Basic Probability

Probability is just a fancy ratio, with what you want to happen on top and the number of things that could happen on the bottom. $\frac{\#\text{ of favorable events}}{\#\text{ of possible events}}$

Its best described to students using an example of rolling a die, having a giant one in class is a bonus, since everyone will be able to see what's happening. Ask the students what is probability of rolling a 2 on a normal (1-6) and fair (not weighted) six-side die (like the giant one you are holding.) Start by reminding them that a probability is a ratio, which we know means a fraction, so we will need something to go on the top and something to go on the bottom. The number of ways that "what we want to happen" can happen goes on top, so in our example, how many ways can we roll a 2? One, of course! So we would write a 1 on the top of our fraction. The total possible ways the die can be rolled would go on the bottom, so in our example, how many possible ways could we have rolled the die? Since it is a six-sided die, the answer is 6. We would write 6 on the bottom and end up with a probability of $\frac{1}{6}$.

Remind students that a fraction can also be written as a decimal and a percent. Have students use the FDP chart to change $\frac{1}{6}$ into a decimal and a percent. Make the connection that if $\frac{1}{6}$ is the probability of rolling a 2 on a six-sided die, than you could also say that $.1\overline{6}$ or $16.\overline{6}\%$ is the probability of rolling a 2 on a six-sided die. This means that probabilities can be represented by fractions, decimals, and percents.

- Have them try this one on their own: what is the probability of rolling a number that is divisible by 3 on a normal six-sided die.

- 3 and 6 are both divisible by 3 so there are two possible ways that we can get what we want. There are 6 different ways that the die can land. $\frac{2}{6} \Rightarrow \frac{1}{3}$
- Again, have them find the decimal and percent.

Now, ask students if they think a probability could come out negative. They should be able to figure out that it would be impossible since we are talking about events happening and there can't be negative events! But what about one… can one be a probability? Poll the class and then prove to them why a probability can be one. What if we wanted to know the probability of rolling a 1, 2, 3, 4, 5, or 6 on a six-sided die? There are 6 ways for us to get what we want and 6 possible outcomes. $\frac{6}{6} = 1$ so one CAN be a probability. Also, point out that it's impossible to have a probability greater than 1. A probability of one means the thing that you want ALWAYS happens and you can't better than always. Poll the class again to see who thinks zero can be a probability. This one is a little easier for students to think about since they can think that there is one chance in something happening. They could ask for a motorcycle for their birthday but the probability of their parents actually buying the motorcycle is ZERO! Now prove it to them using our die-rolling example, ask them what is the probability of rolling a 7 on a normal six-sided die. Since there is not a 7 on a normal six-sided die we would put a 0 on top and 6 on the bottom. $\frac{0}{6} = 0$

Practice Probability Problems

- Could the probability of any given event occurring be any of the following numbers: 7, – 3, 0.48, $\frac{10}{2}$, 1, 1.593, – 1, $\frac{8}{9}$, 23%, 0, and 250%?
  - Make as many of these as you think are necessary.

Theoretical Probability

It sounds scary but it's not, deep breaths. With theoretical probability, you don't actually conduct an experiment, like physically rolling our giant die. Instead you just think. You use the knowledge you have about a situation and some logical reasoning to calculate the probability of an event happening. For example, let's say your church is having a raffle to raise money for a mission trip. You save up some money and you buy 4 raffle tickets. The day of the drawing you find out that there were 100 tickets sold. While we don't have all the tickets in front of us to actually run the experiment but we have enough knowledge to figure this out without it. We want one of our 4 tickets to be chosen, so that is 4 favorable events and there are 100 possible events. So the probability of you winning the raffle is

$\frac{4}{100} \Rightarrow \frac{1}{25}$ or $.04$ or 4% . Why do we even need theoretical probability… can't we just do experiments every time? Ask the students to see what they think. Sometimes its impossible to do an experiment, like when we are dealing with very small or very large things, or when it's not practical, like it would take millions of dollars to run the experiment.

Practice Theoretical Problem

- What is the theoretical probability of rolling a sum of 3 or 7 when rolling two fair six-sided dice?
    - Walk students through these steps.
        - We have to write out all the possible ways that the two dice can be rolled. Don't let students be lazy. They MUST write these all out. Talk about having an organized system to write out the possibilities so that they don't miss any.
            - The bold and double-boxed sets add up to 3 or 7.

Die 1	Die 2	Die 1	Die 2	Die 1	Die 2	Die 1	Die 2	Die 1	Die 2	Die 1	Die 2
1	1	**2**	**1**	3	1	4	1	5	1	**6**	**1**
1	**2**	2	2	3	2	4	2	**5**	**2**	6	2
1	3	2	3	3	3	**4**	**3**	5	3	6	3
1	4	2	4	**3**	**4**	4	4	5	4	6	4
1	5	**2**	**5**	3	5	4	5	5	5	6	5
1	**6**	2	6	3	6	4	6	5	6	6	6

  - Now figure out the theoretical probability. The total amount of possibilities is 36 different rolls. Eight of those rolls result in the sum of 3 or 7, which is what we cared about. So the answer is: $\frac{8}{36} \Rightarrow \frac{2 \bullet 2 \bullet 2}{2 \bullet 2 \bullet 3 \bullet 3} \Rightarrow \frac{2}{9}$

- Make as many of these as you need

Experimental Probability

This is the same idea as theoretical probability because we want to know the number of ways a thing occurs and divide it by the number of ways that thing could occur. But now we will be using the results from an experiment. For example, let's say we want to know the probability that a person prefers chocolate to vanilla. So let's do an experiment… have students vote for which like better and record the results. The answer will be the number of people who voted for chocolate over the total number of people who voted.

Practice Experimental Probability Problems

- Ethan rolls a fair, six-sided die twelve times and gets the following results on each roll: 1, 5, 3, 3, 6, 2, 4, 3, 1, 3, 1 and 2. Based on Ethan's rolls, what is the experimental probability of rolling a 3?
  - $\frac{4}{12} \Rightarrow \frac{1}{3}$

- What is the difference between the theoretical probability of rolling a 3 and Ethan's experimental probability?
  - The theoretical probability is what we expect to happen. In this case we expect a probability of $\frac{1}{6}$. As it turns out, the experimental probability from Ethan's experiment was $\frac{1}{3}$. The reason there is a difference between these two is because Ethan

only rolled his die 10 times. The more times he rolls the die the closer and closer he will get to the theoretical probability. To find the difference, subtract the theoretical probability and experimental probability.

- Make up more of these as needed.

Frequency

Frequency is a fancy of saying how often something happens. For example, if I were to ask the theoretical frequency of rolling a 2 on a six-side die, the answer would be once every six rolls. You're probably thinking that this is exactly the same thing as the theoretical probability of rolling 2 on a six-sided die and you are correct. Frequency and probability are the same thing. In your homework, write the frequency in words and probability as a fraction.