Data and Chance Course Syllabus

<table>
<tr><th colspan="2">Week 1</th></tr>
<tr><th colspan="2">Day 1 (Monday)</th></tr>
<tr><td>Honor Code, etc.
Venn Diagrams

Pre-Test

Basic Probability, Probability Definitions, and Sample Spaces</td><td>

Introduce Journals, first journal entry
Get to know you games.

Name Game(s)
Create Nametags (like the number line thing from NUMB class) and do introductions

Honor Code & Technology Use Policy
Venn Diagrams

Students write down three yes-no questions that they want to learn about their classmates.
Students in our class and INDE ask each other the yes-no questions
Students make a Venn Diagram, placing names of students into the circles.

Pre-Test
Rock-Paper-Scissors

Rock-Paper-Scissors cheering section game!
Cornell Notes on Basic Probability using Rock-Paper-Scissors as an example. How many different outcomes are possible in a round? (9: {RR, PP, SS, RP, PR, RS, SR, SP, PS}). Determine the probability of you winning, tying, or losing a round (1/3 in each case). May build interest by reading/listening to a story on the Rock Paper Scissors World Championships ($50,000 prize, story at http://www.npr.org/templates/story/story.php?storyId=6466928) Pairs play, recording outcomes, then compare their performance with the predicted probability.

Experiment
Event
Simple Event
Sample Space
Probability

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<tr><th colspan="2">Day 2 (Tuesday)</th></tr>
<tr><td>Theoretical Probability vs. Experimental Probability,

Law of Large Numbers

Introduction to Expected Value</td><td>

Journals

Rules for Rock-Paper-Scissors-Electricity posted on the board. Students play the game a few times to get the hand of it.
Students find the probability of winning Rock-Paper-Scissors-Electricity, decide what they should choose to play, Rock-Paper-Scissors or Rock-Paper-Scissors-Electricity if they want to win

Theoretical vs. Experimental Probabilities

Ask two volunteers to play a game of Rock-Paper-Scissors-Electricity until the winner is not the person who uses the best strategy/the strategy with the highest probability. “Student x played scissors and won. But scissors has the worst probability of winning. How is this possible?” Class discusses how a larger probability doesn’t guarantee an outcome.
Define Theoretical Probability and Experimental Probability in notes (Cornell Notes).
Look at example of flipping a coin. Flip a coin once, Flip a coin 10 times, Flip a coin 100 times, Flip a coin 1000 times (by adding the class results), etc. Compare Theoretical Probability to Experimental Probability.
Define Law of Large Numbers.

Finding Experimental Probability

Students find the experimental probability of a coin landing heads if it is spun on a table

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Week 1	
	○ Students find the experimental probability of the different ways the pigs in Pass the Pigs can land (the pigs are essentially loaded 6-sided dice). ○ Class discusses the uses/benefits of experimental probability. • Game of Chance 1 → Is it fair or not? Explain (THINK, PAIR, SHARE) ○ Before students play the game they decide choose which player they want to be and then explain, in their journal, why they want to be that player. ○ Class discussion/review class norms (and sentence starters) about class discussions. ○ Play the game multiple times ○ Class shares results, records data ○ Class discussion: Did actually playing the game change your mind about which player you want to be? Why or why not? ○ Students answer: Do you think this is a "fair" game? Why or why not?
Day 3 (Wednesday)	
Tree Diagrams Fundamental Counting Principle Permutations and Combinations	• Journals ○ Using experimental probability to check if dice are fair • Mini lesson on tree diagrams. ○ Students take Cornell Notes. Use the Rock-Paper-Scissors and Rock-Paper-Scissors-Electricity as examples. ○ Practice problems: Differentiate by giving advanced students the "Dressing for the Job" worksheet and the rest "Choosing CTY" • Fundamental Counting Principle ○ Challenge students to make a massive tree diagram (liscense plate problem). Ask: How much space do you think you need to make this tree diagram? ○ Define Fundamental Counting Principle (mn Rule) in notes ○ Mini lesson on factorials and white board problems for practice/check for understanding • Permutations ○ Permutation intro activity: divide into groups of 4 (3 or 5 is okay, but the resulting # of permutations could be too easy or difficult to figure out), and determine how many different ways there are for them to stand in line. This can be moved before the work time if students need a break from sitting earlier. Debrief: what were your strategies, your answer if any, and does this have anything to do with the FCP? ○ Repeat, but with 4 students chosen from a group of 5. How was this different? The same? Relate to FCP explicitly. ○ Notes on permutations, including how to use permutations to calculate probabilities (what is the probability of a specific order of people in line?, what is the probability that George is first in line?, etc.) • Combinations ○ Combinations intro activity: Divide into groups of 5 (3 is okay, but the resulting # of permutations could be too easy to figure out; 4 is okay). Groups determine how many different ways there are for them to form a team for 3-on-3 basketball (assuming no one is assigned to any given position). Debrief: what were your strategies, your answer if any, and does this have anything to do with the FCP? How is it the same as when we found permutations of ways to stand in a line yesterday? How is it different? Focus on the difference that *order matters for permutations* but *order doesn't matter for combinations.* How could we make this into a permutations problem? (Assign each player to a position.) Given a # of people to choose out of a total # of people, will there be more combinations or more permutations? (Can you find an exception to this? If we choose 1 person out of 1 person total, there is one combination and one permutation that satisfy this.)

Week 1	
Day 4 (Thursday)	

Permutations and Combinations.
 	
Expected Values
 	
Monty Hall Problem
	• Journals
	  o Handshake Problem
	  o Counting the University of Oregon Football Team Uniform Combinations (mn Rule)
	• Around the World Combination and Permutation Practice Problems
	  o Multiple combination and permutation problems are lined up around the outside of the room. Students choose where to start, solve that problem. The answer to the first problem sends them to a second problem. This pattern repeats with the instructor and TA checking students' work every four problems.
	• Notes on Expected Values
	• Monty Hall Problem
	  o Introduce Monty Hall Problem by showing a clip of "Let's Make a Deal" (https://www.youtube.com/watch?v=sZCpXz9tk_o).
	  o Describe the actual rules of the problem, demonstrate a game, and have students write their initial reaction on a notecard. Students discus what they think with a partner.
	  o Students use solo cups, 2 Pass the Pigs, and a toy car to find the experimental probability of winning when switching and the experimental probability when staying
	  o Class discusses which choice is best, have discussion of theoretical probability of winning

Day 5 (Friday)	

Expected Value
 	
Law of Large Numbers
	• Journal
	  o Find an expected value
	  o What is the expected value of a fair game
	  o Change the game so it is fair
	• Deal or No Deal
	  o Show parts of "Deal or No Deal" gameshow on YouTube (http://www.youtube.com/watch?v=QO_gpyrI0lc)
	  o Ask: "Should the contestant make the deal with the banker? Why or why not?" (lead students to the Expected Value argument and finding the expected value)
	  o "What's the difference between playing Deal or No Deal vs. playing games in a casino?" (casino games are played again and again so the Law of Large Numbers is important, but Deal or No Deal is only one shot).
	• Dice Sum Game (Horse Race Game)
	  o *Why did some numbers come up more often than others? On each die each outcome has the same chance, so shouldn't the outcomes of our die be equally likely?* Discuss.
	  o Students have 3 min. to list all possible ways to get each outcome ((1,2) and (2,1) make 3, etc.)
	  o Share strategies. Mini-lesson on tree diagrams.
	  o Students complete tree diagram for sum-of-two-dice and compare the theoretical with experimental probabilities.
	• Addition Rule and Mutual Exclusive
	• Multiplication Rule and Independence
	  o Give two examples: Flipping 2 coins vs. drawing 2 cards (from a deck of two red and two black cards). Students find the probabilities involved in both situations then discuss with their elbow partners what's different about the two situations (dice are independent while the cards that are drawn without replacement are not).
	Notes on Multiplication Rule and Independence

Week 2	
Day 6 (Monday)	

Multiplication Rule
 	
Expected Value
 	
Casino Project
	• Journals
	  o Expected Value
	  o Multiplication Rule
	• Multiplication Rule Practice
	  o Students complete practice problem worksheet
	• Expected Value Practice
	  o Groups of students are given Games of Chance #3-10. Each group is asked to find the expected value for three of the games (and more if they have extra time). Each group is assigned their games based on their ability (differentiated, grouped homogenously).
	• Casino Project
	  o Students create a casino game where they are trying to win the most money possible (to do this they need to create a game that gives them the biggest advantage possible but where players win enough that they still want to play).
	  o Students must calculate the expected value of their game.

Day 7 (Tuesday)	

Casino Project
 	
Basic Statistics Vocabulary
	• Journals
	• Casino Project
	  o Students work on Casino Project
	• Casino Project Dry Runs
	  o Students play each other's casino games and provide constructive feedback
	  o Students make adjustments to their casino games based on feedback from their classmates
	• What Are Data?
	  o Ask: "What is statistics" (the study of data). "What are data?" (Information, with context)
	  o Show an example of data without labels to show the importance of context
	  o Notes on basic statistics terms
	  ▪ Experimental Unit
	  ▪ Variable

Day 8 (Wednesday)	

Casino Project	• Journal
	  o Math riddles and patterns
	• Casino Day!!!
	  o Students from other classes visit DACH and play our casino games.
	  o Students count their casino game profits and calculate the average profit they made per round

Day 9 (Thursday)	

Expected Value, Law of Large Numbers
 	
Categorical vs. Quantitative Data
	• Journals
	  o Many questions reviewing the casino project
	• Recap Casino Day
	  o Students create posters displaying their expected value calculations, their average winnings per round, the number of times their game was played, their total winnings, etc.

Week 2	
Categorical Data Displays (Bar Charts and Pie Charts)	○ Students share what they liked about the games other groups created and what they would have changed about their own games if they could do the project again. • In or Out (Categorical vs. Quantitative Data) ○ Two groups, one is "in" and one is "out". Instructor shows one example at a time. Students hold up cards indicating if they think the example is "in" or "out." After all students make their predictions then the instructor tells the class which group the example belongs to. Students use the similarities and difference between the examples to explore the differences and similarities between the groups. ○ Play two practice games first (2 legs and 4 legs, and wings vs. no wings) the play categorical vs. quantitative data. ○ Notes on categorical and quantitative data • Displaying Categorical Data ○ Students finish bar charts or pie charts to graph the distribution of the different pieces in Chex Mix or colors of skittles
Day 10 (Friday)	
Birthday Problem (using the complement to find a probability) Categorical Data Displays Misleading Graphs Histograms	• Journals ○ Article on Harvard Reunion ○ Birthday problem • Chex Mix and Skittle Bar Graphs ○ Students finish bar charts or pie charts to graph the distribution of the different pieces in Chex Mix or colors of skittles ○ Gallery Walk: Students' charts are posted around the room. Pairs of students go to each chart and discus one thing they like about the chart and one think that they think can be done to improve the chart. They write down their suggestions on chart paper and move to the next graph. Class discusses what makes a good display of categorical data • Battery Choice Activity ○ Groups of students are given different bar charts that they are supposed to use to decide on one of four batteries to purchase (the bar charts display the battery life). Each of the different bar charts is misleading in a different way (all use the same data). ○ Ask students what battery they would choose – hopefully different groups will choose different answers because of the charts ○ Jigsaw – have students form new groups where every group has at least one person with every type of misleading chart. Each person acts as an "expert" and describes his/her misleading chart and why it's misleading • Mislead Graphs (Real World Examples) ○ Discuss real examples of misleading graphs. Ask students to explain what is misleading about each. • Animated Movie Project ○ Students create misleading graphs using data about the amount of alcohol and tobacco use in animated films. • Histograms ○ Have students create a bar chart from Murder Rate data and show that quantitative data doesn't pile up nicely making it necessary to group values into bins. ○ Notes on histograms, using Murder Rate data as an example

Week 3	
Day 11 (Monday)	

Misleading Statistics
 	
Histograms
 	
Stem Plots
 	
Spread
 	
How spread affects mean and median
	• Journals
	  o Misleading Statistics
	• Review Histograms
	• Stem and Leaf Plots
	  o Take notes with Murder Rate as the example
	  o Students complete the super hero move example
	  o Students figure out how to split stems and deal with other variations of stem-and-leaf plots by working in small groups on example problems
	• Spread
	  o Number of Modes
	  o Symmetric vs. Skewed (right and left) – direction is toward the tail
	  o Outliers
	• Mean and Median with Skew and Outliers
	  o Jigsaw Activity where groups work on either Part I (symmetric, no outliers), Part II (symmetric, one outlier), or Part III (skewed) of the activity. Each person creates a histogram or stem plot of their data sets and finds the mean and median. After they complete their worksheet in small groups they split up and form new groups where each group has one member from groups I, II and III.
	  o New groups compare answers, paying special attention to how symmetric, skewed and data with and without outliers change affect the mean and median.
	  o Class discussion
	  o White board examples to practice and check for understanding.

Day 12 (Tuesday)	

Mean, Median, Mode
 	
Scatterplots, Association Between Two Quantitative Variables
 	
Correlation
	• Journals
	  o Find missing values in a data set when given the mean, median, and mode.
	• Scatterplots, Relationship between two Quantitative Variables
	  o Check students' confidence with scatterplots. If necessary teach a mini-lesson on scatterplots.
	  o Show many examples of scatterplots with different data and ask students to describe the relationship between the variables in the example scatter plots. Make sure they hit all 4 key points and take notes
	  ▪ Form
	  ▪ Direction
	  ▪ Strength
	  ▪ Outliers
	  o Ask students what they think "correlation" means (they will likely describe association not correlation). Define correlation in the notes and have a discussion about the difference between association and correlation.
	• Guessing Correlations
	  o Using a computer lab, have students go to web applets where they guess correlations after looking at scatterplots
	  ▪ http://www.stat.tamu.edu/~west/ph/coreye.html (can add and remove points, but requires JAVA)
	  ▪ http://www.rossmanchance.com/applets/GuessCorrelation.html (like the first but without the ability to add or remove points, does not require JAVA)
	  ▪ http://higheredbcs.wiley.com/legacy/college/mann/0470444665/applets/applet_14_v6.html (multiple choice)

Week 3	
	○ Discuss what students learned using the applets and record key points learned about correlation by guessing in notes ○ Draw a curve in the first applet and ask students to guess at the correlation (they will guess lower than it is). Emphasize that correlation is a measure of the *linear* relationship and not any other kind of relationship • Correlation is not Causation ○ Show Spurious Correlations at http://www.tylervigen.com/spurious-correlations and discuss ○ Lurking Variables ▪ Ice cream sales and crime rate ▪ Number of Firemen at fires
Day 13 (Wednesday)	
Scatterplots, Association Between Two Quantitative Variables, Correlation. Correlation is not Causation. Fundamental Principles of Experimental Design Experiments vs. Observational Studies	• Journals ○ Draw scatterplots to match given correlations ○ Examples where correlation is not equal to causation (students should be able to recognize this, they are free to speculate as to what the lurking variables might be). • Airplane Design School (continued) ○ After students present their airplane design to the class each student throws their airplane once to see whose flies the furthest. ○ Ask: "Did we figure out anything about designing the best airplane today?" If students answer "yes" keep providing other reasons why the planes that did well flew further. ○ Ask: "What do we have to do to test the individual design elements" (Lead discussion into controls) • Notes on Experiments and Observational Studies ○ Controls ○ Random Assignment of Experimental Units to Treatment Groups ○ Replication (within an experiment) ○ Replication (of an experiment) • Visit BSEN class and participate in studies ○ Determine what the other classes' treatments, controls, and if they are conducting an experiment or an observational study.
Day 14 (Thursday)	
Experiments vs. Observational Studies Linear Models Regression Post-Test	• Journals ○ Students identify the treatments and controls in various studies. ○ Students determine if the study is an experiment or an observational study based on ○ Students decide if causal statements about the results of the study are appropriate based on the design of the study • Linear Models/Regression ○ Ask: "What is a model? (a simpler version of the real thing). Ask: "Why do we use models" (because they are simpler and we can actually work with them when the real thing is much too complicated). ○ Linear Model Notes ▪ Example from SAT Question and # of Words ▪ Show students how to use the TI-83 or TI-84 calculator to create a scatterplot and find the regression line ▪ Use regression line to make predictions ▪ Don't extrapolate • Scoot – Regression Practice

Week 3	
	○ Regression practice problems are placed around the room. Students choose which problem they would like to start with, solve that problem, and then "scoot" on down to the next problem. ○ Each problem asks students to ▪ determine if a linear model is appropriate, ▪ find the regression equation ▪ make two predictions ▪ decide if making a prediction for an x value is appropriate (based on where the x-value falls in the range of the data) • Post-Test
Day 15 (Friday)	
	• Journal ○ Write a letter to instructor and TA ○ What did you learn? • Instructor's Evaluation • Scoot – Regression Practice (continued) • Closing Ceremony • Parent Conferences