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| **TEAM Lesson Plan Template** |
| Teacher: Dr. Jeremy Entner |
| Subject/Grade: Probability and Statistics / 8th Grade / High School |
| Lesson Title: CUTIT/GRAPHIT/SORTIT |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| **SMP3**. Construct viable arguments and critique the reasoning of others.**SMP5**. Use appropriate tools strategically. (A histogram is a tool for this lesson). **SMP7**. Look for and make use of structure. (Students look for similarity among histograms). **7.SP.D.8** Summarize numerical data sets in relation to their context. a. Give quantitative measures of center (median and/or mean) and variability (range and/or interquartile range), as well as describe any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. b. Know and relate the choice of measures of center (median and/or mean)and variability (range and/or interquartile range) to the shape of the data distribution and the context in which the data were gathered **B.S.ID.B.2** Interpret and use data from tables, charts, and graphs. **S.ID.A.2** Understand histograms, parallel box plots, and scatterplots, and use them to display and compare data.  |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledgeStudent-Friendly (I Can Statement) |
| I can compare and classify data sets. I can compute the frequency with which an item appears in a data set. I can construct a histogram and a frequency histogram.  |
| **MATERIALS AND RESOURCES**  | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook.  |
| **Activities & Materials** Yogurt cups; Lids; Pens / Pencils; Number sheet handouts; Worksheet handouts; Scissors; projector, graphing/statistics calculator or computer.Desmos online calculator: <https://www.desmos.com/calculator>Desmos histogram creator: <https://www.desmos.com/calculator/lcnnbqh0nc>Dr. Entner’s video, for teachers, not students: <https://www.youtube.com/watch?v=_qkPm8sM4ww>**What if the technology is not working?** Most of Activity 1 does not require much computation. It calls for cutting up a piece of paper and manually constructing a histogram. Activities 2&3 requires photocopies at some point before the activity, but no technology during the exercise. **Routine for distributing materials.** Place materials at a center and have students rotate to it.Activity 1 must happen before Activities 2 and 3, so a round robin format will not work.  |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners** **Differentiation****----- Content** In Activity 1**, i**t is easier to make a histogram for some sets of numbers than for others. For example, Inti is fairly complicated, and Aegir and Aesir are less complicated than Inti. Juno is straightforward, and Vesta, with only two values in the data set, is quite easy to work with. It may make sense to choose an appropriate data set for some students. **----- Process** Most students will make a histogram by hand on a worksheet, but some students may enter their values in a calculator or computer instead. Each data set needs a histogram at the same scale/number of bins for Activity 2, but the teacher can produce that one if a student needs to use technology for Activity 1.  **-----Product** Some students will calculate actual ranges, standard deviations, and other 1-variable statistics for their data set (using a calculator). It is also worthwhile to discuss the data sets qualitatively, e.g. “this one looks more spread out.” **----- Tiered Assignments ----- Flexible Grouping****----- Learning Centers \_\_\_\_ Other \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_****Accommodations****\_\_\_ Preferential Seating \_\_\_ Extended Time \_\_\_ Small Group \_\_\_ Peer Tutoring** **\_\_\_ Modified Assignments \_\_\_ Other** **Early Finishers:** |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Describe the etymology of the word “histogram.” The name “histogram” came about in the late 1800s in the style of the word “telegram.” The electric telegraph was invented in the early/mid 1800s, and the “-gram” suffix for something written must have caught on. “Histogram” comes from the Greek word “histos” meaning “mast” and the English suffix “-gram” meaning written (or recorded) thing. Ultimately “-gram” comes from the Greek word “graphein,” meaning write. Draw a ship  then erase everything but the masts  . It is a histogram!“Thing written in masts.” |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n** We have looked at measures of the center (means and medians) of data sets, and we have talked about measures of variability (range and interquartile range). With the next several activities we are going to create some graphs, called histograms, of some data sets. We will work together to examine a lot of data sets. We will look for similarities and differences among these data sets in terms of their centers and variability. **Motivating Students** \_x\_ Verbal Reinforcement **Presenting Instructional Content** \_x\_ Hands-On. Students will cut number sheets, prepare histograms, and analyze data sets.  \_x\_ Work Examples. Activity 1 will begin with an example to show students how to complete a histogram and a cumulative distribution function on a worksheet. \_x\_ Discussion. Activity 2 is a group discussion about sorting histograms. ***Instructional strategies:***There are three connected activities. The description below calls them Activity 1, Activity 2, and Activity 3. These probably do not occur in one day. Before Activity 1, work an example to show all students how to cut a number sheet, record a number on the histogram, fold the paper the number is on, and put the number in the yogurt cup. Pay particular attention to the scale on the horizontal axis. There are separate bins for “1” and “1.5,” for example. Also show how to compute the cumulative distribution function using the Proportion scale on the worksheet. **Modeling and Guided Practice** **Activity 1**. Prepare a center with number sheets, worksheets, scissors, yogurt cups, lids, a marker, calculators, and pencils. Students may work at their own pace to do the following:1. Select a number sheet and get a worksheet. On the worksheet, write the student’s name and the name of the data set from the number sheet in the blanks provided.
2. Get a yogurt cup and write the name of the data set on the bottom.
3. Cut the number sheet so that each number is on a separate slip of paper. Each student should take care not to mix their numbers with those of another student.
4. After all cutting is done, begin work on the histogram using the grid on the worksheet. For now, ignore the scale labeled “Proportion” on the left hand side of the grid. Just use the “Frequency” scale on the right hand side.
5. Pick up one of the number slips and shade the corresponding spot on the histogram with the number. (If using a calculator, enter the number in the STAT table). Shade darkly. Fold the slip of paper and put it in the yogurt cup. Folding will help keep the slips from sticking together in the cup, and putting the number in the cup will keep it from being selected twice.
6. Continue the process in step 5 until all 60 numbers are recorded on the histogram. Put the lid on the yogurt cup. Store the yogurt cup for Activity 3.
7. Complete the table titled “PROPORTION LESS THAN OR EQUAL TO X” on the worksheet. Express answers to the thousandth’s place. Values will be zero for all numbers in the table less than the smallest number in the data set. Once reaching the smallest value in the data set, use the “PROPORTION” scale on the left of the grid. For example, using the Aegir data set, the proportion less than or equal to X is 0 from -10 to -6.5. At -6, there is one square filled in on the histogram. This is 1/60, or about 0.017, of the data set. Looking to the left, we see the value 0.017 on the proportion scale. There is no change at -5.5. Reaching -5, we have one more square on the histogram. We see the proportion for that one square is 0.017, and we add this value the previous value to get 0.033. There is no change at -4.5. Reaching -4, we get two new squares, and we add 0.033 for these two squares to the previous value of 0.033 to get 0.067. We continue in this way until reaching 6, at which point the proportion less than or equal to 6 is 1.000. Enter this value of 1.000 in all remaining blanks in the table.
8. Record the minimum and maximum values of the data set in the labeled boxes.
9. Visually determine the center of the data set. This is meant to be an estimate. Enter the value in the block labeled “Center” on the worksheet.
10. After finding the center, visually estimate the point halfway between the minimum value and the center. Record this value in the “Halfway from the Left Side” box. Note that this is an estimate of the first quartile, Q1.
11. Visually estimate the point halfway between the center and the maximum value. Record this value in the “Halfway from the Right Side” box. Note that this is an estimate of the third quartile, Q3.
12. Find the mean, median, and range of the data set and record these in the labeled boxes. If using a TI calculator, simply find the 1-Var Stats to get all of these numbers except the variance. For the variance, square the standard deviation (or use [CATALOG] [V] variance(L1) ).
13. Compare the computed values to the visually estimated values.
14. Identify the data set as “symmetric,” “bell shaped,” etc. Circle all that apply.

 **Activity 2**. Make copies of the histograms prepared by students during Activity 1. If students from multiple classes/sections have prepared histograms, collect them ALL. The more you have, the better Activity 2 works. (Alternatively, use the images provided on the even numbered pages of the file NUMBERSHEETSGROUPED.pdf. ). Prepare a center with a copy of each of the histograms. Students should work together in a group of 4 or 5 to sort the histograms into groups based on the shape of the histogram. For example, Aegir and Aesir look a lot alike. Amun and Anubis look different from those, but look like each other. Do not tell the students these examples or what to look for, just ask them questions like the following, and encourage students to discuss. You might make a rule that each person must pick up a histogram and say “I think this one belongs with \_\_\_\_\_ because \_\_\_\_\_ .” Achieve some type of agreement on the groups.Do some of these look like the others? Which ones? Group them as best you can. Are there some that don’t really fit with anything else? We are grouping by looks!Can you give the groups names? (*Group 1, Group 2, etc)*  How many different groups did you make? Do they all look exactly the same within a group? Are there some that are almost the same? What should they be called? Approximate? Inside a group of histograms: How are they similar? What makes them different? Can you turn one into another? If you add a number to everything in the bucket (which we are remembering, not using, for this activity), does that change one into another? If you multiply, does that change one into another? Which ones can be grouped like that? How do the means compare within a group? How do the standard deviations compare within a group? How do the proportions at the bottom of the worksheets compare within a group? Are they the same, just shifted around a bit? Are they almost the same? If you were going to reach into a bucket and pull out a single slip of paper, which bucket would give the best chance of getting a \_\_\_\_\_\_\_ ? ( *put a number in the blank* ) Is there only one bucket which will give this best chance? How did you decide which bucket would be best? Which bucket gives the best chance of selecting a number less than \_\_\_\_\_\_ ? ( *notice that the cumulative distribution function is helpful to answer this question – we look for a large cumulative value* ) How did you decide which bucket would be best?Which bucket gives the best chance of selecting a number greater than \_\_\_\_\_\_ ? ( *notice that the cumulative distribution function is helpful to answer this question – we look for a small cumulative value* ) How did you decide which bucket would be best?Which bucket gives the best chance of selecting a number between \_\_\_\_\_ and \_\_\_\_\_\_ ? ( *notice that the cumulative distribution function is helpful to answer this question – we look for a large difference between two cumulative values* ) How did you decide which bucket would be best?**Activity 3**. (Students may work in pairs or in groups of up to five students.) Each group will need a pencil, a calculator, a blank copy of the Sample Worksheet, a copy of a histogram from Activity 1, and the yogurt cup from Activity 1 with the same name as the histogram. One student is designated as the recorder and gets the Sample Worksheet. The other students in the group are Samplers. Do not write anything new on the completed worksheet from Activity 1. Write the name from the bottom of the yogurt cup on the Sample Worksheet. Write students’ names on the Sample Worksheet. Remove the bucket lid. The Samplers pass the yogurt cup, taking turns as follows: 1. Reach in the cup and pull out a slip of paper.
2. Read the number on the paper, then re-fold the slip of paper.
3. Watch the recorder record the correct number on the Sample Worksheet histogram.
4. Put the slip of paper back in the yogurt cup.
5. Stir the paper in the bucket or cover the top and shake the cup.
6. Pass the cup to the next Sampler who starts over at step 1.

At any point, ask, * Is the observed number a number you expected to see? Why? Is it very common in the bucket?
* Does the histogram that you are producing by sampling look like the one we made in part 1? Exactly? Close?

The teacher must monitor the groups’ work for Activity 3. The students need to stop sampling the numbers before bins in their sample histogram run off the top of the sheet. On the other hand, they must sample enough so that their sample histogram resembles the original histogram. Depending on the data set, this can happen quickly (should be quick for Vesta or Vulcan) or not (probably takes a while for Inti). Once the teacher decides that there is sufficient resemblance between the sample histogram and the original histogram, have students stop sampling and put the lid on. Have the group count the total number of numbers that they sampled (the total number of squares filled in on the sample histogram). Have the group compare their sample histogram and the original. Then have each group show their two histograms to the rest of the class. Ask the following: * Is the mixing/shaking very important for this process?
* What have we found out about this sampling process? Eventually, do the samples look similar to the original?
* Why doesn’t the sample worksheet grid have the proportions listed down the left hand side? ( *The proportions will depend on the number of times the group has to reach in the bucket. For the original, we knew in advance that there were 60 numbers, so one square was 1/60 of the set. For the sample, we do not know in advance what fraction of the set one square will be. ).*

Now each group should compute the values in the “SAMPLE PROPORTION LESS THAN OR EQUAL TO X” and the other statistics at the bottom of the worksheet, as well as circling the appropriate description(s) of the shape of the histogram. After they compute these, they should compare the numerical results to the original. Ask the following:* How do the fractions (decimals) compare? Are they exact? Are they similar? Do they follow the same pattern?
* Are the mean, standard deviation, and other statistics the same? Are they close?

**Check for Understanding (CFU) –** ***What am I doing for students that progress at different rates?*** ***What do I do if they get it?*** ***What do I do if they don’t get it?***  |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning** The questions listed in the Activities generally fall in the Comprehension through Analysis categories. Here are a few additional questions to assess knowledge and to help encourage students to proceed. **Knowledge:**How many times does the number \_\_\_ appear in your (data set) (sample)? What is the largest number in your (data set) (sample)? How many groups of histograms did your group of students make? **Comprehension:** **Application:****Analysis:** **Synthesis:****Evaluation:** **Thinking**  \_\_ **Practical** –While these are canned data sets, in Activity 3 students experience an actual sampling process. \_\_ **Creative**– Students are asked to name the groups of histograms. They are also asked to find ways to transform one data set into another. \_\_ **Analytical** – Students sort histograms into groups and compare statistics.  \_\_ **Research-based** – Students look at the data sets both visually with the histograms and analytically with the mean/standard deviation/etc. They distributions in these data sets are typical of distributions encountered in real life.**\*What am I going to do to give Ss opportunity to?** **1. Generate variety of ideas:** **2. Analyze problems from multiple viewpoints:** **Problem Solving *Note: Teach 2 or more types of problem solving (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)*** **\_x\_\_ Categorization** In Activity 2, students categorize histograms.**\_x\_ Drawing conclusions/Justifying Solutions** Students must explain why they group histograms as they do. Students are asked to discover the relationship between the sample and the population.  **\_x\_\_ Predicting Outcomes** Which yogurt cup gives the best chance of drawing a \_\_\_\_\_?**\_x\_\_ Observing and Experimenting** Activity 3 |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * How will you group students (homogeneously or heterogeneously)?
* Which group roles will you assign?
* How will each member know their expectations?
* How will you **seamlessly** transition to groups?
* What group product will they create/submit/present?
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| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction.  |
| ***Assessments:*** **\_x\_\_ Teacher Made Test** At a later date, exam questions can exhibit a data set and a histogram. Students are asked to create a histogram for the data set and then compare the two histograms. What is the range? Where is the center? Which exhibits the greatest variability?**\_x\_\_ Questions/Answers** Students will respond to questions throughout the activities. Their answers will indicate whether they understand.  |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| ***During the conclusion part of creating an effective lesson plan teachers must sum up the ideas learned from the lesson. A teacher should also relate this information to future and past coursework to provide students with a broad understanding of the ideas learned. It is important to allow students enough time to ask questions, assert assumptions, and summarize the lesson during this part of the lesson plan.**** ***Review/Summary:*** We have looked at several data sets. We used histograms to study them visually, and we used statistics to analyze the data sets. The shapes we saw are typical of those experienced when studying phenomena like athletic ability, grades, the size of plants of a certain species, and many other things. We have noticed that many of these data sets resemble one another. We calculated cumulative distribution functions and we saw how to use these functions to measure the likelihood of particular outcomes.
* ***Preview for next lesson: link what they did to day with where they are going next.***
* ***Upcoming assignments: remind them of any upcoming assignments.***

**Follow-up Activities/Extension** Give students Sample Worksheet and a yogurt cup with the name on the bottom covered. Make the original histograms available. Have them take a sample from the cup until they can predict the name on the bottom of the cup by comparing their sample histogram to the original histograms.***Reflection: You must reflect on every lesson you teach.*** |

**NOTES:**

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