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| **Lesson Title** | Statistics in water quality analysis |
| **Length of Lesson** | 50 minutes |
| **Created By** | Shane A. Irvin |
| **Subject** | Statistics |
| **Grade Level** | 10th-12th |
| **State Standards** | 5a |
| **DOK Level** | DOK 2 |
| **DOK Application** | Interpret, Make Observations, Graph, Organize |
| **National Standards** | Select and use appropriate statistical methods to analyze data |
| **Graduate Research Element** | In my research descriptive statistics are used to compare the collected turbidity and total suspended solids data to specific color bands or spectral values. |

**Student Learning Goal:**

Statistical analysis including mean, median, mode, histograms, and quartiles are used in most research to prove the success of data collection.  This proof allows scientist to essentially trust the research they are citing as valid and trustworthy.  The introduction of basic statistics is valuable to the future development of students.  The basic statistics that will be covered will be seen by the students throughout their development, thus establishing the learning goal.  The students will demonstrate the ability to understand the usage of basic descriptive statistics using real world applications

The students' ability to use statistics in a real world application will be tested by allowing them to statistically analyze collected data for values ranging from mean to standard deviation.  The students will then be required to provide a skew graph and describe what is represented by that graph.  The goal of the lesson is to teach the students about using statistics with real world samples and to see what natural events can affect those samples.  The lesson will also provide examples where the graph will be skewed right, left, and not skewed at all.

**Materials Needed (supplies, hand-outs, resources):**

Writing utensil, individual computers with excel, data sheets for statistical analysis, PowerPoint (explaining where data points are from and what skewness is), scratch paper.  The PowerPoint is attached along with data sheets used for this specific lesson.  The materials can be duplicated and changed if teacher does not want to use graduate students data.

**Lesson Performance Task/Assessment:**

The students will be requested to provide statistical analysis of a given dataset. They will represent their knowledge on the subject by providing answers in an in class discussion as well as proper analysis of given data. They will be asked specifics about the data including standard deviation and means of specific points. They will then be asked to find the frequency of a specific data set from the collected data. After drawing a histogram, skewness of the collected data will be requested from the students asking them what type of skew is occurring from selected data. The student will then be explained what caused the skewness to occur this way.

**Lesson Relevance to Performance Task and Students:**

The relevance to this lesson is directly based off of the current subject the students are studying. At this point in time in the school year, the students are in descriptive statistics. Instead of having them do problem sets out of the book, the teacher can provide a real world viewable example of the application of descriptive statistics from a close by water source.

**Anticipatory Set/Capture Interest:**

The teacher will capture the interest of the students by bring in samples of water that are cloudy and ask them if they would want to swim in this. Once the answer is provided to the teacher, then he/she will move forward by describing what data has been collected and needs to be analyzed. In the graduate student's case, the data is from his project, allowing him to describe what he does through the referenced PowerPoint presentation, showing examples of the creek and the captured samples from that creek. At this point in time the teacher will proceed to guided practice.

**Guided Practice:**

A collected data sheet (see attached) will be provided to the students. This data sheet will be explained to the students as their data set that needs to be statistically analyzed. The teacher will begin the provide PowerPoint presentation describing where the collected data, where it is from, why it is collected. The graduate student of this project will describe what happens when heavy rain occurs versus drought in the ecosystem. This will come into play later when the students create histograms with the given data set. The students will then go through a review of what they already know. What is mean? What is standard deviation? What does a histogram consist of? All of these answers will then lead into what they will do with the provided data.

**Independent Practice:**

The students will then, in groups at each table in the classroom (groups no bigger than 3) analyze the data for mean and standard deviation. The students will be required to graph this in excel to show the means with standard deviation. They will be asked to describe what this data means. What the standard deviation is telling them. Once the students have compiled this data, they will analyze the data for a median and a mode. After this analysis, the students will find the frequency of the data to form a histogram of the data. After this interpretation the students will be asked to explain why they believe the histogram is the way it is and they will apply skewness to the graphed data. Once the students have shown that they have completed the assignment the following questions will be asked:

**Why is the first histogram not statistically accurate?**
It's not statistically accurate because the class size does not account to the range. Let's consider the classes from 0-70 even if the majority of them are zero.

**What happens when we decrease the grouped data size (by 5)?**
If we decrease it by five we notice the skewness of the graph changing. Little alterations to your data set can really shine errors in assumptions of data during analysis.

**Are the samples skewed compared to the weather?**
Flow rate moves the sediment from the bottom of the stream creating a larger gradient increasing the turbidity of the creek. This makes the histogram negatively skewed.

**What would happen to the skewness of the graph if the samples were taken during a mixed wet and dry period?**
The histogram would potentially have bimodal properties.

**What does the histogram tell us about the sediment load?**
A positively skewed histogram means low sediment, negatively skewed histogram mean high sediment.

**What part of the creek is in worse condition?**
Using assumptions that flow rate and specific parameters are equal in all points of the stream, the worse point of the creek with this data set is point 5 near the bridge.

**Remediation and/or Enrichment:**

Remediation:
In situations that remediation is needed the student can see the instructor for one on one tutoring. The student can also be paired with a high performing student with full understanding of the lesson.

Enrichment/Extension:
In situations where there is full understanding, the lesson can extended by incorporating harder statistical analysis, including consideration of linear modeling with the found frequencies. The lesson can also be extended to incorporate other statistics values such as "z testing" and "t testing". All of these extensions depend on the students' ability and knowledge of the subject matter. Individual IEP's will be supported.

**Check(s) for Understanding:**

I will ask them to provide me with the answers to the questions in the independent practice section:

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**Closure:**

In closing, I will ask the students:

**How can this be applied to other sciences?**
Animal populations can be modeled; Test grades can be modeled, etc.

The teacher needs to make sure the students have a grasp on all that statistics can do, not just the information they read in a book.

**Possible Alternate Subject Integrations:**

Due to the broad range of statistics, this lesson can be incorporated in any class that teaches elementary descriptive statistics. Most high school, this class is taught in the mathematics department; therefore this is the reasoning for only stating this above as subject taught.

**Teacher Notes:**

Be prepared to individualize with the students. Some are going to work right through this while others will have trouble. If necessary let them try and guess what the histogram will look like before they actually start to analyze the data.