**Unit 5: Investigation 4 (4 Days)**

**Explorations of Data Sets**

***CCSS:*** 8-SP 1; S-ID6; S-ID 8

**Overview**

In this investigation, students will be collecting and analyzing in interdisciplinary activities. In this investigation, students will apply all of their knowledge from the previous two investigations. The role of the teacher is to get the class prepared and organized, and then will walk around to observe and ask questions. There are many activities to choose from, but it is important that you do **at most 4 days** of activities.

**Assessment Activities**

**Evidence of Success: What Will Students Be Able to Do?**

Students will be able to answer a question about the world that can be analyzed with bivariate data. For student generated data, the students will be able to use technology to calculate the regression equation and correlation coefficient. The students will be able to solve an equation for *y* given *x* and solve for *x* given *y*. They will be able to explain the meaning of slope and intercepts in context and distinguish between data that is correlated compared to casual.

**Assessment Strategies: How Will They Show What They Know?**

**Exit Slip 5.4** asks students to make a prediction based on the regression equation they have found for the ulna-height data collected in class.

**Journal Entry** asks students to describe the process of making a prediction based on a set of data that have been collected.

**Launch Notes**

All of these lessons include manipulative that should be displayed in the front of the class so as the students enter that ask “Are we doing something with those \_\_\_\_\_\_ today?”

**Closure Notes**

Once the investigation is complete be sure they reflect on the work they have done. Is it valid? How useful was technology? Did our correlation guarantee causation? As interesting as the applications may be, continue to emphasize and review the math content and skills that were applied. This may be done with **Exit Slip 5.4 – 321 blastoff** and **Journal Entry 5.4.**

**Teaching Strategies**

I. Begin this investigation with **Activity 5.4.1 Forensic Anthropology**. This will take two days to complete. Start by showing the Power point activity to give student background information.

The PowerPoint concludes by posing a problem to the students: How do you find the height of a person whose skeletal remains include an ulna and no other long bones? Instead of or in addition to the PowerPoint, you could bring in a variety of washed and boiled bones from the butcher. Another prop might be dolls and action figures. Once the slide show is completed, distribute the activity sheet. Before breaking into small groups, read the introductory paragraph, complete step 1, and discuss step 2. Then break up into groups of 4

To gather data, you might want to give each group a tape measure (for height) and a ruler (for ulna length). Have each student write the average of his or her height and ulna data at a central collection place such as the blackboard, interactive whiteboard, on a computer spreadsheet or on an overhead transparency. It may help your class if you have other data included (i.e. principle, other teachers, or your own data). Tell the students to record all their classmates’ data on their activity sheets. Let the small groups struggle for short while with the scale. This will lead to a discussion on how the tight clustering of the data points will lead to inaccuracy when getting the equation by hand. If you have traditional classes, all students should finish the first two pages before coming into class the second day.

When the students begin using the calculators, they are allowed to use their sheets from previous lessons. If the students do not have calculator directions, then you may want to give them some. Compare the results from the calculations by hand with those from the technology. Discuss the advantages and disadvantages of using technology. Note that you would want to use technology if you had “messy” data, if you were making a presentation, and to find as good a linear model as possible. Technology will find the line of best fit.

If your school has access to the internet, or your students have access at home, then the extension questions on page 4 will be a great way to verify their work. The linear regression equations developed by Professor Trotter are found at

<http://www.ehow.com/how_5611616_determine-height-through-skeleton.html>.

One example of the Trotter equations for determining stature is “Stature of white female = 4.27 ∙ Ulna + 57.76 (+/- 4.30)” where *m* = 4.27 centimeter change in height for every centimeter change in stature and *b* = 57.76. There are many other examples online as well. If your students do not have this access readily available, then you should skip the extension and have the students work on the letter to the commissioner of the police department.

**Differentiated Instruction (Enrichment)**

Which is better correlated with height? Length of foot, shoe size or length of the ulna? Students may measure foot length and record shoe size, then plot height as a function of each. Should female data be grouped with male data for shoe size? Research the history of detective work and how footprints or shoe prints are used to help identify criminals and solve crimes.

**Exit Slip 5.4** asks students to make predictions based on the data they have collected in Activity 5.4.1.

II. Following the activity on forensic anthropology, you should have students work on at least one other activity that requires them to collect data and apply a linear model.

Here are several options.

**Activity 5.4.2 Rubber Bands** requiresa lot of room for the students, so this may have to be done in a hallway. **For the students’ safety be sure that they stand clear of the flying rubber bands.** This activity will take a long time to collect the data. Discuss with the students why it is more accurate to take the average of three trials as opposed to just shooting the rubber band once. This is a good time introduce the concept of “outlier” in the context of two-variable data; this will be more fully developed in the next investigation. Students have the option of using the calculator or finding a line of best fit by hand. As the students are working on questions 4 and 5, have them identify examples that involve interpolation and those that involve extrapolation. You may conclude by discussing sources of error that might make their predictions inaccurate.

**Differentiated Instruction (For Learners Needing More Help)**

Lessen the time it takes to input data by transferring data to student calculator lists by linking or to student computer with a flash drive. This will enable students to focus on the essential tasks.

**Activity 5.4.3 Stadium Wave.** There are two versions to this activity. **Activity 5.4.3a** is more open ended and less scaffolded than **Activity 5.4.3b**. This activity becomes very funny while collecting data. It is much harder to do the wave than you would anticipate. Once all the data are collected they may work in groups to come up with an equation. They have the choice of creating an equation by hand or using technology. To address Problem 2 in **Activity 5.4.3a**, they will need to use the internet to find the number of seats that are around the top row of Fenway Park. Require students to submit individual reports. As in a lab in a science class, all the data collection and computation may be done in teams, but the lab reports must all be done individually.

**Activity 5.4.5 Balloons** requires a 9-inch (diameter) balloon for every student, one 12-inch balloon, string for each group, and meter stick for each group. Read the active question and procedure with the students. Demonstrate one example so the students know the approximate location of the circumference. Let the groups work on the rest on this activity with little guidance. The students can find the answer to number 5 either by creating an equation by hand or with the use of technology. When you think every group has made their predicted time, then gather the class’s attention and take out the 12-inch balloon. Even if every group is not up to number 8, you should still perform the actual test and then have students go back to questions 7–9 if they need to.

For **Activity 5.4.5 Walking Away**, put the students into groups of 3. They can take steps any size they want, but remind them to try to stay consistent with every trial. To expand this, you may want to make the students find the equations both by hand and with technology. Although all the questions are written on the paper, the teacher should ask each group different questions. Is this an example of interpolation or extrapolation? How would you describe the relationship between the two variables? What is the strength and direction of the correlation? Why did you choose to get the equation the way you did?

**Group Activity**

Every example in this investigation is a group activity. Try to rotate the way you make your groups. Do one activity with high students grouped with low students. Do another activity with students grouped by ability in which higher levels have less scaffolding then lower level groups.

III.Two additional activities are provided for this Investigation. Unlike the previous ones, **Activity 5.4.6** **Population and Representation** does not involve experimental data and can be assigned for homework if students have computer access. As an alternative you can provide them with this data set showing the population of each state and the number of representatives it elects to the U.S. House of Representatives.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| State | Population | Rep. | State | Population | Rep. |
| Alabama | 4,779,735 | 7 | Montana | 989,415 | 1 |
| Alaska | 710,231 | 1 | Nebraska | 1,826,341 | 3 |
| Arizona | 6,329,013 | 9 | Nevada | 2,700,551 | 4 |
| Arkansas | 2,915,921 | 4 | New Hampshire | 1,316,472 | 2 |
| California | 37,253,956 | 53 | New Jersey | 8,791,894 | 12 |
| Colorado | 5,029,196 | 7 | New Mexico | 2,059,180 | 3 |
| Connecticut | 3,574,097 | 5 | New York | 19,378,104 | 27 |
| Delaware | 897,934 | 1 | North Carolina | 9,535,475 | 13 |
| Florida | 18,801,311 | 27 | North Dakota | 672,591 | 1 |
| Georgia | 9,687,653 | 14 | Ohio | 11,536,502 | 16 |
| Hawaii | 1,360,301 | 2 | Oklahoma | 3,751,354 | 5 |
| Idaho | 1,567,582 | 2 | Oregon | 3,831,074 | 5 |
| Illinois | 12,830,632 | 18 | Pennsylvania | 12,702,379 | 18 |
| Indiana | 6,483,800 | 9 | Rhode Island | 1,052,567 | 2 |
| Iowa | 3,046,350 | 4 | South Carolina | 4,625,364 | 7 |
| Kansas | 2,853,118 | 4 | South Dakota | 814,180 | 1 |
| Kentucky | 4,339,362 | 6 | Tennessee | 6,346,110 | 9 |
| Louisiana | 4,533,372 | 6 | Texas | 25,145,561 | 36 |
| Maine | 1,328,361 | 2 | Utah | 2,763,885 | 4 |
| Maryland | 5,773,552 | 8 | Vermont | 625,741 | 1 |
| Massachusetts | 6,547,629 | 9 | Virginia | 8,001,024 | 11 |
| Michigan | 9,883,635 | 14 | Washington | 6,724,540 | 10 |
| Minnesota | 5,303,925 | 8 | West Virginia | 1,852,996 | 3 |
| Mississippi | 2,967,297 | 4 | Wisconsin | 5,686,986 | 8 |
| Missouri | 5,988,927 | 8 | Wyoming | 563,626 | 1 |

Since the U.S. Constitution provides for representation based on population, students should find a strong positive correlation between the two variables. In class discussion you may draw upon what students have learned from their study of American government in their social studies classes. (You may want to point out that there are 435 Representatives. Based upon its proportion of the total U.S. population Connecticut had six representatives up through the year 2000, but based on the 2000 and 2010 censuses it now has only five.)

Finally **Activity 5.4.7 Conducting an Experiment** provides students with the opportunity to design and conduct their own experiment. Each group will need a stop watch and possibly other materials such as a tape measure, jump rope or step stool. If aerobic items are not available they can always do jumping jacks, push-ups, run in place, or any other exercise.

Explain to the class that they are going to be put into groups and that each group need to think of a way to create an experiment that shows the relationship between one specific exercise and teenagers’ heart rate. Split the class into 4 groups A, B, C, and D and give students no more than 10 minutes to reach an agreement of what type of exercise they will do.

In this experiment, the group may choose either to have one person do every trial or to have different students conduct the trials. Either approach is acceptable; just make sure that the groups include in their report all variables that may affect the results.

There are three important pieces to this activity that the students must pay attention to. 1) The groups must vary the amount of exercise, either by varying the time or the number of number of reps for each trial, 2) each student should have a resting heart rate before doing the next trial, and 3) they have to count the heart rate for the same number of seconds after every trial. (*always* 10 seconds, 30 seconds, 1 minute, etc.)

**Journal Entry**

Select an activity in class in which you collected data and describe how you were able to use the data to make a prediction.

**Resources and Materials**

* **Activity 5.4.1 Forensic Anthropology**
* **Power point for Activity 5.4.**1
* **Activity 5.4.2 Rubber Bands**
* **Activity 5.4.3a Stadium Wave**
* **Activity 5.4.3b Stadium Wave (scaffolded)**
* **Activity 5.4.4 Balloons**
* **Activity 5.4.5 Walking Away**
* **Activity 5.4.6 Population and Representation**
* **Activity 5.4.7 Conducting an Experiment**
* **Exit Slip 5.4**
* Bulletin board for key concepts
* Student Journals
* Graphing Calculators
* Projector
* Computer lab
* Rulers
* Several yard/meter sticks or several tape measures
* Rubber bands (400-500)
* Several stopwatches or the ability to project online stopwatch (or use a cell phone)
* Masking tape
* Several pieces of 2-foot long rope. Different diameters
* 9-inch balloons for every student in the class.
* 12-inch balloon for the teacher.
* Small aerobic exercise equipment.