WAMC Lab Template

Math Concept(s): Linear Regression
Source / Text: Based on a lab by Karl Loree
Developed by: Nick Genereux E-Mail: ngenereux@touchetsd.org
Date: Summer Conference 2022

See the following documents (attached):

- Lab Instructions
- Student Handout(s)
- Rubric and/or Assessment Tool

Short Description (Be sure to include where in your instruction this lab takes place):

Lab Plan

Lab Title: Data That Makes a Line Lab

Prerequisite skills:
Graphing by hand, slope, slope-intercept form

Lab objective:
This lab would be used to reinforce the topics of slope and slope-intercept formulas, as well as to make predictions for multiple real-world applications. The concepts of appropriate domain and the limits of extrapolation

Standards: *(Note SPECIFIC relationship to Science, Technology, and/or Engineering)*
Mathematics K–12 Learning Standards:

- N.Q.A.2 - Define appropriate quantities for the purpose of descriptive modeling.
- N.Q.A.3 - Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.
- A.CED.A.2 - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- A.CED.A.3 - Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context.
- F-LE.A.2 - Construct and compare linear, quadratic, and exponential models and solve problems
- F.LE.B.5 - Interpret the parameters in a linear or exponential function in terms of a context.

Standards for Mathematical Practice:

- MP.4 – Model with mathematics
- MP.5 – Use appropriate tools strategically
- MP.6 – Attend to precision
- MP.7 – Look for and make use of structure

K-12 Learning Standards-ELA (Reading, Writing, Speaking & Listening):

- ELA-LITERACY.RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
- ELA-LITERACY.RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
- ELA-LITERACY.RST.11-12.8
- Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

K-12 Science Standards

- Multiple possibilities

Technology

- Innovative Designer - 4.d. Students exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.
- Computational Thinker - 5.b. Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate
- problem-solving and decision-making.
- Creative Communicator - 6.c. Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations
- Global Collaborator - 7.c. Students contribute constructively to project teams, assuming various roles and responsibilities to work effectively toward a common goal.

Engineering

- 1.5.b Computational Thinker - Students collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
- 1.6.c Creative Communicator - Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.

Leadership/21st Century Skills:

21st Century Interdisciplinary themes (Check those that apply to the above activity.)

☐ Global Awareness ☐ Financial/Economic/Business/Entrepreneurial Literacy ☐ Civic Literacy
☐ Health/Safety Literacy ☐ Environmental Literacy

21st Century Skills (Check those that students will demonstrate in the above activity.)

LEARNING AND INNOVATION
Creativity and Innovation
☒ Think Creatively
☒ Work Creatively with Others
☐ Implement Innovations
Critical Thinking and Problem Solving
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☐ Use Systems Thinking
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☒ Solve Problems
Communication and Collaboration
☒ Communicate Clearly
☒ Collaborate with Others

INFORMATION, MEDIA & TECHNOLOGY SKILLS
Information Literacy
☐ Access and Evaluate Information
☐ Use and manage Information
Media Literacy
☐ Analyze Media
☒ Create Media Products
Information, Communications and Technology (ICT Literacy)
☒ Apply Technology Effectively

LIFE & CAREER SKILLS
Flexibility and Adaptability
☐ Adapt to Change
☒ Be Flexible
Initiative and Self-Direction
☒ Manage Goals and Time
☒ Work Independently
☒ Be Self-Directed Learners
Social and Cross-Cultural
☒ Interact Effectively with Others
☐ Work Effectively in Diverse Teams

Productivity and Accountability
☒ Manage Projects
☒ Produce Results
Leadership and Responsibility
☐ Guide and Lead Others
☒ Be Responsible to Others

Teacher Preparation: (What materials and set-up are required for this lab?)

Materials

Many possibilities are possible, based on student interest. Some suggestions:

- Meter sticks / tape measures
- Stopwatches (phone apps okay)
- Mass scale
- Calipers or micrometers
- Thermometer
- Decibel meter
- You will need graph paper, straight edges, and possible colored pens for graphing

Set-Up Required:

- Gather materials that may be relevant for students. Try to anticipate their interests.

Lab Organization Strategies:

Leadership (Connect to 21st Century Skills selected):

- Students will need to work in teams to collect and analyze data. They will have a limited time to collect data, and will need to discuss many aspects of their data using critical thinking.

Cooperative Learning:

- Students will be working together to collect data, graph points, calculate slope, interpret slope, write their linear regression, and make predictions. They will be sharing their discoveries with their peers as well as the teacher when they are asked scaffolding questions.

Expectations:

- All students will collect data, calculate slope using the slope intercept formula, perform linear regression using digital tools, determine reasonable domain and range, work in small groups, and present their findings to their group.

Timeline:

- 1-2 50 min periods (depending on what measurements will be made)

Post Lab Follow-Up/Conclusions:

Discuss real world application of learning from lab

- Anticipating what types of phenomena or data will be linear without being proportional requires abstract thinking and problem-solving. It is likely that students will need to make multiple proposals before the teacher is ready to approve their plan.
- Recognizing that technological tools are often equivalent to their own estimations could build confidence in their ability to apply their understanding to more situations without feeling that they must master complicated calculations.

Career Applications

- Financial planning, science and engineering, sports (data analysis), construction

Optional or Extension Activities

- Students could make larger posters to display in the hallway.

Data That Makes A Line Lab

- You will be working with a partner to record one set of bivariate data with at least 4 pairs. Your data set should not include $(0,0)$.
- You should come up with your own idea if it is school appropriate. Make it about something that interests you or that you're curious about!
- Before you collect your data, make sure that your project allows you to follow the project instructions. Check with your teacher first.

Our Topic	Teacher Suggestions	Approved

1) Record your data here:

2) What is your independent variable (x-variable) and its units?
3) What is your dependent variable (y-variable) and its units?
4) Use graph paper to plot the data points. Use appropriate labels and titles. You will be attaching it.
5) Use a straightedge to draw a line that has about half the lines above it, and half the lines below it.
6) Identify your slope and what it means. Does it make sense? Explain.

7) Identify your y-intercept and what it means. Does it make sense? Explain.

8) Record your equation for the line of best fit:

9) Use Desmos to create a table. Then use the following command to graph a line of best fit: $y_1 \sim m x_1 + b$

   You will attach a printout of your graph to this assignment.

10) Record the Desmos equation for the line of best fit, and include the R^2 value:

11) How well did you determine the equation for the line of best fit by hand? Why are there differences?

12) Predict what _____ (y) would be if _____ (x) was _____. Show all your work.

13) Test your prediction from #12. Was it close? If not, why do you think so?

14) What value or values of x seem unreasonable to use for predictions? Explain your thinking.

15) What value or values of y seem unreasonable as results? Explain your thinking.

16) How do your answers for unreasonable x and y values seem to be related?

17) Summarize your project in a paragraph. What went well in the project? What didn't go well? What would you change if you could do it again? What would you keep the same? Do you have any other observations? Please explain fully in at least 6 sentences.

WAMC Lesson Plan

Name(s): Nick Genereux
Email Address: ngenereux@touchetsd.org
Lesson Title: Data That Makes a Line Lab
Date: Summer 2022 Conference
Text: not specific STEM Correlation: Math Lesson Length: 2 days

Big Idea (Cluster): Linear Regression	
Mathematics K–12 Learning Standards: N.Q.A.2, N.Q.A.3, A.CED.A.2, A.CED.A.3, F-LE.A.2	
Mathematical Practice(s): MP4, MP5, MP6, MP7	
Content Objectives: Students will practice graphing data, but apply their previous understanding of slope and y-intercept to real world applications. Students will use and compare multiple methods of constructing lines of best fit. Students will understand the strengths and limits of lines of best fit.	Language Objectives (ELL): Students will reinforce concepts and connect them to specific terms and symbols, using both verbal and written communication.
Vocabulary: Slope, y-intercept, linear, scatterplot, independent and dependent variables	Connections to Prior Learning Slope intercept formula Graphing data points
Questions to Develop Mathematical Thinking: • What are your independent and dependent variables? How is the independent variable affecting the dependent variable? • Are this the most effective units to measure with? • How many decimal places make sense to use in this situation? • Are the two equations approximately the same? • Does the pattern make sense if you keep increasing x?	Common Misconceptions: • Students will try to select relationships that are proportional without recognizing that this is specifically not allowed. • Students may try to collect unrelated data, such as measuring many different objects with the same units, rather than using a trend or pattern • Students get confused about independent vs dependent variables. • Students often have trouble making graphs by hand – they often make them much too small, or spend too much time getting axes “perfect”. • Students will often force their line to go through the origin.

Assessment (Formative and Summative):

- Teachers should provide written formative feedback on measurement plans, and determine whether students have a mental model of linear equations
- Student created graphs and Desmos created graphs will be turned in.
- Students will respond to deeper thinking questions. Teachers should determine whether the responses need to be expanded on, and suggest better mathematical language when appropriate. Pay close attention to whether their situation requires limited domains due to real world restrictions. Question 12 requires students to make predictions using calculations – this step is the main application of the lab.
- Students will summarize their thinking and observations at the end. Look for complete sentences and vocabulary usage.

Materials:

- Graph paper
- Chromebook for Desmos
- Printer (or a way to send screen captures to be printed)

Instruction Plan:

Introduction:
Say: “The world is filled with examples of linear relationships. We have seen some already, and you may know of others.” Have a brainstorming session for possible linear situations, and try to sort out purely proportional situations to direct their attention.
Say: “You and a partner will be working to investigate one of these relationships.”

Explore:
Introduce the lab, and show students some of the measurement tools you have ready. Allow them to discuss what they would like to study (including values they can research online), but require each group to write out their plan and share it before giving approval. It will be important to offer some feedback or cautions in the space provided.

When I observe students:
Students should be actively engaged in data collection, and talking about the lab. Encourage partners to talk with other groups to problem-solve the measurements or technical aspects, but try to keep them focused on answering their situation.
Check for complete sentences and showing work when writing. Have partners switch roles as often as possible – use Pair Programming methods.
Watch for lines going through the origin, or too few data points.

Questions to Develop Mathematical Thinking as you observe:
How precise do your measurements need to be? Will you be able to graph that accurately?
What is the slope telling you about the relationship?
What significance does the y-intercept have?
Do you think someone else would get the same equation if they tried this?

Answers:
Being overly precise does not help most situations students are using.
The slope tells you how much the dependent variable increases or decreasing when the independent variable increases by 1. They needs to be translated into their specific situation.
The y-intercept tells you the “starting value”. Again, this needs to be translated for specific situations.
Sometimes, students will get different data due to measuring their walking pace, or other specific situations. This is good to identify for interpreting their models.

Summarize:
Say: “You have collected data, and determined linear equations that can model that trend. You were also able to decide whether your pattern can be used to predict other values, without needed to collect all of the other data. Why might this technique be helpful to use?”
Have a conversation about possible applications, and emphasize that while the predictions are not perfectly accurate, they do allow for predictions with very low cost or effort. Consider having students do a gallery walk to investigate each other’s findings.

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