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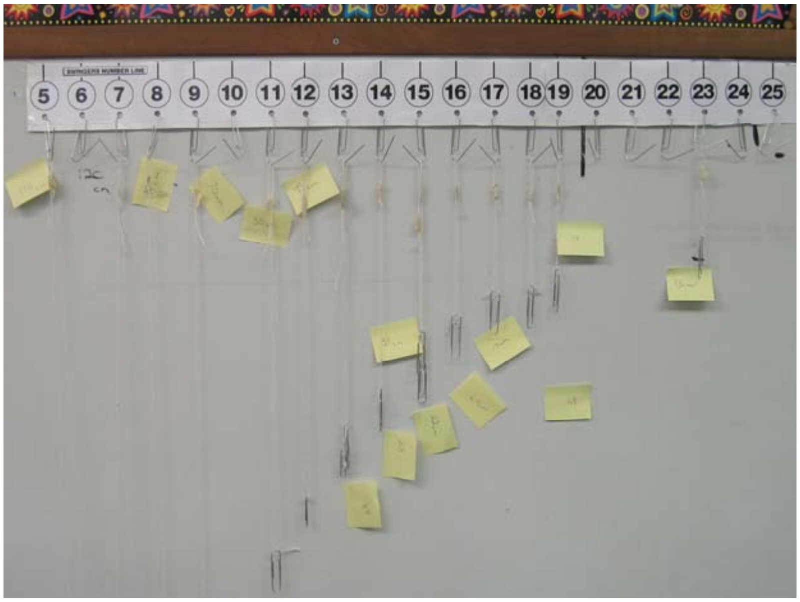

Photo by Joanne Johnson

Assessing with Learning Progressions in Science

FOSS Variables

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Northwest Educational Service District 189
Together We Can

Skagit Valley College
Where Learning Comes to Life

Funding information:
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Program Code: 62
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Learning Progression

Variables

Prerequisite skill:
Understand the general concept of a hypothesis

Experience with running a scientific experiment

Learning Target:

Identify and control variables: Variables are the parts of a system to be investigated.

Success Criteria:
I can…

Identify the variables in the system

Formative Assessment:

Cards sorts (p. 57 Keeley), with questions feedback (p. 129 Wiliam)

Learning Target:

Observe and compare the outcomes of experiments; Identify relationships between independent and dependent

Success Criteria:
I can…
carry out an experiment identifying the independent and dependent variables

Formative Assessment:

Identify the variables; label independent and dependent for the "Springs" experiment.

Learning Target:

Design and carry out experiments:
Scientific experimentation tests a hypothesis by changing on variable at a time; variables

Success Criteria:
I can…

design an experiment to determine the affect one variable has on a system

Formative Assessment:

Identify the variables; label independent and dependent for the "Boat Construction" experiment.

Learning Target:

Graph data: graphs are very helpful tools to show data

Success Criteria:
I can…

Present data in a visually pleasing and effective way

Formative Assessment:

None.

Learning Target:

Use data to interpret and predict results.

Success Criteria:
I can…

Use a graph to explain trends and make predictions

Formative Assessment:

Data match (p. 75, Keeley)

Questions from a graph.

Big Idea:

Use scientific thinking to conduct investigations and build explanations while observing, communicating, comparing, and organizing data.

Later big ideas that build on this big idea include:

Further application of the scientific method to more complicated and intricate experiments.

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1. Scientific Method
    a. Introduce via lecture on whiteboard
        i. Observation/Problem/Question
            1. Can be simple every day things, or very scientific observations
        ii. Hypothesis
            1. Tentative explanation for a set of observations
            2. An educated guess at the answer to a question/observation.
            3. Must be testable
        iii. Experiments
            1. Again, make careful observations to correctly understand the results
        iv. Repeated process
            1. If correct, prove again
            2. If incorrect, adjust hypothesis and test again.
            3. Important thing: test again
                a. Why?
        v. Theory/Law
            1. Law: concise verbal or mathematical statement
            2. Theory: unifying principle that explains a body of facts
            3. Are theories/laws set in stone?
        vi. Imperfect and always changing
            1. Inconsistent results: ex: BPA
            2. Wrong results not always wrong: sticky stuff on Post-it notes
        vii. Everyday process as well as scientific
            1. Scientific method is a specific method to go about designing and implementing experiments
            2. It is also used in everyday situations—ex: Observation: I'm cold; Hypothesis: Don't have sufficient clothing; Experiment: put on a sweater; Observation: If I warmed up, hypothesis was correct, if not form a new hypothesis.
    b. Formative Assessment: Card sorts p. 56 Keeley

        Take an envelope per pair/triple and group each statement into one of three categories:
        1. Observations
        2. Hypothesis
        3. Experiments

        Paperclip together and return to envelope with names on them.
    c. Feedback – Instructor will review and respond with 3 questions to start Saturday off with.
        i. Questions dealt with addressing incorrect groupings, or extending scientific method concepts.

            For example:

            Q: One of your experiments does not provide an explicit description of the experiment to be done. Where would they better fit? Which ones are they?

            Q: Three of your hypotheses do not provide an explanation/reason for the observation. Where would they better fit? Which ones are they?

            Q: Which of the statements would investigate the change in volume of a gas when temperature changes to hot and cold?

            Q: What would be an observation that would lead to one of your hypotheses?

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2. Designing an experiment
   a. Pre-assessment/Activity: Take one hypothesis from above example (or one you wrote) and describe how you would test it. Be sure to define the variables—both independent and dependent.
   b. Lecture: Importance on keeping all variables constant except for one.
   c. Post-assessment: Address experiment described above… any changes? Share with someone else
   d. ALTERNATIVE: Discuss/Question who had used the scientific method already that day.
      Example: Observation: my sweater was not in the closet; Hypothesis: perhaps I already wore it and is in the laundry; Experiment: check the laundry basket—sweater wasn't there; Hypothesis: perhaps it is in the stack of folded clean clothes; Experiment: check stack of clothes—sweater was there.
3. Vocabulary
   a. Lecture/Information
      - Independent variables answer the question "What do I change?"
        - Goes on x-axis
      - Dependent variables answer the question "What do I observe/measure?"
        - Goes on y-axis
      - Controlled variables answer the question "What do I keep the same?"
      - Extraneous variables answer the question "What other variables could be affecting the relationship between independent and dependent variables that cannot be controlled?"
4. Springs
   a. Background info—$F = kx = ma \quad k = ma/x$
      i. Pendulums, springs both have a "vibration" or an "oscillation.
      ii. This motion is periodic—repeating in the same path back and forth
      iii. Equilibrium position: the spring at rest, the pendulum at rest
      iv. Magnitude of the restoring force is directly proportional to displacement in the spring.
      v. Hooke's Law: $F = -k\,x$ (minus sign is so the force is always in the direction opposite the displacement.
      vi. k is the spring constant, the greater the k, the greater the force needed to stretch a spring
      vii. Due to F and x not being constant (varies with each other) can't use basic a, v, and x eq'ns.
      viii. When spring is hanging… $F = -\,k\,x$ in the upward direction… $F = m\,g$ in the downward direction
      ix. T (period) = $2\pi\sqrt{m/k}$
      x. f (frequency) = $1/T$
   b. Experiment:
      i. Determine k for a spring by varying the mass on the end of the spring and measure the length of the spring at the equilibrium position.
         1. Post Experiment Questions: 1. What are the variables of the system? 2. Which ones is/are independent and dependent? 3. Why did we repeat the experiment three times?
      ii. Measure the cycle (period, T) of a spring by using different masses and stretch the springs to measure the period.
         1. Post Experiment Questions: 1. What are the variables of the system? 2. Which ones is/are independent and dependent? 3. How did you test each variable one-at-a-time?

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5. Boat construction
    a. Experiment—form 2 or 3 groups:
        i. Make a hypothesis over what is the best shape a "boat" can be to hold the maximum number of pennies before sinking.
        ii. Construct a few boats (3 is probably good) out of aluminum foil with dimensions 15 cm x 15 cm
        iii. Test your hypothesis.
        iv. What are your conclusions? Hypothesis correct? Why or why not?
        v. What would be your next step
    b. Post-assessment: What were the variables in this experiment, which were controlled, which were dependent, and which were independent? What are some uncontrolled variables?
    c. Experiment—keep same groups from above
        i. Determine if the water level of a swimming pool will rise, lower, or stay the same if a rock in a boat is moved from in a boat to in the pool. Make a hypothesis, design an experiment, and test your experiment. WARNING: variables must be carefully considered, especially with materials chosen.
6. Using graphs
    a. Assessment: Data match
        i. Using handout "Determining Information from a Graph" Indicate which statements about the graph you agree with, which you disagree with, and discuss how you know.
    b. Assessment: Graph conclusions
        i. Using handout "Determining Conclusions about Graphs" Answer the questions regarding the trends and conclusions that can or cannot be drawn from the graphs. Discuss the variables both accounted for and not accounted for.

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Experiments	**Observations**
Hypothesis	**Names:**
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Hypothesis	**Names:**
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Hypothesis	**Names:**

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Some tomatoes in my garden are larger than others.	The part of the garden that gets more sun should produce larger tomatoes.
The sky is blue during the day.	A thinner tire for a bike will provide less friction with the road.
The weather is warmer in the summer than it is in the winter.	If a plant receives fertilizer, then it will grow bigger than a plant that does not receive fertilizer.
When more mass is placed on a spring, the spring is decompressed.	If fenders are put on a bicycle, they will keep the rider dry when riding in the rain.
When a balloon filled with helium is let go outside, it rises into the sky.	Beethoven's contribution to music would have been much greater if he had married.
When a match burns, heat is evolved.	There is more traffic between 8 and 9 in the morning because most people start work at 9.
A stack of paper doesn't compress.	Statues cored in acid rain because the acidity is sufficient to dissolve calcium carbonate, the major substance of marble.

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I get tired when I run a marathon.	Four bowls of lettuce are prepared with four new dressings: sesame seed, oil and vinegar, blue cheese, and anchovies.
A tea kettle will whistle when the water boils.	A balloon is placed in an ice bath and then placed in a tub of hot water.
Sugar dissolves better in hot tea than in iced tea.	Add pennies in a constructed boat to see how many they will hold before sinking.
I will water 4 bean seeds in separate containers. Each container will get 10 more mL of water.	Put salt in three test tubes and add water, alcohol, and rubbing alcohol to see which will dissolve the salt.
I will look at the affect oven temperature has on cooking cookies.	Refrain from eating tomato products for 1 week and gauge acid reflux.
Replace the light bulb in a lamp that isn't working.	Put different objects in a dish and move a magnet below to see which objects move.
Put another log on the fire, and test the room temperature in 15 minutes.	Run DNA diagnostics on swabs from the people of interest, and evidence from crime scene.

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Springs

Part A: Determine k, the spring constant, for a spring

1. Vary the mass on the end of the spring and measure the length of the spring at the equilibrium position.
2. Calculate the *k* using the equation: *k* = m*g/y

   m = mass (kg); g = 9.8 m/s^2; y = length of displaced spring in meters
3. Repeat with 3 masses, and average the *k* for each trial.

What are the variables of the system?

Which is/are independent? Which is/are dependent?

Why did we repeat the experiment three times?

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Springs

Part B: Measure the cycle (period, T) of the spring

1. Using different masses as well as stretching springs to different points to release, determine how the period change?

What are the variables of the system?

Which is/are independent? Which is/are dependent?

How did you test each variable one-at-a-time?

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The relationship between the period, T, and the mass is $T = 2\pi\sqrt{m/k}$
Does your data support this? Why or why not?

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Water and A Boat

Part A: Construct a boat

1. Construct a boat from a 15 cm x 15 cm piece of foil that will hold the most pennies.
2. Draw pictures with rough dimensions with your number of pennies held before sinking.

What are the variables of the system?

Which is/are independent? Which is/are dependent?

What other variables are there that we did not test? How could we test them?

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Water and A Boat

Part B: A rock and a boat

1. Imagine a person in a boat in a swimming pool. The person has a rock in the boat with them. The person picks up the rock and tosses it into the pool (without splashing any water out). What happens to the level of the water? Does it rise, lower, or stay the same? Make a prediction:

2. Design an experiment and request the materials from Amy to prove your prediction. Describe your experiment here in words and/or pictures.

What are the variables of the system?

Which is/are independent? Which is/are dependent?

If you could do this experiment again, what would you change? Why?

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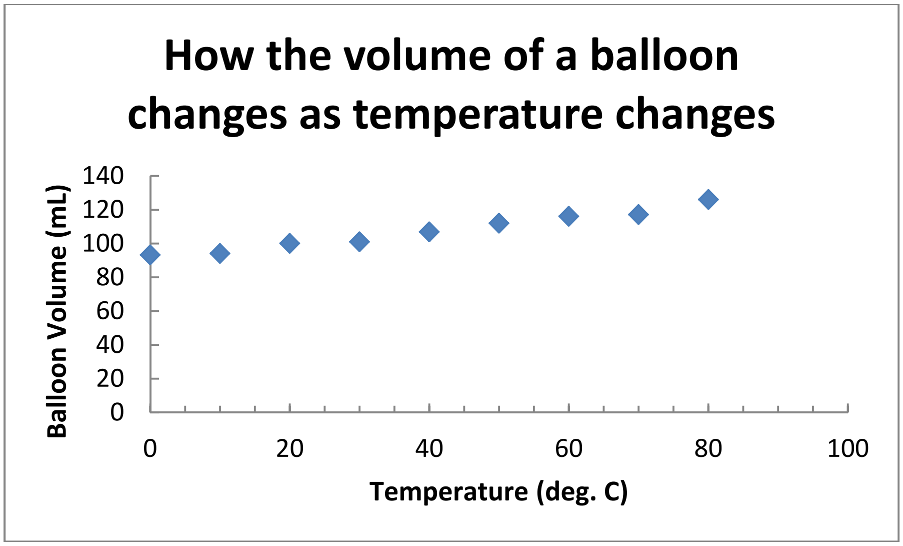
Determining information from a graph

Look at the graph to the right.
Determine which of the following statements you agree or disagree with, and how you know.



1. This graph tells us the relationship between volume of the balloon and temperature.

2. The balloon is filled with helium.

3. Temperature is the independent variable, while the balloon volume is the dependent variable.

4. The units of volume are mL.

5. If the balloon were measured at 70 mL, the temperature would be below 0 ˚C.

6. A balloon that has a volume of 95 mL would be around 120 ˚C.

7. As the temperature increases, the volume of the balloon increases.

8. A balloon shrinks when brought outside on a cold day.

9. If the volume of the balloon decreases, then the temperature must have increased.

10. If a balloon were put in a 150 ˚C oven (300 ˚F) the balloon would increase in size to about 220 mL because at 75 ˚C, the balloon is about 110 mL big.

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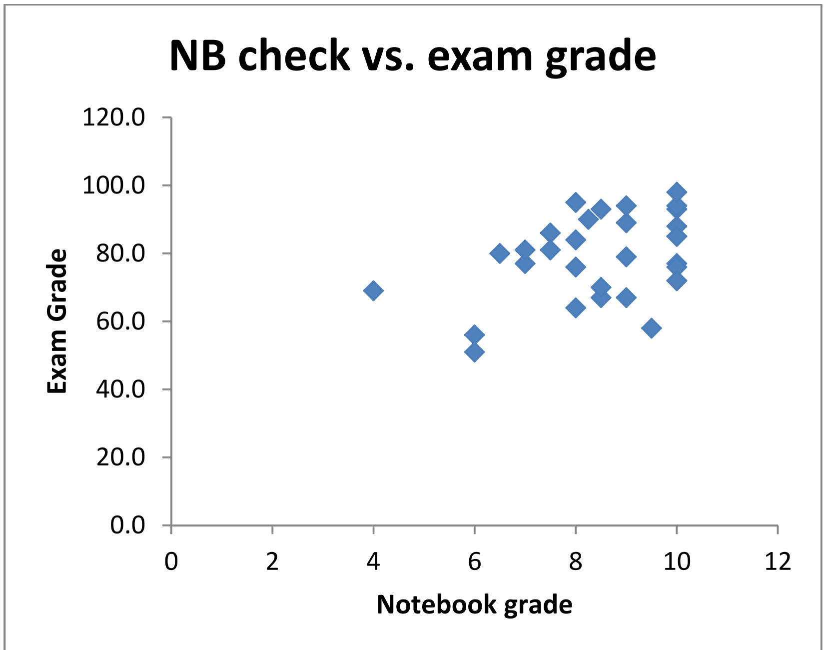
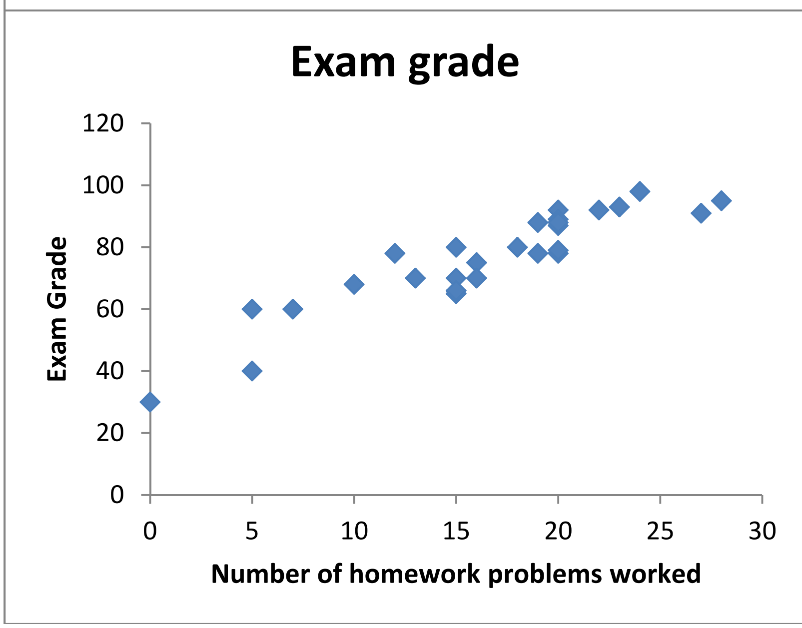
Determining conclusions about graphs



What trend(s) do you see?

What can be concluded from this graph?



What trend(s) do you see?

What can be concluded from this graph?

From this data, what would you tell a student in order for them to get a good exam grade?

Are all the variables accounted for?

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