Modeling Hubble's Law

3-d teaching module

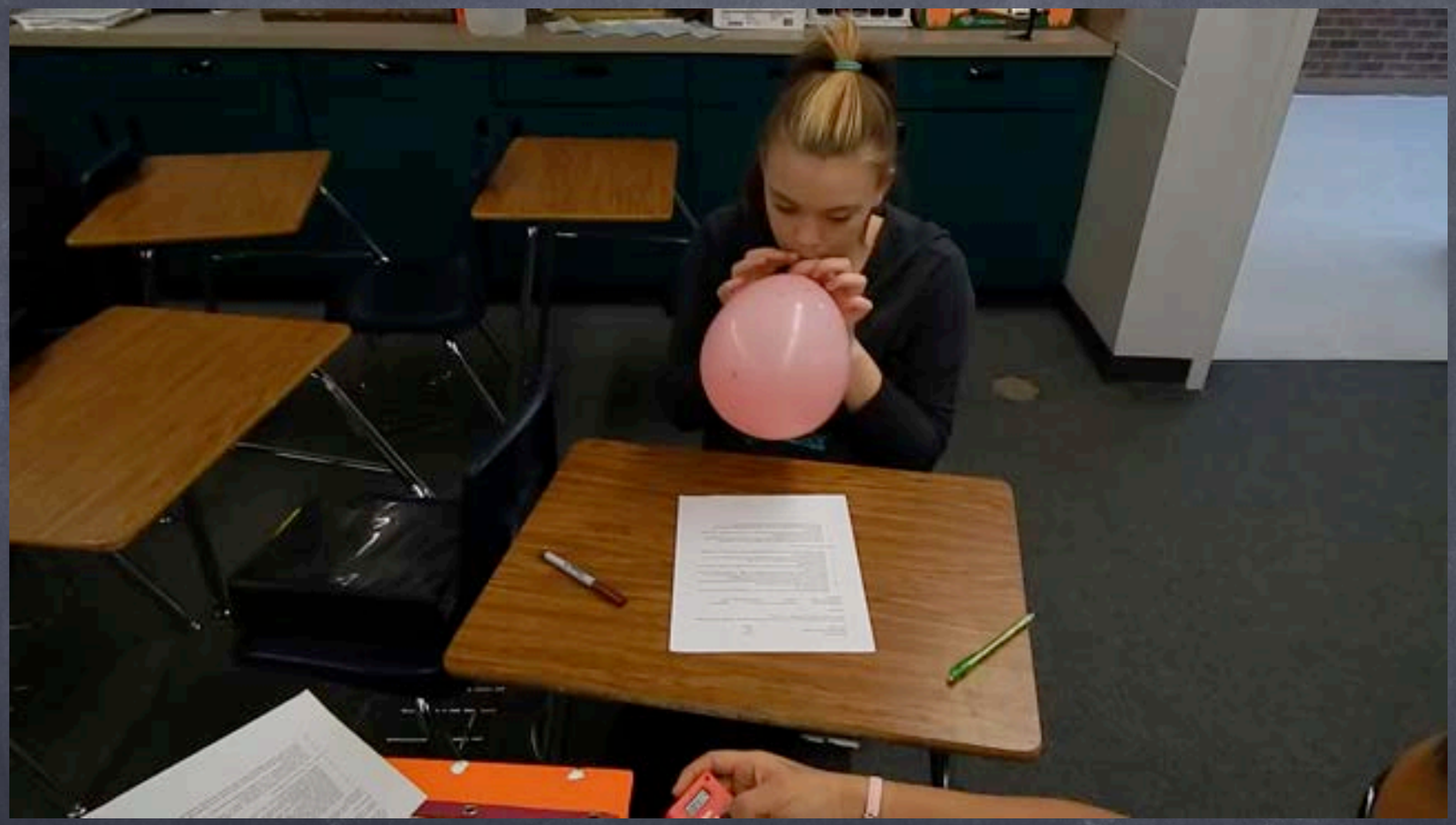
Background

- High school students in earth science read about Hubble's law explaining that galaxies moving in the expanding Universe travel at different velocities.

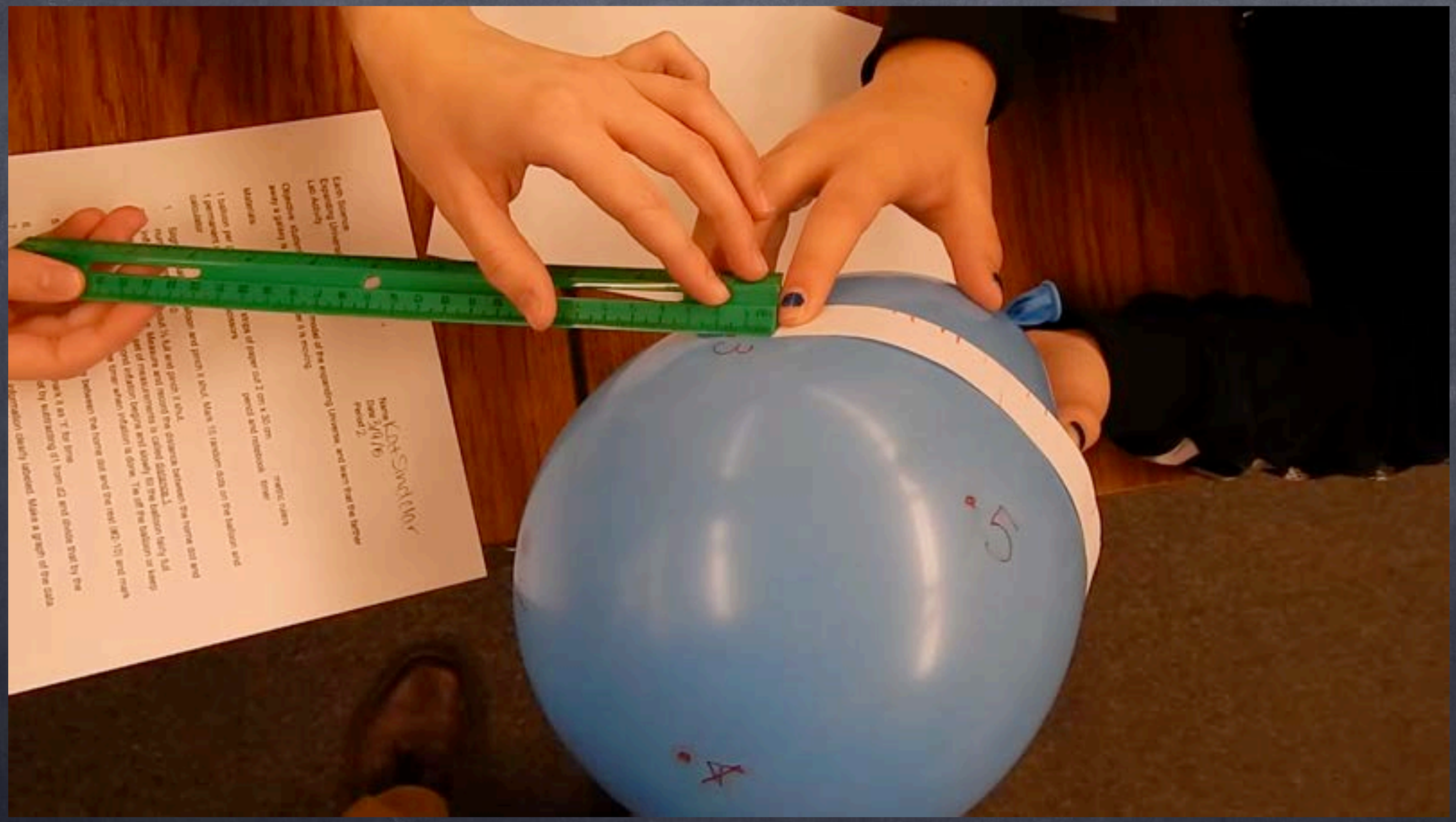
NGSS practice #2

- Developing and using models.
- Students make models to understand the concept.

Video segment #1



Video segment #2

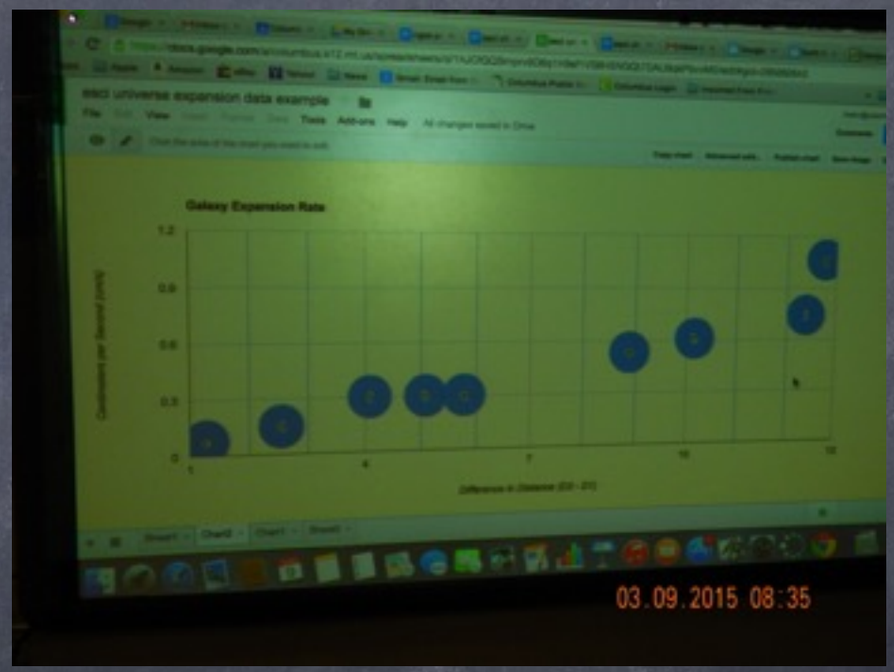


NGSS practice #4

- student investigation to produce data for analysis & interpretation

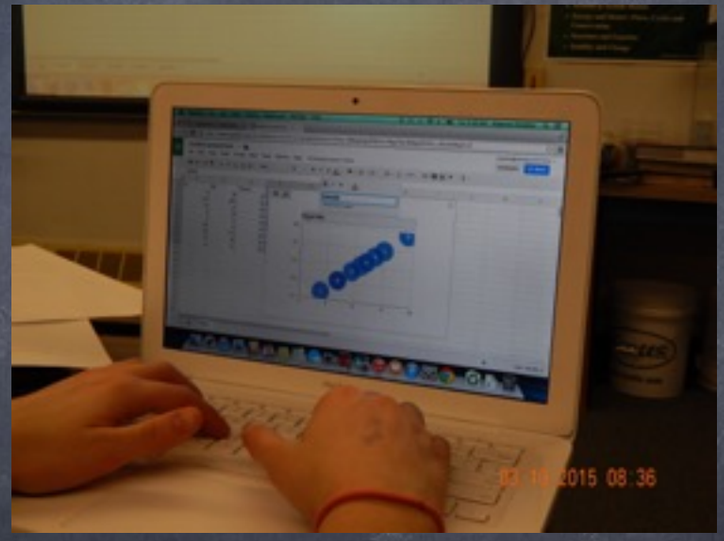
NGSS practice #5

- students using mathematics & computational thinking to represent variables and their relationships



NGSS
crosscutting concept #1

- Patterns
- The data show that the further away the dots on the balloon, the faster it travels in mm/sec.



Crosscutting concept #2

- Cause & Effect
- The further the dots on the balloon were at the beginning, the faster they moved away.

Crosscutting concept #4

- Systems & system models
- The balloon models Universe inflation and the ink dots model galaxies.
- The expanding distance between dots during inflation models growing space.

Protocol for activity

Earth Science
Expanding Universe Model
Lab Activity

Name
Date
Period

Objective: students will observe a model of the expanding Universe, and learn that the farther away a galaxy is from us, the faster it is moving.

Materials:

1 balloon per group of 2 — 2 strips of paper cut approximately 2 cm x 30 cm
metric rulers — 1 permanent marker — scissors — pencil and notebook
timer — calculator — paper tape

Before beginning the lab, tape the two paper strips together end to end to make one long strip.

1. Slightly inflate the balloon and pinch it shut. Using a permanent marking pen, mark 10 random dots on the balloon and number them #1 - 10.
2. Inflate the balloon about ⅓ full and pinch it shut.
3. Assume dot #1 is home. Place the edge of the paper strip from the balloon dot #1 to dot #2. Mark the distance on the paper edge. Using the metric ruler, measure and record the distance between the home dot (#1) and the rest of the dots (#2-10). This first set of measurements is called distance 1. Make a data table to record the measurements in.
4. Start the timer when the second inflation begins and slowly fill the balloon fairly full WITHOUT popping it. Stop the timer when inflation is done. Tie off the balloon or keep it pinched shut. Record the time of inflation and mark it as “t” for time in your data table.
5. Repeat step 3 and measure and record the distance between the home dot and the rest (#2-10) and mark them as distance 2. Record these measurements in the data table.
6. Record the distance difference for each dot by subtracting d1 from d2 and then divide that by the time of inflation d2-d1/t. The result becomes the rate of inflation between these two dots.
7. Make a scatterplot graph of the data for rate of inflation and distance traveled.

Answer the following questions

1. As the Universe (balloon) expands, what happens to the distances between dots (galaxies)?
2. If you started with a fully expanded balloon first, and ran the experiment backwards, what would happen to the galaxies?

Student reflections

Earth Science
Hubble's Law Universe Expansion
Model Formative Assessment

Name Olivia Hess
Date 3/10/19
Period 3

Directions-
Using your NGSS practices and crosscutting concepts reference sheet, describe the practices and ccc's used in the model lab activity and give evidence to support them. See the example below.

Example:

NGSS practice #2 developing and using models.
Evidence: we used balloons, rulers, and markers to model the Universe expansion as described by Edwin Hubble in 1925.

Developing and using models- we used balloons to represent galaxies moving away and also rulers and markers to ~~as the~~ model. Asking Questions and defining problems- how much will the dots on the balloon move apart. Planning and carrying out investigation- planned the investigation & getting supplies carrying out the investigation. Analyzing and interpreting data- determining how much the ~~marks~~ on a balloon will move. Using mathmatics and computational thinking- had to subtract distance 2 and distance one and divide by the time Constructing explanations and designing solutions - blew up balloon and constructed how expansion worked