Modeling Gravity and Orbits in the Fabric of Space and Time

Question to think about:
*How does gravity act on objects in the universe and affect their motion?*

Purpose:
Your group will use a model to better understand the concept of gravity and how gravity acts on objects in the universe and affect their motion.

Activity #1: Introduction to Gravity- Small Class demo groups
Place the flat, circular weight near the middle of the fabric circle.
1. What happens to the fabric?
Now place a marble anywhere on the fabric. Try several locations.
2. What happens to the marble?
Starting near the edge of the circle, roll the marble toward the side (parallel to the weight). Try rolling it at different speeds.
3. What happens if you roll the marble slowly?
4. What happens if the marble is rolled at a medium speed?
5. What happens if the marble is rolled quickly?

Activity #2: Explore!- Individual
*Constraints* - no more than two weights used on apparatus. No more than 5 objects on apparatus. This will cause it to stretch out of shape and ruin it for future classes.
Use the tray of different weights, spheres and marbles to look for patterns.
Things that you could try:
- Rolling different sized marbles
- Using more than one weight
- Rolling more than one marble at a time
- Rolling marbles in different directions
- Any other creative ideas that your group can think of

Record any patterns that you notice in the space below:
Activity #3: Plan and Conduct Your Own Experiment as a GROUP

Choose one of the patterns from Activity #2 to investigate. Write it as a purpose question below. **Think about what questions can we ask and investigate about gravity.**

Some key ideas to consider and demonstrate.

- Explain that in the absence of gravity, space is planar and objects in motion move in straight lines shown when you roll the marble across a corner that remains relatively flat.
- Explain that objects with mass warp space-time so the course of traveling objects is altered. Shown when you roll the marble across or/and around a few of the medium mass objects.
- Explain that if an object's speed is slow enough and/or the warping of space by the objects is great enough, objects can get trapped and crash into the planet or star, or the object can get sucked into the black hole, never to return.
- Explain that many objects are either pulled into the massive objects to be destroyed nor able to completely escape its influence. Instead, they may move into any number of elliptical-like orbits. Explain that the planets in our system tend to orbit in nearly circular orbits. Demonstrate a circular orbit with the marble. Other objects, like comets, however, take on long elliptical orbits, when they are near the orbited object they speed up and when farther away, they slow. Again, demonstrate with the marble.
Final Report (template is on Google Slides)

* Mean that this needs to be done before group can do ANY experimenting.

*Purpose question: How does....

Make a hypothesis about what you think the pattern is.

*Hypothesis: If we change.... then the ..... will be....

Create a numbered list of the steps (procedure) that your group will use to conduct an experiment that can answer the purpose question. Make sure to collect some QUANTITATIVE data (numerical data such as time, number of marbles, distance, etc.) with QUALITATIVE data (word observations) and have multiple trials.

*Procedure:

*Variables - Identify from the hypothesis above.

❖ Independent/ Manipulated Variable(s) IV (what is being tested/ CHANGED):

❖ Dependent/ Responding Variable DV (what is being measured):

❖ 3 Control Variables CVs (what should be kept the same during the testing):

*Data table: (Quantitative) set up ahead.

Create and insert a data table that your group will use to collect the data. Also, make sure to include any other observations.

Qualitative observations: (min of 3 stmnts)

Analyze your group’s data by making a claim (the answer to the purpose question) and supporting it with evidence (your group’s data) and reasoning (an explanation of how the evidence supports your group’s claim).

Claim:

Evidence:

Reasoning:

Your group will eventually turn the group report into a Google Slides presentation to share with the class.
Making a Gravity Simulator

Materials (for making one gravity simulator):

- Fabric - Lycra/Spandex 80% Nylon and 20% Spandex - 2 yards
- ½ inch PVC or PEX Pipe - 16 feet (PVC holds its shape but is more difficult to attach; PEX is easier to attach but does not hold its shape as well)
- ½ inch PVC outer couplings - 4
- ½ inch x ½ inch brass inner couplings - 4
- Large binder clips - 16
- PVC pipe cutter

Procedure:

1. Cut the PVC or PEX pipe into four 4-foot pieces.
2. Place in inner and outer coupling on one of the ends of the pipe.
3. Connect a second pipe to the end of the first that has the couplings.
4. Repeat until the pipes form a circle. The last connection is the most difficult.
5. Place the fabric over the circle. The fabric may have a glossy side. If so, have the glossy side facing out (the glossy side is where the students will roll the marbles).
6. Connect the fabric with a binder clip.
7. Go to the opposite side of the circle. Stretch the fabric tight and connect it with a second binder clip.
8. Repeat using the remaining binder clips. Make sure to space them out evenly.
9. Adjust the tightness of the fabric as needed.