

Modelling with Science	Strand A - Grades 9 - 12
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Lesson Plan

Assessment	AFL, observation, self assess.
Cross-curricular	Math, Technology

Big Ideas

Learning Goals

- How to turn observations into inferences
- What a scientific model is and how to create one.
- How to try to falsify a model.

Specific Expectations

A1.1 formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

Description

With an easily constructed 'Science Rope Tube', teachers will show students how all four ends of the rope tube seem (astonishingly) connected. Students will make observations and inferences, create models, and try to falsify and improve those models.

Materials

Making a Science Rope Tube Handout
 Modelling in Science Visuals
For Teacher Rope Tube
 Length of PVC plastic or cardboard tube, caps or tape for covering tube ends, string or rope (the more slippery the better), metal or plastic ring (clamps and carabineers work well)

For Student Tubes

Toilet paper rolls (1 per group), string, scissors, random materials (tape, washers, rubber bands, paper clips, pulleys, etc.)

Safety Notes

No safety concerns

Introduction

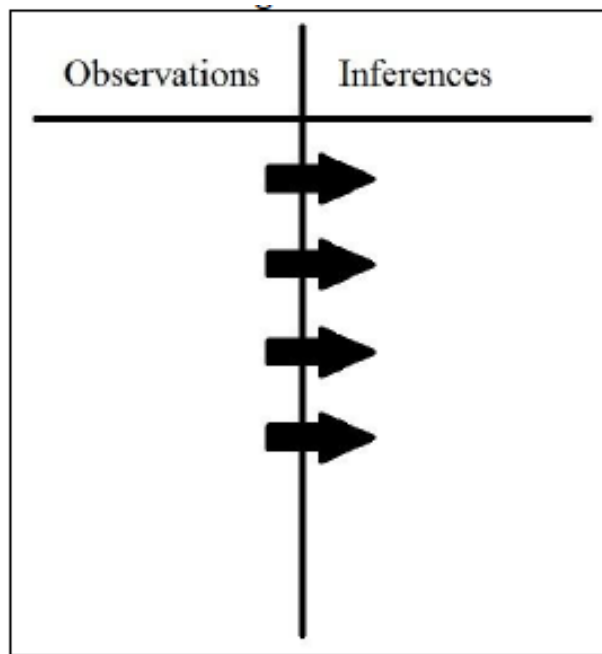
- Introduce students to the Rope Tube of Science (pre-built by teacher, see Link: Making a Science Rope Tube) and demonstrate for the class what happens when pulling the four ropes in random orders. Students will be excited and intrigued by the mystery and begin to wonder how the tube works.
 - *See a demonstration here: <https://youtu.be/j5hRmTkOJBA>
 - Inform students that you are not going to let them see inside the tube.
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Action

- Provide pairs or small groups with large whiteboards or chart paper and have students create a T-chart as follows:

Observations	

- Again, demonstrate pulling on ropes in various order and move through the classroom. Direct students to watch and brainstorm a list of observations that they can make of the 'Rope Tube'. Encourage students to use all of their senses (they may hear the ring clacking inside for example) and include even simple and obvious observations (ex. "there are four rope ends" or "the tube is a cylinder").
- Groups should add 'Inferences' to their T-chart (as shown below) then draw arrows over from each observation. For each observation, students will attempt to infer something about the inner makeup of the rope tube. This may not be possible for all observations. Remind students that inferences are a 'best guess' and all inferences taken together could be seen as a hypothesis.



- Either formally or informally, have students share their observations that lead to inferences about the inside nature of the tube.
- Have pairs or groups work together to create a 2D visual representation (a MODEL) of what they believe the inside of the tube looks like.
- Have each group post and share with the class their best model.

Falsification

- "Ok class. It's time for one of the most difficult and important parts of science. Falsification. This is when we try our best to (politely) point out issues those other models might have. It's also important to suggest tests that we could do to see if a model is really correct".
- Grouping similar models together, go through each type of model as a class and solicit thoughts about why the model might not work. Encourage students to suggest problems with each model and tests that might prove/disprove the model (ex. if a model shows a big knot in the center with four strings coming out, how might the ropes be pulled to test if this model is accurate?).
- **It is crucial that the teacher reserve judgment and only act as a guide and facilitator to student's ideas.

Consolidation/Extension

Building Physical Models

- Give each pair/group a toilet paper roll, string, and provide a grab bag of other random materials for class use (tape, washers, rubber bands, paper clips, pulleys, etc.). Instruct groups that they are to take what they have learned and work to build a rope tube that behaves as identically to the large tube as possible ("don't show other groups!"). If groups finish quickly they should attempt to build another rope tube that is built differently but behaves the same way.

- Students should share their models and any conclusions that they can make.

WARNING: NEVER SHOW STUDENTS THE INSIDE OF THE TUBE OF SCIENCE!!!

- Discuss with students how this process is really the nature of science. The rope tube can represent what people used to think about atoms. Scientists couldn't use a magnifying glass and look inside to see the atom. They were forced to take outside observations and use them to try to figure out how the inside of the atom was made up. Show the following video about the Rutherford Gold-Foil experiment and describe the analogy between that experiment and what they've done with the rope tube:
http://www.backstagescience.com/videos/rutherford_gold_foil.html