By: Ayla Weiss

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| Teacher:  | Subject/Grade: 9th grade science |
| Objective/Standard: Students should understand the scientific method and be able to design an experiment and write a report about it.  | Materials:Two heavy books (textbooks are good), cardstock paper, aluminum foil, plastic wrap, paper towels, tape, coins |
| Length of Lesson: 1-2 class periods | Goal: (What do you want students to know/create): Students should learn how to think logically in order to problem solve. They should be able to identify the different parts of experiments and write a neat lab report. The final creation should be a bridge.  |

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| Engage: *Video/ present problem/ questions to hook students.* [*https://www.youtube.com/watch?v=M998mXia-uM*](https://www.youtube.com/watch?v=M998mXia-uM) *This is a great video of the Mario M. Cuomo Bridge being built in a time lapse. It is mesmerizing to watch and should get students excited about engineering and infrastructure.* * *Ask students what they notice about the bridge…they will probably first point out the bigger things: it’s really long, it’s a cable-stayed bridge, there are many lanes for cars, trucks, and pedestrians.*
* *Then, the teacher should point out that the details of the bridge become infinitely small. For example, there are exactly 192 stay cables which are made of steel strands, etc.…*
* *Basically, every decision in designing a bridge is super important, no matter how small. How do engineers and scientists make these decisions? After all, there is no room for mistakes when you build a bridge. They follow a process called the Scientific Method that allows for controlled trial-and-error that allows scientists to make good decisions.*
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| Explore:  *Ask question to gather student knowledge- hands on activity students can do to activate prior knowledge and begin to connect to new learning:** *The teacher should divide the students into groups and then pass out cards that each have a different term written on them:*
	+ *Question, research, hypothesis, experiment, analysis, conclusion, observations*
	+ *First, in their groups students should discuss each term and write a short definition/description on the back.*
	+ *Next, the students should be told to put the terms in order of how they would approach a problem.*
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| Explain: *Meat of the lesson- where you teach what you want them to learn* *This should include activities for students/ Vocabulary** *Next, the teacher should explain the scientific method and its order. It would be helpful for them to pull up a flow chart with a visual representation of the steps with arrows and how they relate to one another.*
* *It is also important that teachers point out that the order of the steps is not concrete, although it is still important to include each one in some way.*
* *In terms of designing an experiment, the teacher should also define words such as independent variable, dependent variable, controls, bias, etc.…*
* *Next, teachers should introduce the simple bridge project. Students should be in groups of ~4. The experiment can be based on this video:* [*https://www.youtube.com/watch?v=CqYGVW2Eu6Y&t=114s*](https://www.youtube.com/watch?v=CqYGVW2Eu6Y&t=114s)
	+ *First, students should formulate a question—what are the interested in testing? For example, how does the length of the bridge affect its ability to hold pennies? How does the material of the bridge affect its ability to hold pennies? How does the shape of the bridge affect its ability to hold pennies?*
	+ *Next, allow students to do some research – depending on what the teacher wants, they can use the internet, books, ask each other questions, use prior knowledge.*
	+ *Students should write down their hypothesis. Teacher should reinforce the “If…then…” construction of predictions.*
	+ *Students should test their hypothesis with an experiment. Students should build the bridge and count how many coins the bridge can hold.*
		- *Students will have the opportunity to record what variable they changed and how many coins it held, make observations and ideas for change, and then actually make that change to their design (the independent variable) and see how the change impacts the results.*
* *Finally, the students should write down their conclusion. Which version of the independent variable was the most successful? What future questions do they have after completing this experiment?*
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| Evaluate: *How will you assess that they learned it- project- quiz- daily question to gather that they are making progress.* * *Finally, in order to communicate the results, students should write a practice lab report. With this assignment, it is more important that the teacher gives valuable feedback so students can improve than giving harsh grades because scientific writing is a new skill for many students that is difficult to grasp. It is important to remind students that they should use numbers and evidence to back up their claims.*
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|  Elaborate: *Connect to real world- where or how will they see this concept in life** Show students an engineering problem in their community—for example in the Bahamas, many houses on the coast are not built with foundations that can withstand hurricanes. As a class, design a question and plan each of the steps of the scientific method in a way that can be used to solve this problem.
* Then, make a list of other possible problems in the community that can be addressed through use of the scientific method. This way students can connect what they have just learned to something in the community they feel passionate about.
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Worksheet:

Question: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Independent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dependent variable: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Controls: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hypothesis:

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| Variable | Number of Pennies |
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Observations & Idea for change:

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Conclusion:

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Questions for future research:

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