What is the Scientific Method, anyway?

Steps to the Scientific Method

1. Identify the Problem/Research Question
2. Form a Hypothesis
3. Create an Experiment
   - Procedure, materials, variables/control
4. Perform the Experiment
   - Collect data, journal
5. Analyze the Data
   - Charts/graphs, modify the experiment if necessary
6. Communicate the Results

What is the Scientific Method??

- http://www.bozemanscience.com/scientific-method

- Start at 5 min.

Decide on a Topic!

- Your topic should be:
  - Something that you are interested in that can be used to create an experiment
  - Something you don't understand or have a question about
  - Something you don't already know the answer to
  - Something science-focused
  - Related to a hobby or talent

Try it out…

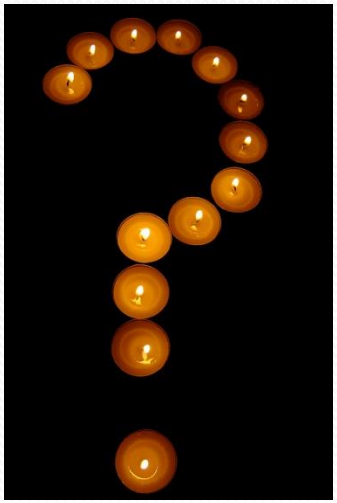
- Spend 5 minutes writing about something related to science that interests you.
  - Use your book – flip through it and find sections that you think are the coolest
    - Strange but True Facts
  - Think: "I wonder what would happen if…"
  - Think: "If I do this….then this will happen…"
- "Science Buddies" survey:
  - http://www.sciencebuddies.org/

Topics…

- Topics can be related to:
  - Natural Disasters
  - Health/Food
  - Animals
  - The 5 senses
  - Energy
  - Acceleration/force
  - Weather
  - Human Body
  - Cells
  - Agriculture
  - Plants
  - Gravity
- You should avoid topics including human subjects, behavioral science, vertebrate subjects, bacteria, hazardous materials/firearms

Write your Research Question

- Now that you have your topic, you need to turn it into a question that your project will be based upon.
- **Question** – what you want to know about your topic; your question forms the basis of your hypothesis.
- Example: If you want to learn how to cook a turkey in the ground, you could ask, ***"How can I cook a Thanksgiving turkey in the ground that tastes just as good as one that comes from an oven?"***



Research Question:

"How can I cook a Thanksgiving turkey in the ground that tastes just as good as one that comes from an oven?"

Try it out…

- How can you change your topic into a question?
- Try to make sure your question can't be answered with a simple "yes" or "no."
- You will be trying to answer this question for the remainder of your project…
- Take some time to write down 3 different ways that you can create your Research Question.

What is a Hypothesis??

- A **hypothesis** is a testable statement that you make as an answer to the question you have about your topic; an important statement used to guide the entire experiment.
- You should **always** word your hypothesis in this way: "If…….then….."
- Example: "**If** I bury a raw turkey in a hole in the ground and surround it with hot coals, **then** the turkey will cook the same as it would in a conventional oven."
- Your hypothesis is your "educated guess" at what you think will happen when you try to answer your research question.

Hypothesis:

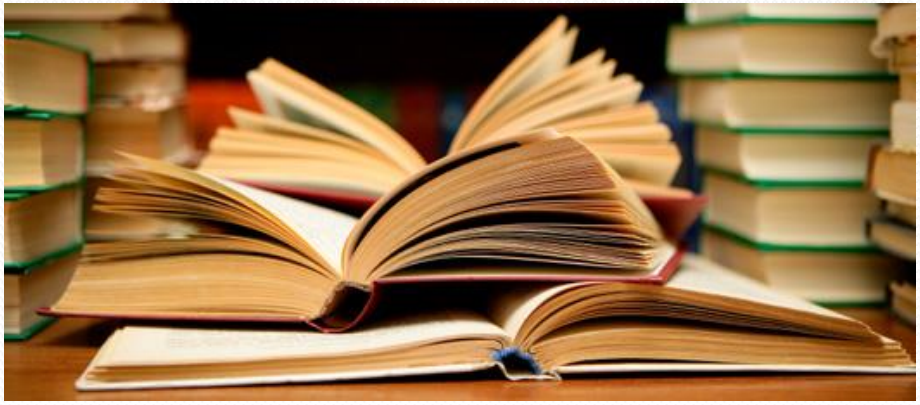
"**If** I bury a raw turkey in a hole in the ground and surround it with hot coals, **then** the turkey will cook the same as it would in a conventional oven."

Create Your Experiment

- There are many things that go into creating your experiment. It is very important that everything is well thought out before you try to conduct your experiment. This step makes you THINK about what it will look like:
  - Find at least 5 sources of research. Record them. Take down notes.
  - Materials
  - Procedure (step-by-step process)
  - Variables/control

Research

- Any information you gather from different sources (books, the Internet, magazine articles, interviews of specialists, etc.) which helps you know more about your science project topic.
  - Pit Cooking: How to Cook in a Hole in the Ground
    - http://bbq.about.com/od/barbecuehelp/a/aa061006a.htm
  - How to Cook a Turkey in the Ground
    - http://www.youtube.com/watch?v=oVFDcyiSipM
  - Interview w/ brother & cousin




Fantastic-Farm-and-Country-Photos.com

Materials

- When you are listing materials, use exact measurements **in metric system**; make sure to list measuring tools as well as safety equipment.

- Turkey Experiment:
  - Thawed 4kg, 6kg, and 8kg turkeys
  - Oil & seasonings
  - 3 packages of tin foil
  - Shovel
  - Rocks
  - Matches
  - Firewood
  - Cooking thermometer

Variables

- A **variable** is anything that affects your topic and can change in your experiment.
- In the turkey example, some of the variables are the depth of the hole, the size of the turkey, the amount of time that it was in the ground, how frozen/thawed it was, etc.
- There are different types of variables: independent and dependent

Independent Variable

Independent variable:

- The independent variable is the *one thing that you change* in your experiment to figure out what impact it has on the topic you study.
- I decided to cook three raw turkeys and I put them each in a 100 cm. hole for 12 hours. However, one turkey was one was 4 kg, one was 6kg, and the other was 8 kg.
- The **weight of the turkey** is the independent variable in this situation because it is the variable that I am testing and that is changing.

- You may only use ONE independent variable!! Using more than one will skew your results! Everything in your experiment stays the same except for that one thing.

Dependent Variable

<u>Dependent variable</u>:

- The dependent variable is the *change that happens in your experiment as a result of the independent variable.*
- Turkey experiment: The **turkey's temperature** will be the dependent variable in this case.

Constant Variables

Constant Variable:

- Your constant variables are the variables that stay the same throughout your entire experiment. You do not mess with them at all.
- Turkey experiment:
  - Depth of the hole
  - Number of hours the turkey cooked
  - Fire set up
  - Tin foil wrapping


EAT
BEEF

Procedure

- A **procedure** is a list of the steps you complete to perform your experiment from start to finish.

- Turkey Experiment:
  - Buy a raw 4 kg. turkey
  - Oil/season turkey as desired
  - Wrap the turkey with at least 15 layers of tin foil
  - Dig a 90 cm. hole in the ground and place some good sized rocks in it.
  - Stack firewood in the hole and light it; let it burn for about 3 hours (or until fire burns down to plenty of coals)
  - Carefully place the turkey in the ground
  - Surround the turkey with the hot coals and rocks.
  - Cover the hole up with the dirt again
  - Let the turkey cook for 12 hours in the ground
  - Dig turkey out of hole, uncover, and check its temperature (should be 74° Celsius)

- *Follow the same procedures but with a 6kg and 8kg turkey to discover the temperature difference in the three!

Perform the Experiment

- This is the part you have been waiting for!!
- Now that you have all of your materials in place and you know what your procedure is to carry out…do it!
- As you carry out your experiment, keep a notebook close by to take notes and make observations about what is happening.
  - This will be your data in later steps.

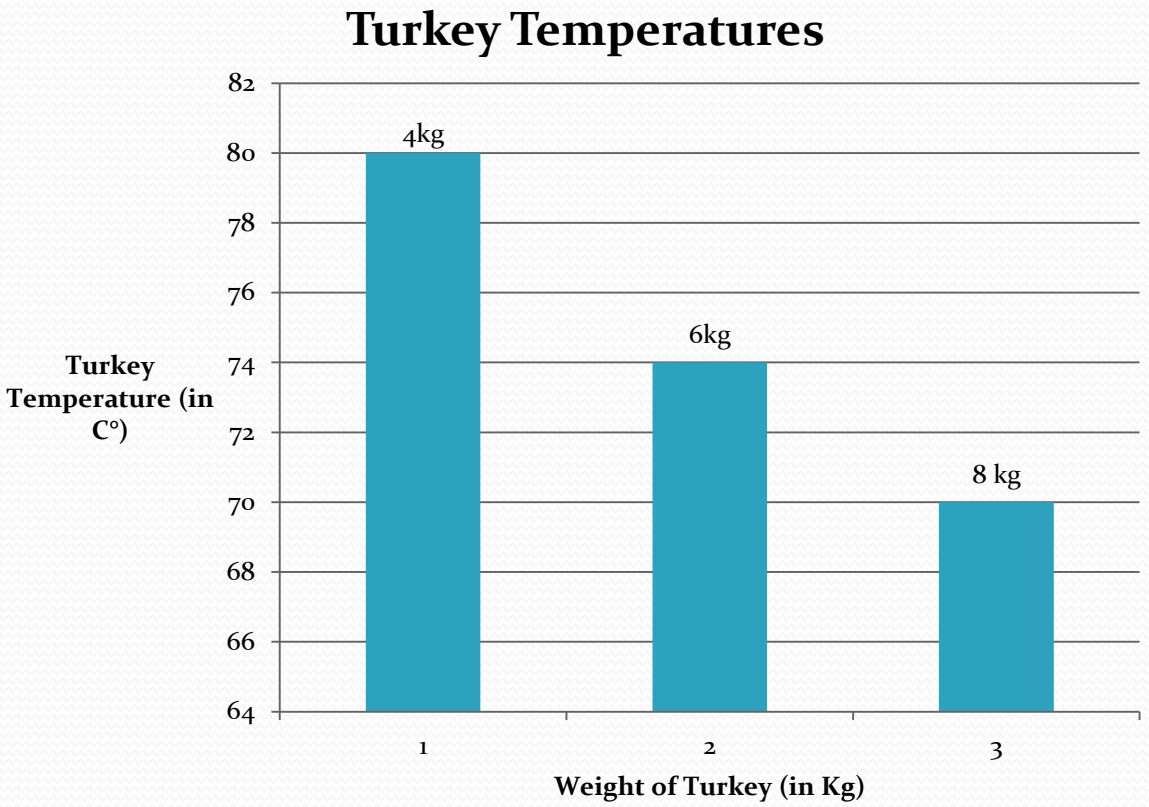
- <u>Turkey Experiment:</u>
  - The bigger the turkey, the more tin foil I had to wrap it in and the bigger the hole had to be
  - It took longer for the fire to die down than I wanted, but after 6 hours it was ready to go
  - I needed extra help putting the turkey in the hole because the coals were hot!

- **In order to get more accurate results, you should carry out your experiment at least three times and average the data for your chart/graph. Judges are looking for this!**


OIL

Analyze the Data

- Data: observations listed in the form of a chart or graph, so that you can clearly see the results of your data collections.
  - After 14 hours, the 4 kg. turkey was 80°C– over cooked!
  - After 14 hours, the 6kg. turkey was 74°C– perfect!
  - After 14 hours, the 8 kg. turkey was 70°C– undercooked!



Graphing Guidelines

- **T** – Title (Y-axis label vs. X-axis label)
- **A** – Axis (Independent variable on X-axis, Dependent variable on Y-axis)
- **I** – Interval (If you skip a space once, you always have to skip a space)
- **L** – Label each axis with a title AND unit of measurement (Ex: Distance (cm/sec))
- **S** – Scale (What you count by – 1's, 5's, 10's) Use as much of the graph as possible

Data

- **When you collect your data, you MUST use the metric system!!!!!!!!**
  - Forgot? Go to Google and type in "inches to centimeters" and a conversion calculator will pop up in seconds to help you out!

- Do your experiment at least three times and write down results of each. Find the mean (average), median (middle number), or mode (most seen number) of these results to plot in your graph.

- Ms. Geiser is more than willing to help you with this…just ask!!

Modify the Experiment (if necessary)

- If your project flopped or if something unexpected happened, you should modify your experiment as needed.

- Example:
  - If all three of the turkeys were overcooked, I would have to put them in the ground for 10 hours rather than the original 14 hours.
  - If all three turkeys were overcooked, I could switch to larger turkeys – 10kg, 12kg, and 14kg.

Communicate the Results

- **Results**: a simple, factual summary of what happened in the experiment

- You want this section to be brief. You will go into more detail in your conclusion section.

- Example:
  - After conducting my experiment twice, I found that cooking a 6kg. raw turkey for 14 hours in a 90 cm. hole will result in a cooked turkey!
  - When I cooked a smaller and larger turkey under the same variables, I ended up with an overcooked and under cooked turkey.

Write a Conclusion

- **Conclusion**: your opinion about what happened during the experiment. It must be based on the data you collected.

  - Explain any differences you got in your data compared to the research you did.
  - Were there any flaws/errors? Why do you think they happened?
  - How can you apply this to everyday life??
  - How could you expand your research?
  - Include your opinions and observations…

Create a Display Board

- Your display should include the entire story of your experiment.
  - Question, Hypothesis, Data/charts, Procedure, Results, Conclusion
- It should be neat and colorful. Do not use pen or pencil, but instead type your information!
- Make your font large enough for others to read easily
- Have parents take pictures of you while you are doing the experiment and include these on your display

Blooming Algae!

Question:
How does fertilizer affect algae?

Hypothesis:
The more fertilizer there is, the more the algae will grow.

Background Research:
Eutrophication is caused by Algae Bloom. This happens when nitrates and phosphorous cause the algae over-growth. The bacteria eat the dead algae and use up all the oxygen. This kills the aquatic life.

Algae 2000X magnification

Algae are very simple plants. They only have one cell. One piece of algae alone is called alga.

Materials
4 80oz. jars(2.37 liter)
Fertilizer
Water from pond
Measuring cup
Aluminum foil

Procedure
1. Fill each jar with water.
2. Measure and add 10ml. of fertilizer to on jar and 25ml. to another jar.
3. Add 10ml. of fertilizer to a third jar and cover with aluminum foil.
4. Add nothing to the fourth jar. This is control.
5. Label each jar and place on a sunny window sill.

Results:
The jar with 10ml. grew good, but not the best. The jar with none did not grow. The jar with 25ml. grew the best. The jar with 10ml. and the foil cover did not grow very well.

Conclusion:
Farm run-off definitely has a negative affect on ponds. The algae pollute the water. This eutrophication destroys the aquatic life.

Classroom Presentation

- Your classroom presentation should be around 5 minutes long.
- Show/explain your display board.
- Bring along any models or visuals that you want to share with the class.
- If your experiment is easy to do, you can model it for the class.
- Don't read straight from board. Practice at home and use note cards for assistance if needed during class.
- Speak loud and clear…don't be nervous! ☺

Sussex County Science Fair

- **All students from grades 6 through 12 in all Sussex County Schools (public, private, charter, technical) are eligible to participate in the SCSF.**
- **Team projects are not eligible – you must do your own work! You may only enter one project.**
- **Winners at the SCSF are eligible to participate in the Delaware Valley Science Fair (DVSF), which is a tri-state science fair. Medal winners in the DVSF are eligible to participate in the International Science and Engineering Fair (ISEF)**