

THE SCIENTIFIC METHOD

Is the world round,
or flat?

OBSERVATIONS

It seems flat ...

- When you walk, you don't feel like a circus elephant on a ball



It seems round ..

- When a ship disappears over the horizon, it disappears bottom first



SCIENTIFIC METHOD: STEP 1

Step 1: State the Problem

- Observations lead to questions.
- Questions about the world around us are the starting point of scientific investigation.

Step 1: What is the shape of the world?

- Why do ships disappear bottom first as they go over the horizon?
- Could the world be round?



SCIENTIFIC METHOD: STEP 2

Step 2: Form a hypothesis

- Hypothesis = educated guess, *or* prediction
- Prediction stated in such a way that it is testable
- If ..., then statement

Step 2: Shape of the World

- **If** the world is round, **then** it is possible to sail around the world in one direction and return to the starting point



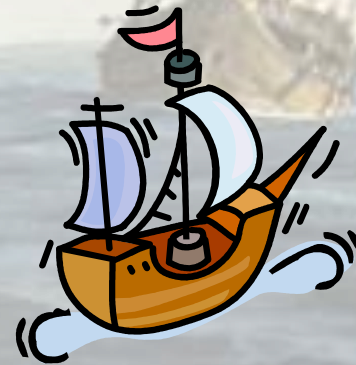
SCIENTIFIC METHOD: STEP 3

Step 3: Experiment

- Experiment = Test of a hypothesis
- A properly phrased hypothesis can be tried out!

Step 3: Shape of the World

- The hypothesis: **If** the world is round, **then** it is possible to sail around the world in one direction and return to the starting point
- The experiment: Attempt to sail around the world



SCIENTIFIC METHOD: STEP 4

Step 4: Conclusion

- The experiment is a test of a hypothesis, so there are only two possible conclusions:

- The hypothesis is supported

or

- The hypothesis is ***not*** supported

Step 4: Shape of the World

- Magellan's crew successfully sailed around the world by heading west during the years 1519 to 1522



- It ***is*** possible to sail around the world.
 - The hypothesis is supported.

SCIENTIFIC METHOD

Summary



Step 1:
State the
Problem



Step 2:
Form a
Hypothesis



Step 3:
Experiment



Step 4:
Conclusion



SCIENTIFIC METHOD REFINED

Keeping an eye on variables

- A researcher gave some 11 year old boys a dietary supplement to speed their growth
 - A year later, they were a lot taller
 - The researcher concluded the supplement sped their growth. Is that right?
- No!! The growth could be due just to getting older
 - It's necessary to control variables in an experiment
 - Control = standard for comparison
 - Compare boys who received the supplement to boys who didn't



Reproducibility

- In 1989, Stanley Pons and Martin Fleischmann claimed they discovered cold fusion
 - Fusion is the process that powers the sun
 - Normally it occurs only at very high temperatures.
 - If it could be done at low temperatures it could provide cheap energy for us all
- Unfortunately Pons' and Fleischmann's experiment could not be reproduced by others



LAWS & THEORIES

Definitions

- Theory - an explanation based on observed fact (provides framework for hypotheses)
- Law - theory that has been upheld for a long time
 - laws can be modified to fit new observations

Examples

- Ships disappear bottom first as they go over the horizon *because* the world is round
- The earth is not actually round. It is an oblate spheroid (flattened at the poles)
 - Pictures from space and precise gravity measurements show that the earth is not perfectly spherical

