

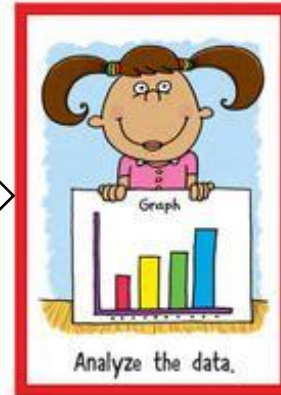
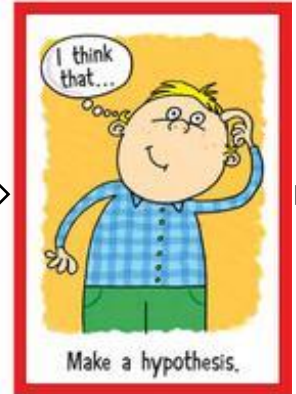
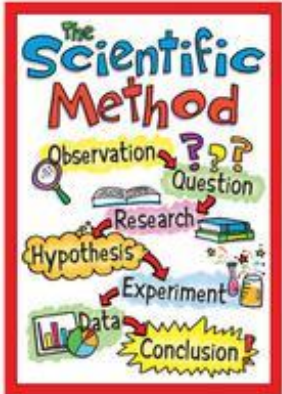
INITIAL OBSERVATION



WONDER

RESEARCH

HYPOTHESIZE



PLAN

EXPERIMENT
ADDITIONAL
OBSERVATIONS

DATA

ANALYSIS

CONCLUSION!

Describe the Elephant



It weighs 480 kilograms.

It has large ears and long trunk.

It has gray wrinkly skin.

~~**It is very cute!**~~

It is young.

It is about 1.5 yards tall.

Qualitative vs Quantitative Data

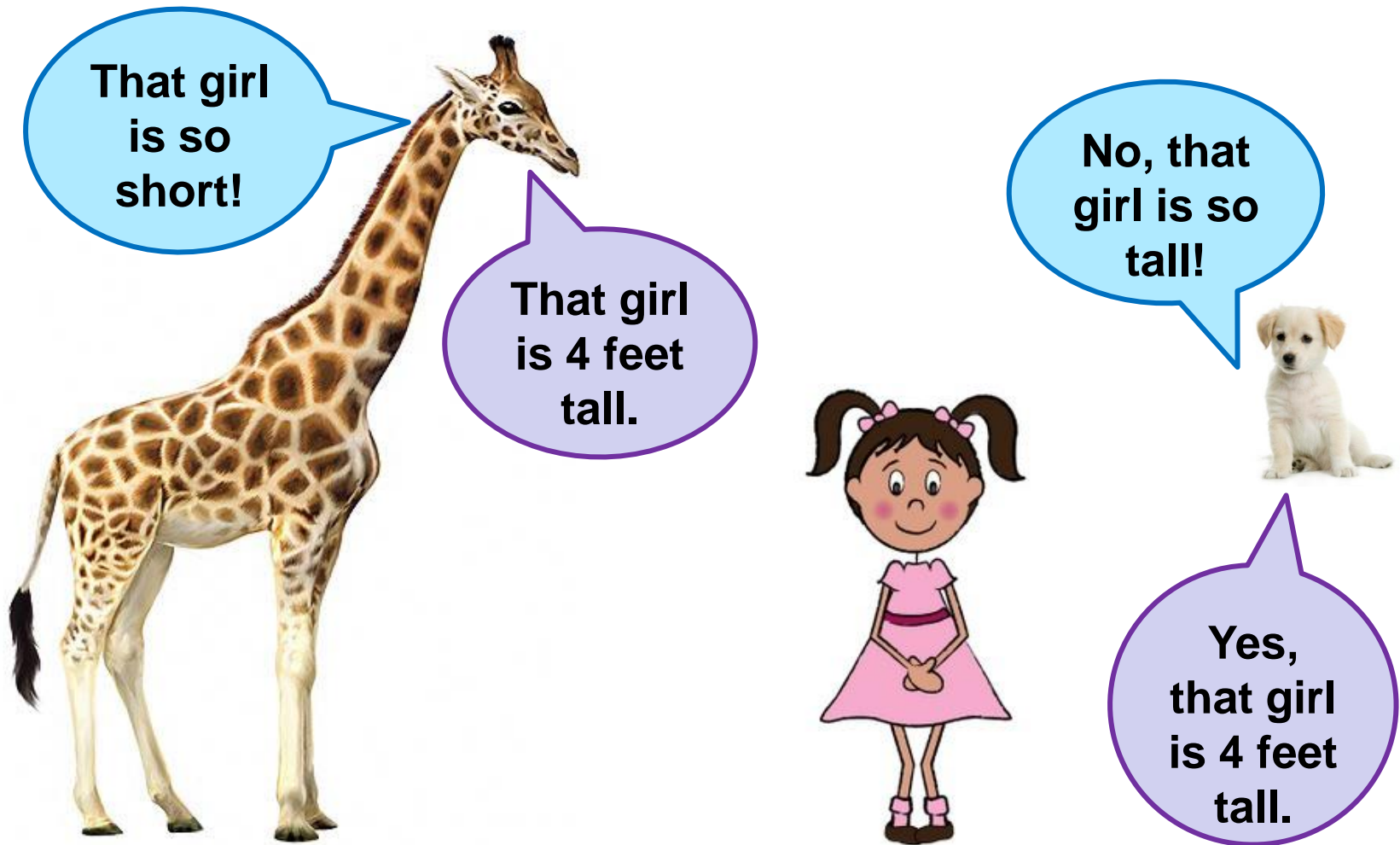
Qualitative (letters)

- **Descriptions** using words.
- Data which can be **observed** but **not measured**.
- What the object is *like*: texture, smell, taste, appearance, etc.
- ***Subjective, relative***

Quantitative (numbers)

- Specific **numbers**.
- Data which can be **measured**.
- Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, age, etc.
- ***Objective, specific***

Qualitative observations are **subjective**



Quantitative observations are **objective**

Observation depends on observer

- Location and size of an observer
- Observer limitations



can only see visible light



can see ultraviolet light



Measurement

- the assignment of numbers to objects or events
- a type of **quantitative observation** made with a **measuring instrument**
- includes both a **number** and a **unit**
- **units** of measurement are essentially **arbitrary**: people make them up and then agree to use them

Measuring is an important part of everyday life!

What can we measure?

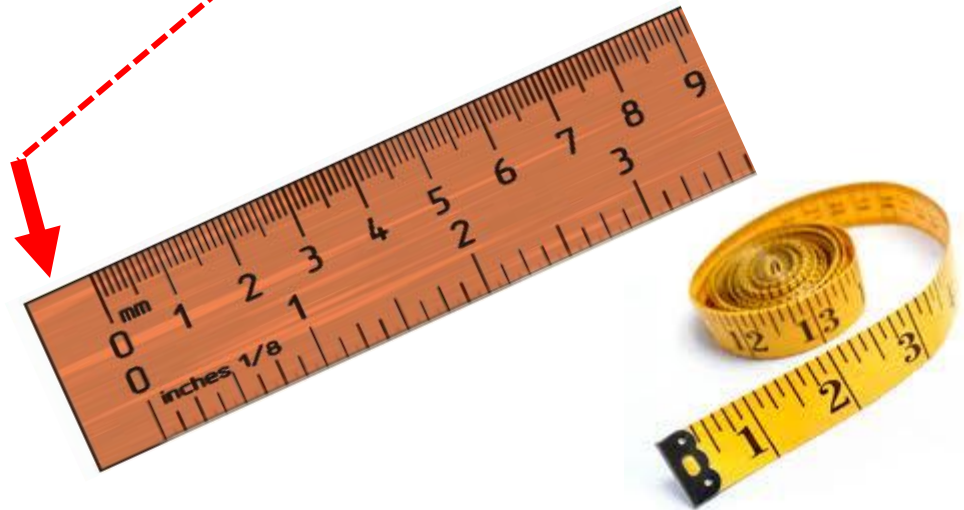
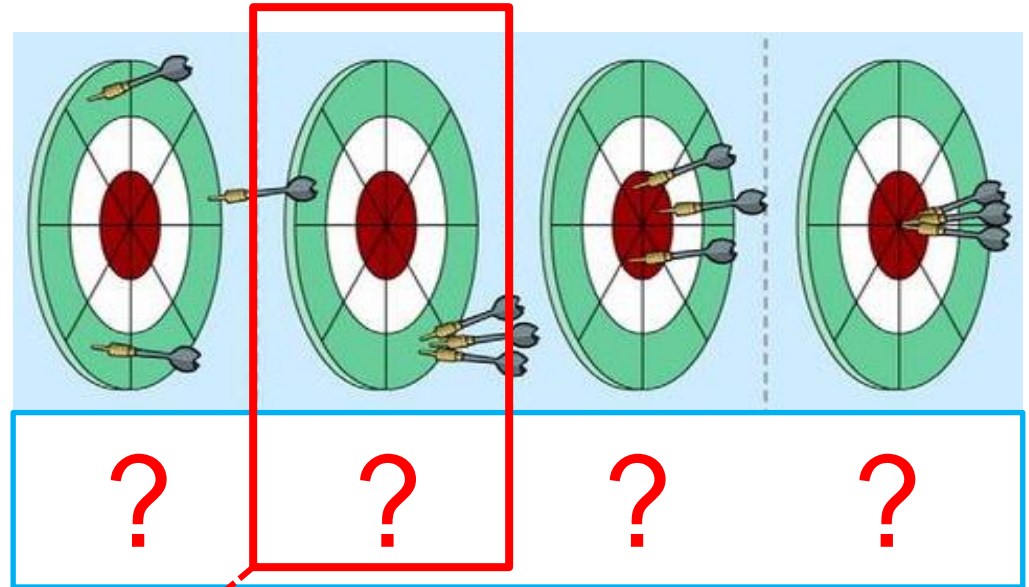
Why do we measure?

How can we measure?

How well can we measure?

How good is the measurement?

- **Accuracy** is how close a measured value is to the *actual (true) value*.
- **Precision** is how close the measured values are to *each other* (repeatability and reproducibility).
- **Bias** is a built-in (systematic) error which makes *all measurements wrong by a certain amount*.



WHAT can we measure?

- Length
- Distance on land
- Depth of water
 - Mass
- Temperature
 - Time
 - Light
- Electric current
 - Color

And HOW?

- ✓ Ruler
- ✓ Measuring Chain/Tape
- ✓ Sonar (echo sounder)
- ✓ Weighing scale
- ✓ Thermometer
- ✓ Clock, timer
- ✓ Photometer
- ✓ Ammeter
- ✓ Spectrometer

**AND
SO
ON...**