Ways of Acquiring Knowledge

Informal Methods
1. Authority
2. Tenacity
3. Experience

Formal Methods
1. Induction
2. Deduction
3. Scientific Method
Learning Targets

1a. Identify, describe, and give an example of each of the six ways of acquiring knowledge.

1b. Identify a strength and weakness of each of the six ways of acquiring knowledge.
Learning Targets

2a. Identify the steps in the Scientific Method, in order.

2b. Describe the two essential characteristics of a good experiment.

2c. Define the three types of variables that may occur in an experiment.

2d. Describe the difference between the experimental group and control group in an experiment.

2e. Describe the function of a control group in an experiment.
Informal - Authority

Knowledge gotten from “worthy” source

Examples of sources, worthy or not?

• Experts (Aristotle, Einstein …)
• Parents
• Teachers
• Books, including textbooks
• Prophets (Christ, Buddha, Mohammed …)
• Internet, news media
• Tyrants (like Hitler)
• Bigots, and other morons
Informal - Authority

**Advantages?**
- Very easy
- Valid if source is good
- Can find an “authority” for any topic

**Disadvantages?**
- Easily leads to invalid “knowledge” if source is not properly evaluated
Informal - Tenacity

Knowledge that’s been passed on for so long it gains veracity (Persistent)
• Frequently involves subjects that we don’t want to consult authorities about
• Examples: Old Wives’ Tales?
• Examples: Stereotypes?
• Examples: Scientific “Laws”
Informal - Tenacity

Advantages?
• Very easy, even bypassing authority

Disadvantages
• Unchallenged and therefore often often wrong
Informal - Experience

Learning from what we experience

“The best teacher”, assuming the experience is interpreted properly

Examples?

Learning that the stove is hot

Snake bites you once, it’s his fault; snake bites you twice, it’s your fault

Hands-on-learning, labs, etc…

Discipline: misbehavior followed by consequences

Operant Conditioning, Behavior Modification

My father’s mugging
Advantages?

Best to rely on own experiences, or are experiences of “authorities” more useful?

Experiences happen all the time

Disadvantages?

Misinterpretation of experience: the pan isn’t painful, it’s the heat; the mugger’s race is irrelevant, etc…

We can’t experience everything, atoms for instance (that’s where authorities take over)
Formal - Induction

- Reasoning from specific examples to a general conclusion.
- Example: Dissect 10 cats and find they all have a four-chambered heart, conclude that all cats have 4-chambered heart.
- Logical process formalized by Francis Bacon in 15th century (see handout)
- Perfect induction: Dissecting every cat on the planet to be sure.
- Surveys are examples of induction.
Formal - Induction

**Advantages**
- Solid, for the group being examined

**Disadvantages**
- Only applies to group examined
- The larger the group, the more work
- Perfect induction impossible
Reasoning from general principles to specific conclusions

The reasoning process is called a *syllogism*, which consists of a major premise, a minor premise, and a conclusion.

Example: I know heavy objects fall faster than light objects. A billiard ball is heavier than a tennis ball. Therefore, a billiard ball will fall faster than a tennis ball.

A *non-sequitor* is when the logic of the syllogism goes awry.
Formal - Deduction

**Advantages**
- Logical
- If done carefully, gives good results

**Disadvantages**
- Requires pre-existing premise; where does this come from, and is it good?
- Non-sequitors; misapplied logic
Formal - The Scientific Method

Combines the best of induction and deduction

The ultimate process for advancing knowledge

Four (or so) steps:

– Observation of interesting phenomenon, followed by more research
– Hypothesis
– Experiment
– Conclusion
– (Repeat as needed)
Observation

Observation is induction

Subsequent research is deduction, and may include reliance on other authorities

Genius: Newton was the first person to observe that apples always fall down; Einstein was the first person to seriously wonder about an absolute point of reference
Hypothesis

- Word origin
- Books call this “educated guess” which is nonsense
- Better thought of as an untested, preliminary conclusion
- Can (should?) be expressed as “If…then”
- Follows directly from the initial observations
- Leads to experiment
- Occam’s Razor: when faced with 2 or more hypotheses, pick the least complicated
Experiment

- Follows directly from the Hypothesis
- Leads to the conclusion
- The part of the Scientific Method we cut corners with in everyday life
- Three variables in an experiment: independent, dependent, and extraneous
- Two essentials of a good experiment are the control group and having just one independent variable
- Galileo was a brilliant experimenter; Aristotle considered experimentation to be low-brow
Conclusion

- Follows directly from experiment
- Leads to more cycles of scientific method
- Conclusion that has been tested hundreds of times becomes a *Theory*
- Theories that have been tested thousands of times over many years become *Laws*
- We’re too cynical to do “laws” anymore
Problems with Sci Method

- Hypothesis must be based on Observation, Experimental designed based on Hypothesis, Conclusion based on Experiment
- Good experiments are VERY hard to execute
- Easy to fall in love with hypothesis
- A lot of work
Advantages of Sci Method

- Gives good results
- Repeatable
Conclusions: Correlation vs. Cause and Effect

Correlation means there is some connection between two variables, but not necessarily a cause and effect one.

Scientists are very hesitant to describe a relationship as cause and effect.

Examples:
- Marijuana as a gateway drug
- Lower pregnancy rates among volunteers
- Relationship between rape and ice cream sales
- Being a Sr. Mentor and being in AP courses
Example of Sci Method

Observation: I notice that my pet pigeon, having escaped from its cage 150 miles from home, manages to find it’s way home

What next?