Advanced Biology Lab Investigations

Advanced Level Biology Lab Investigations

By

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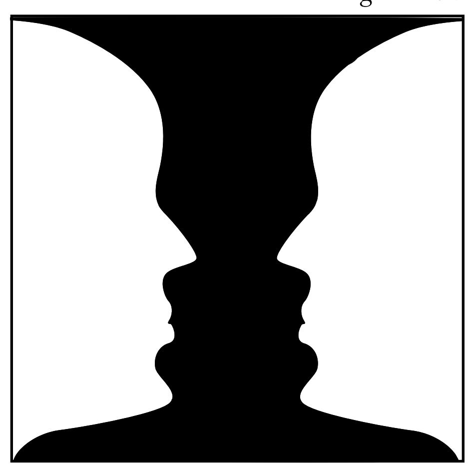
What is Science?

Science is a continual process of repeated examination, criticism, and revision…

Although the Latin root meaning of the word **science** (scientia) is **knowledge**, we might consider expanding this meaning of scientific knowledge to: **to learn** or **to explore**. Improving the various aspects of our knowledge, and the tools we use to advance it, is what science seems to be all about. Every aspect of the process and contents of science is open to **repeated examination, criticism and revision**.

Today, science can be defined as the investigation of nature through observation and reasoning, aimed at finding out the truth. Scientists need to be willing to seek out and accept criticism. If the goal is truth, then the individual through whom the truth is revealed should not be of consequence, providing the means are moral. It seems that many times these things have an impact: personal ambition, prejudice, false assumptions, and beliefs about the existence or non-existence of greater beings or a Supreme Being. **To the true scientist, all of these should be of absolutely no consequence. Truth and truth alone is what should matter.** To eliminate a line of reasoning because you don't like the conclusion is poor science. Sir Arthur Conan Doyle once said through fictional investigator, Sherlock Holmes, "Once you eliminate the impossible, whatever remains, no matter how improbable, must be the truth." We see clearly in a court of law that someone who is prejudiced cannot be a juror. The same must be true for science.

Figure 1.0 a



Vase or face?

While generally not accepted or admitted, fundamental beliefs, world views, and expected outcomes have an impact on scientific conclusions. A Westerner would often take the view that either argument "A" is correct or argument "B" is correct. On the other hand an Easterner might take the view that both argument "A" and "B" are correct. So which is right? Is the "either/or" view correct or the "both/and" view correct? To illustrate this, see Figure 1.0 a. Does this represent a figure of a vase or two faces? With the amount of information available, it would seem the "both/and" view would be the best way to go. Poor scientists might say, "The figure is a vase and I'm going to prove it!" and then proceed to search for evidence that this is a figure of a vase. This is called a **Ruling Theory** where evidence is deliberately sought out that supports the theory while conflicting evidence is ignored. Ultimately, there is truth but unless we are all-knowing, we must have an open mind. In the case of the figure, it is very possible that it represents something totally different from a vase or two faces. Without more information, there is only speculation.

In this biology lab course, we will attempt to be open-minded and careful to recognize **underlying assumptions about what is evidence and what is extrapolation** or what is interpretation based on different perspectives. However, just as in a court of law, sometimes plain and logical evidence is silenced. While this is absolutely wrong in science, it is the truth. **When evidence is silenced, the scientist's philosophy becomes his religion.**

What is Inquiry?

Ralph Waldo Emerson once said "Men love to wonder, and that is the seed of science."

Inquiry based learning is the foundation of this Advanced Biology curriculum. Inquiry is a method of scientific investigation that stems from the curiosity of the student. It encourages students to formulate their questions, pursue research, and design their own experiments. It is based on current brain research that shows brain activity in the long-term memory areas when students are actively pursuing their own quests. Teachers take a very different role as curators or facilitators instead of the traditional lecturer.

The new 2013 Advanced Biology curriculum recognizes the engaging and motivational benefits to the student for inquiry learning and encourages depth of investigation and critical thinking as opposed to breadth with surface memorization.

John Dewey recognized the importance of student discovery in the early 1900s and started his Chicago laboratory for high school students. He said, **"Every great advance in science has issued from a new audacity of imagination."**

Guided instruction for inquiry based student investigations

Inquiry based labs allow students to engage in science practices that require them to think and act like scientists. There are several levels of inquiry based learning. 35 percent of the QSL wet labs investigations are inquiry. In the one-year Advanced Biology Quality Science Lab kits (semesters 1 and 2), there are a total of 32 labs: nine are pre-labs, and of the 23 investigative wet labs, eight are inquiry based, student guided investigations. Students are encouraged to research, select their driving question from a list of choices (although they are not limited to these choices), design their own labs using the Experimental Design (ExD) format, and conduct their own experiments. These are student guided because lab practices and techniques needed in the inquiry investigations are modeled after previous guided instruction lab investigations, data collection, and data analysis.

About the Author

Marlene Kent has a Biological Science degree from California State University at Fullerton, a USC Masters in Systems Management, and is currently a Ph. D. candidate in Educational Technology. She worked in biomedical and aerospace engineering and is a certified quality engineer. She has taught community college technology courses in addition to high school and middle school sciences and math. Marlene is currently retired from serving over 18 years in education. She is responsible for developing Mobile Science Labs for home school students and mentoring robotics high school competition teams. Her hobbies include kayaking, white-water rafting, working with home school students in the sciences, and being a grandmother.

Supplies Included

Equipment

24-well reaction plate
Beads, black
Beads, white
Beaker, plastic 150 ml
Beaker, plastic 30ml
Beaker, plastic 50ml
Conductivity Tester
Cups, 2oz
Cups, 9oz
Dialysis tubing
Digital scale
Forceps
Gloves, disposable
Graduated cylinder, 10ml
Magnifying glass
Microscope coverslips
Microscope slides
Microscope slides, concave
Paper lunch bag
pH paper indicator strips
Pipet, 1ml, serological
Pipet, mini (fine tip)
Pipets, graduated
Razor blade, straight edge
Ruler, 15 centimeter
Safety goggles
Stopwatch
Syringe, 5cc
Syringe, 60cc
Test tube rack
Test tubes with caps
Thermometers
Toothpicks
Tubing, 1 cm silicon

Solutions

Red food coloring
Hydrochloric acid, 0.1 M
Iodine solution
Toluidine blue stain (0.5%)

Solids

Glucose (dextrose)
Glucose test strips
Lactase tablets
Ovalbumin powder
pH Buffers 4.0 in test tube
pH Buffers 7.0 in test tube
pH Buffers 10.0 in test tube
Protein test strip
PTC Test strips
Yeast envelope

Other

Biotech transformation kit

Supplies Needed

LAB 1

Computer

Spreadsheet program (Microsoft® Excel, Google® Docs, etc)

LAB 2

Computer

Internet access

LAB 3

Potato, peeled

Table salt

Table sugar

Distilled water

Microscope

Elodea water plant

LAB 4

(2) onion bulbs

(2) glass canning jars

Microscope

Paper towels

Distilled water

Light bulb heat source

LAB 5

Table sugar

Distilled water

Knife (for cutting lactase enzyme tablet in half)

(2) Spoons (for crushing lactase tablet)

Whole milk

LAB 6

Baking soda
Liquid dish soap
Living leaves (like spinach, ivy, etc.)
Hole punch
(2) clear plastic cups
Light source

LAB 7

Incubator oven at 37 °C
Ice water bath (crushed ice)
Warm water baths (Styrofoam cups) at 42 °C and 37 °C
Microwave oven
Marking pens (red and green)
Masking tape

LAB 8

Corn syrup, dark
Distilled water
Glass jar
Tape