

CHAPTER 2: Involving Learners in Doing Science

***Teaching Science Through Inquiry and
Investigation***

**Twelfth Edition
Contant/Bass/Carin**

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What's Curiosity Got to do with Science?

Scientists thrive on **curiosity**—and so do children. Children enter school alive with questions about everything in sight, and they differ from scientists only in not yet having learned how to go about finding answers and checking to see how good those answers are. Science education that fosters **curiosity** and teaches children how to channel that **curiosity** in productive ways serves both students and society well.

What Part do Imagination, Wonder, and Enthusiasm Play in Science Education?

“All my life through, the new sights of Nature made me rejoice like a child.”

~Marie Curie

“Every kid starts out as a natural-born scientist, and then we beat it out of them. A few trickle through the system with their wonder and enthusiasm for science intact.”

~Carl Sagan

“The true sign of intelligence is not knowledge but imagination.”

~Albert Einstein

What Does Doing Science Mean to you?

“Effective teachers of science understand what it means to do science.”

-Vasquez, 2008

“It is the supreme art of the teacher to awaken joy in creative expression and knowledge.”

- Albert Einstein

“Science does not know its debt to imagination.”

-Ralph Waldo Emerson

“The whole art of teaching is only the art of awakening the natural curiosity of young minds or the purpose of satisfying it afterwards.”

- Anatole France

What are Science Process Skills?

During the 1960s science educators identified a set of discrete skills called science process skills. They thought that science is best learned by doing science; that children should learn processes, not memorize facts; and that if students practiced and mastered individual skills, they would be able to use them to solve scientific problems.

Science Process Skills

Basic	Integrated
Observing	Controlling Variables
Inferring	Defining Operationally
Measuring	Hypothesizing
Communicating	Interpreting Data
Classifying	Experimenting
Predicting	Formulating Models

There is no single accepted list of science process skills.

Science Process Skills & Inquiry

Asking questions related to the world around us and recognizing that different questions are answered in different ways are important skills for **doing science**.

“The important thing is not to stop questioning. Curiosity has its own reason for existing.”

~Albert Einstein

According to the National Science Education Standards (1996) **asking questions** about objects, organisms, and events in the world around us is also the very first task in inquiry.

Science Process Skills

INQUIRY

OBSERVING

Noting the properties of objects and situations using the five senses (may involve instruments that extend the senses.

- ~Seeing
- ~Hearing
- ~Touching
- ~Smelling
- ~Tasting

Observations are either qualitative or quantitative:

- Qualitative observations describe the qualities or properties of the object, organism, or event that is observed.
- Quantitative observations involve numbers, based on counting or measurement.

Science Process Skills

INQUIRY

CLASSIFYING

Relating objects and events according to their attributes
May involve classifying:

- Places
- Objects
- Ideas
- Events

MEASURING

Expressing the amount of an object in quantitative terms, or comparing an object to a standard

Examples:

- Length in Meters
- Volume in Liters
- Mass in Grams
- Force in Newtons
- Temperature in Degrees Celsius

Science Process Skills

INQUIRY

COMMUNICATING

Process of describing, recording, and reporting experimental procedures and results to others

- May be oral, written, or mathematical
- Organizes ideas using appropriate vocabulary, graphs, other visual representations, and mathematical equations.

- Analyze and interpret information using:
 - Direct evidence
 - Indirect evidence
- Communicate valid conclusions
- Construct (using computers)
 - Simple graphs
 - Tables
 - Maps
 - Charts

Science Process Skills

INQUIRY

INFERRING

Giving an explanation or tentative conclusion about objects, events, or organisms based on observations and prior knowledge

...Inferring looks back in time.

PREDICTING

Forecasting a future occurrence based on past observations and/or patterns in data

...Predicting looks forward in time.

Science Process Skills

INQUIRY

QUESTIONING

Ask questions that can be answered through scientific investigation

HYPOTHESIZING

Making a statement (possible answer) to guide an investigation of a question.

Science Process Skills

INQUIRY

EXPERIMENTING

Testing a hypothesis through the manipulation and control of independent variables and noting the effects on a dependent variable.

INTERPRETING

Arriving at inferences, explanations, or hypotheses from data that has been placed in a data table or graph

Controlled Experiments

Elementary school students seem to understand controlled experiments better when they think of them as **fair tests**.

Controlled experiments involve:

1. Deliberately changing one variable at a time,
2. Observing the effect on another variable, while
3. Holding all other variables constant.

Three Types of Variables Important in Scientific Investigations

A **variable** is a property of objects or events that can change, has variations, or has differing amounts.

- A **manipulated variable** (also called an **independent variable**) is a variable that the experimenter deliberately changes or manipulates in an investigation.
- A **responding variable** (also called a **dependent variable**) is a variable that changes in an investigation in response to changes in the manipulated variable.
- **Controlled variables** are variables that are deliberately kept constant or unchanged in an investigation in order not to confound the results—that is, so the investigation is a fair test.

Fundamental Abilities Necessary for Students to Do Scientific Inquiry

Asking Questions

Planning and Conducting Investigations

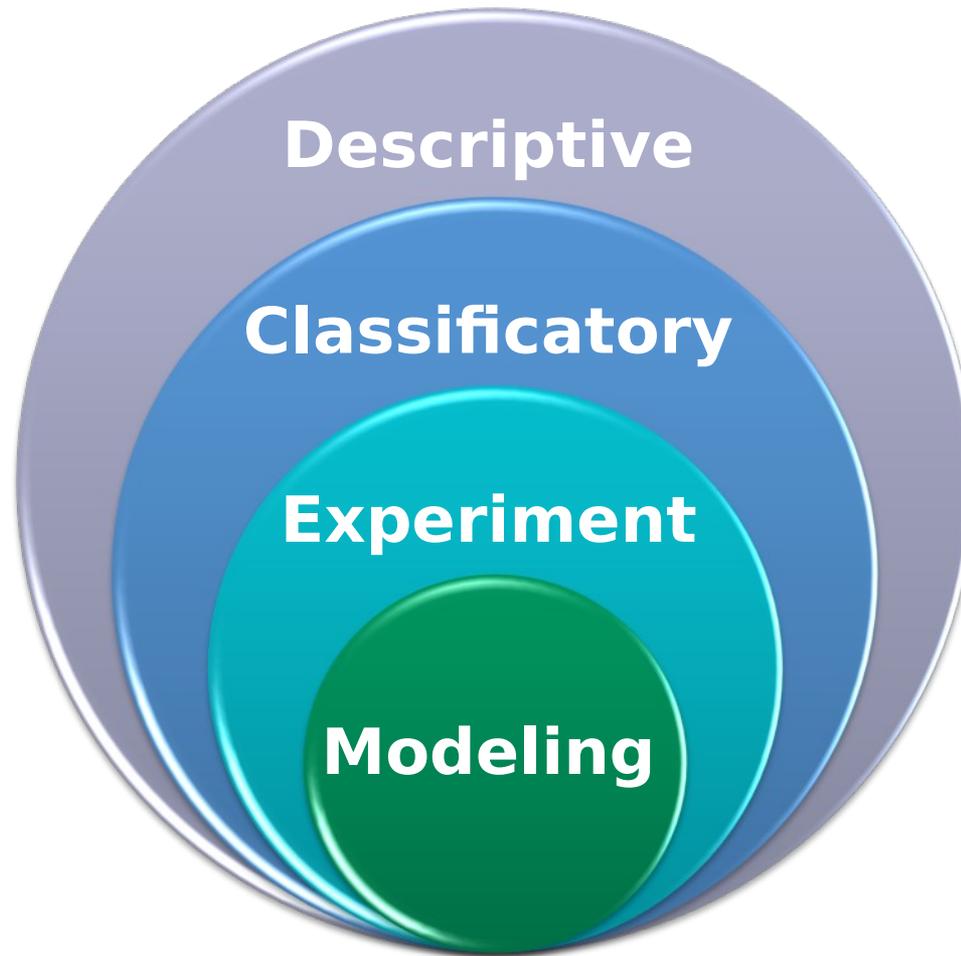
Gathering and Analyzing Data

Developing data and/or evidence-based explanations

Communicating About Investigations

Common Types of Science Investigations for Grades Pre-K through Eight

There is not a single, fixed set of steps that scientists always follow in doing science, no one path that leads them unerringly to scientific knowledge (AAAS, 1990)



According to the *National Science Education Standards*, children should become familiar with these types of investigations.

Technological Design and How it Relates to Scientific Inquiry

As stressed in the *National Science Education Standards*, science and technology are closely related, but their goals differ. The **goal of science is to learn about the natural world**, while the **goal of technology is to modify the world to meet human needs** (NRC, 1996).

Compare and contrast the **Fundamental Abilities Necessary for Students to Do Scientific Inquiry** slide #16 with the **Tasks of Technological Design** slide #19.

Tasks of Technological Design

Stating a
Problem

Designing an
Approach

Implementing a
Solution

Evaluating the
Solution

Communicating
about the
Problem Design,
and Solution

Final Thought

“Imagination will often carry us to worlds that never were. But without it we go nowhere.”

~Carl Sagan