Knowledge: What is It? What Kinds are There? How do We Construct It?

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2025

What Is Knowledge?

Teachers help students to construct (gain, figure out), apply or use, and improve knowledge. But what is knowledge? This chapter draws on the long history of work on *epistemology*, or the study of knowledge. Important sources are in the Reference section.

Knowledge is our human picture (representation) of reality.

Over thousands of years, human beings have learned that there are (so far) five “things” that make up our reality---five that we can discover (construct, figure out), store in language, text, and art, and communicate. The five kinds of knowledge are

1. *Classes/concepts/names*. These are the main chunks of that make up our world. Shapes, colors, objects, persons, animals, activities, and millions more. Classes and concepts are groups or collections of individual things (examples) that are the same in certain features that *define* the class or concept and its name.

2. *Facts* are statements of subject and predicate about *individual examples* of classes/concepts. We learn that “The Earth (subject: an example of the class or concept, planet) is the third planet from the Sun. Its circumference is about 25,000 miles (the predicate that tells about the subject).”

3. *Rule relationships* (Kameenui & Simmons, 1990) are statements about how whole *classes of things* are connected. “All (things in the class of) turtles are (in the larger class of) reptiles.” “When temperature decreases (the class of examples of temperatures decreasing), some animals go into hibernation (hibernating animals is another huge class).”

4. *Routines, or strategies* (Kameenui & Simmons, 1990), are steps, phases, or stages in Nature and in human tasks. For instance, stages of child development, stages by which mountains emerge and change (the rock cycle), steps for decoding words, solving math problems, and doing inquiry projects.

5. *Behavior* (Bandura & Walters, 1977; Lindsley, 1991; Powers, 1973; Skinner, 1965) is movements, usually with some purpose: reading aloud, writing numerals, taking notes on a Nature scene, climbing a mountain to take rock samples.

Knowledge Analysis

Here’s an activity that reveals the five kinds of knowledge. Let’s *construct knowledge* of this mountain scene. Here are the steps in the knowledge-constructing routine. Let’s scan the scene; focus on something of interest; notice its features; use these features to identify it; tell (list) what we’ve found; and continue until there is no more to be learned.

Figure 1.1. Mountain Scene. What Kinds of Knowledge Does it Contain?



1. *What Classes/Concepts/Names, and Their Examples, Are “In” The Scene?*

Here are classes/concepts/names that you might teach, or that students (who have prior knowledge of classes in Nature) might identify.

* Things that are (in the classes of) geological formations; things that are mountains; things that are peaks, slopes, snow, precipitation, glaciers, and rock debris; things that are angles and slopes; things that are triangular; things that have height, mass, and density; things that have three dimensions.
* Things that are (in the classes of) liquids, things that flow; things that move, things that have momentum; things that are water, things that are clouds, skies, streams, rapids, and snow.
* Things that are (in the classes of) living things; things that are plants, grasses, and evergreens; things that are green; things that are pine trees; things that change with temperature and sunlight; things that have life cycles; things that store energy; things that turn water, carbon dioxide, and sunlight into oxygen; things that are carbon-based life forms.

Can you find any more classes?

*Fact Knowledge*

Facts are the second kind of knowledge that we might *construct* (find, name) and then *know* *about* the scene. Facts (statements of subject and predicate) *tell the features of individual things that are examples of classes*. What facts do we get from---what facts are in---our mountain scene?

* “Two mountains (subject) have snow (predicate).”
* “The two mountains have steep slopes.”
* “The closer mountain has the shape of an equilateral triangle.”
* “A stream (subject) flows down from the mountains and has cold water (predicate).”
* “Some trees (subject) are green and are growing straight and tall (predicate).”

Can you state any more facts?

We will teach students what facts are (statements of subject and predicate about examples of classes); how to *find* lots of fact knowledge in the scenes around them and in text (scan, focus, identify); and to *list* (tell) facts to form *descriptions*. And chapter 12 shows exactly how!

*Rule Relationships*

Here are some rule relationships that we can find in, and that help to explain how things *work* in, the mountain scene.

* “The faster the snow on the mountain melts, the faster it flows down the mountain (causal rule).”
* “All mountains are in the larger class of geological formations (class/category rule).”
* “Wind, water, and ice cause rocks to break loose and pile up (as debris) at the foot of a mountain (causal rule).”
* “Over millions of years, the compressed debris forms metamorphic and sedimentary rock (causal rule).”

*Routines* Some routines (sequences of stages or phases) that we find in the mountain scene are

* Stages by which plants grow from seeds.
* The rock cycle by which mountains form and are transformed.
* Changes in temperature, precipitation, plants, water, and rocks over the seasons.

Can you find any more routines?

*Behavior*

Possible behavior knowledge: knowledge of how to climb a mountain, or knowledge of how to build a bridge across the stream.

What Can We Do with the Knowledge Analysis?

We use our knowledge analysis of the scene to select classes/concepts, facts,

rule relationships, routines, and behavior to teach in 5-part lessons!

If we are smart (which we are!), we will *teach students themselves* to do knowledge analyses of Nature scenes, text, math problems, works of art, speeches, and so on.

Here’s a Big Idea…

All subjects (knowledge systems) consist of the same five kinds of knowledge.

Everything that human beings teach, learn, know, tell, use, and store in language, thoughts, computers, notebooks, videos, documents, textbooks, and art—consists of these and only these five kinds of knowledge.

“Why only these five?”

Because these are the only kinds of knowledge that our

sense organs and nervous systems seem designed to construct.

So, everything in a school’s curriculum (what the school teaches), in its materials (reading, math, science, history, art), and in lessons and independent activities, is made of the *same* five kinds of knowledge. The particular subject (*knowledge system*) does not matter. Because each subject (*knowledge system*) has its *own* set of classes/concepts, facts, rule relationships, routines, and relevant behavior. Here are examples. <Insert table 1.1 near here.>

Table 1.1. All Subjects (Knowledge Systems) Consist of the Same Five Kinds of Knowledge

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Classes, concepts,  names | Facts | Rule relationships | Routines | Behavior |
| Math | Things that are numbers, slopes, numerals, linear, powers, angles, triangles, sines, cosines, scalene, estimations, bisections, equations, plane figures. | “The slope of this line (subject) is y = 3x + 4 (predicate).”  “This graph (subject) shows a curvilinear function (predicate).” | “If you subtract a number from the  left side of an equation, you  have to do the same thing on the right side.” Pythagorean theorem (right triangle): a2 + b2 = c2 | Steps in long division. Steps  in finding  the slope  and  intercept. | Plotting X and  Y values on a graph by hand. Typing data  into a  computer. |
| Science | Things that are solar systems, gravity, frequency, ecosystems, centrifugal force, energy, particles, waves, quanta,  cells, Space, Time, cosmos, galaxies, molecules, entropy, DNA, mitosis. | “The Earth (subject) has one moon (predicate).”  “This rock (subject) is granite (predicate).” | “The *farther* a planet is from the sun the *larger* is its orbit around  the Sun.”  “*Denser* matter moves to the *center* of a forming star.” | Phases of  cell division. The life  cycle of toads. Steps in  performing an experiment.  Steps in doing an inquiry project. | Using a thermometer to measure water temperature in Hardy’s Pond.  Writing and telling what  you did and what you found in each step in an inquiry project. |
| History | Things that are civilizations, political systems, monarchies, rights, authority, power,  legitimacy,  opposition  groups, ideology, representation, war, civil war, democracy,  conflict, constitution, feudalism,  medieval,  ancient,  civilization. | George Washington (subject) was the first President of  the United States (predicate).  The U.S. Constitution (subject) was signed by 39 delegates to  the Constitutional Convention,  on September 17, 1787 (predicate). | When a group  gains *power* (the ability to get  other persons to do what it wants  despite resistance),  it tends to become *corrupt* (to  violate rules and  principles so as to serve its interests).  The more a ruling class uses *violence and threats* against the People to  achieve its ends,  the more *resistance*  it evokes from the People. | Analyzing historical documents  to find and restate the author’s argument.  Arranging facts into a timeline of events. | Reading text  out loud.  Writing or typing notes.  Drawing diagrams. |

Let’s Sum Up

* All knowledge systems (subjects) consist of the same five kinds of knowledge: classes/concepts/names; facts, rule relationships; routines, and relevant behaviors.
* Each subject (knowledge system) has its own set of classes, concepts, names; facts; rule relationships; routines; and relevant behaviors.
* Therefore, no matter what we teach, *we are always teaching the same kinds of knowledge.*
* As you will see in chapters 10-14, there are standardized, effective instructional *formats* (teacher-student communications) for teaching each kind of knowledge.
* Therefore, no matter what the subject is, we teach classes, concepts, names; facts; rule relationships; routines; and relevant behaviors *in much the same way*.

What are the Steps in the Knowledge Construction of Classes/Concepts, Facts, Rules, Routines, and Behavior?

Here’s a simple example.

Figure 1.2. “This is blue.” Figure 1.3. “This is not blue.”

* We scan the two objects.
* We notice their features.
* We see which features are the same (compare) and which ones are different (contrast).
* The nervous system then uses the Method of Difference, as described by Mill (2011) and by Copi, Cohen, & McMahon (2016), to figure out that “blue” can’t be (can’t be defined by, can’t mean) the shape, or the size, or a thing that has lines, or a thing that has four lines or four corners. Why? Because both the example and nonexample of “blue” are the same in these ways.

If they are the same in these ways (shape, size, having four lines and four corners), but one is in the class of blue and the other is not in the class of blue, then shape, size, and having four lines and four corners can’t be what makes one “blue” and the other “not blue.”

So, “blue” must mean (must be defined by) the color sensation—

which is the *only difference* between “blue” and “not blue” or “blue” and “red.”

To draw (construct) this conclusion, the nervous system performed a little routine of *inductive reasoning*, called the “Method of difference” to figure that out.

An Exercise to Demonstrate How We Construct Knowledge

Here is an exercise adapted from Siegfried Engelmann and Douglas Carnine (Engelmann& Carnine, 1982) that demonstrates *that* we do construct knowledge and *how* we construct knowledge; namely, we figure out the general idea (concept, rule, routine) through the steps of inductive reasoning, described by Mill (1882) and Copi, Cohen, & McMahon (2016).

Listen to what you tell yourself as you go from one example or nonexample to the next. <Table 1.2 near here.>

Table 1.2. Which Features Define and Which Do Not Define the Class, Concept, Name Moof?

In other words, let’s construct (figure out) the concept/vocabulary word Moof by comparing and contrasting examples and nonexamples, and then using inductive reasoning to construct the definition—a generalization. This is how we do it, though we rarely notice it. This how students’ nervous systems are *trying* to do it. So, we need to communicate the examples and nonexamples clearly.

|  |  |
| --- | --- |
| Someone shows you these items  and names them—Moof or not Moof.  Your job is to figure out what features define Moof---the features that make examples Moofy vs. not Moofy?  You might keep track by making a list of what features you think  define Moof vs. what features are irrelevant. | Your reasoning might go like this…  a. “Moof might be defined by…”  b. “I think Moof is defined by…”  c. “I am certain that Moof is defined by….” |
| 1. % ^ \* ) @ +  This is Moof. What is Moof?  2. @ ^ r = + \* )  This is Moof. What is Moof?  3. \* & % f ^ ) @  This is Moof. What is Moof?  4. ) ^ \* @ % \  This is Moof. What is Moof?  5. \* % )  This is NOT Moof. What is Moof?  6. \* ^ ) % $  This is Moof. What is Moof? | 1. No idea. Moof could be defined by any feature, all features, or some combination. Since examples of any class/concept will have several features, can we teach a whole class/concept (linear, red, plant, reptile) with just one example? *No.* If you show a snake and say, “This is a snake,” it’s not clear what features put it in the class of snakes. Size? Shape? Color? Movement? Skin? No legs? Many other classes of animals have some of these features but aren’t snakes.  2. How are 1 and 2 (both Moofs) the same?  In one way only? Several ways? How can we narrow  it down? We need more examples. It’s a process of elimination.  3. Comparing 1, 2, and 3 can we eliminate any features? That is, is it still Moof *without* certain features? Which features can we say are not part of Moofiness?  4. So far, which features are always there when it’s Moof? [The method of agreement.] Can we eliminate any more features because it’s still Moof without  them?  5. I think I know which feature makes it Moof. Let  me contrast 4 and 5. Is there a remaining feature in 4 that (when not in 5) results in 5 being not Moof? [The method  of difference.]  6. Does 6 have any features that were absent in not Moof 5 but were in all of the other Moofs? That  feature logically defines Moof and is the difference  between examples that are Moof vs. not Moof.  Hint. Which feature is always in Moof (the Method of Agreement), but is missing in not Moof (the Method of Difference)? Could it be ^? |

That is how the nervous system uses the logic of comparing and contrasting examples and nonexamples to figure things out in everyday life and in the practice of well-designed research. “What is always there when people have diabetes, and not there when people don’t?”

Not age, sex, weight, race, culture, diet, or shoe size. It’s high blood sugar! If that is the difference between having and not having diabetes, then that (not shoe size, race, diet, sex, weight, or age) is probably a cause of diabetes.

Note. Sometimes we think/talk ourselves through the knowledge-constructing process. Imagine how smart students will be when you teach them to do that process.

The Table of Contents shows that we next focus on how to scaffold curricula for *content knowledge subjects* (history, literature, art, social studies, much of science) and then for *tool skill subjects* (reading, math, spelling, and much of science). After that, we will examine basic tools for teaching any subject (by helping students’ nervous systems to construct and then apply knowledge)---all leading to 5-Part Lessons.

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