# 10

# Classification as Context

Classification refers to the act of putting elements in a group based on similarities; this is the same operation in the making of sets. For the purpose of this discussion, *set* is another word for *class*.

A fundamental process in cognition and an important ordering method in writing, classification imposes order on animate and inanimate objects, states, and phenomena. Classifications do not occur in nature; human beings identify patterns and impose categories on them. The classification of phenomena leads to the formulation of concepts and definitions. Classifications are important in science because they enable the codification and regularization of discrete data. Classification, by asserting a relationship of likeness between elements included in a class, describes patterns.

- What's wrong with this picture? (Circle the element that doesn't fit in.)

[peso, lira, dollar, pound, tobacco]
[hydrogen, carbon, methane, oxygen]
[fish, whale, dolphin, porpoise]

In the first instance, *tobacco* does not fit into the group of items because three of the four items in the set are types of currency. *Methane*, a molecule composed of carbon and hydrogen, differs from the other items which are single elements. While fish and dolphins are marine animals, *fish* is the only non-mammalian listing in a series otherwise composed of marine mammals. Most people can recognize a pattern and spot the variation in the pattern; science involves working with the most generally understood and recognized types of pattern. Pattern recognition, whether intuited or explicated, forms the foundation for the operation of classification.

## The Importance of Classification

Classification is important because it gives us a perspective on the object in

question. Classification defines what we see because it determines HOW we see. HOW we see defines the way we TREAT the object in question. Classified as a source of animal products, whales at one time were killed for dog food; classified as an endangered species, whales are protected from commercial hunters.

Most states require testing for sexually transmitted diseases (STDs) before marriage. All states have laws requiring public health care agents to report STDs to the health department. In the matter of STDs, the individual's right to confidentiality is superseded by rule of law. While sexual intercourse offers one route of the transmission of AIDS, most states have not classified AIDS or HIV+ status as an STD, and hence, the disease does not legally fall under the laws which require reporting.[1] While some states have laws requiring public-health reporting, this decision is made at the state level not the national level. If the disease were to be formally classified as an STD, then the way that cases are treated would be subject to regulation at a national level.

S. I. Hayakawa, a linguist and former Senator from California, had this to say about classification:

> Most intellectual problems are ultimately problems of classification and nomenclature. Some years ago there was a dispute between the American Medical Association and the Antitrust Division of the Department of Justice as to whether the practice of medicine was a "profession" or "trade." The American Medical Association wanted immunity from laws prohibiting "restraint of trade"; therefore, it insisted that medicine is a "profession." The Antitrust Division wanted to stop certain economic practices connected with medicine, and therefore it insisted that medicine is a "trade." Partisans of either side accused the other of perverting the meanings of words and of not being able to understand plain English.... Is aspirin a "drug" or not? In some states, it is legally classified as a "drug," and therefore it can be sold only by licensed pharmacists. If people want to be able to buy aspirin in groceries, lunchrooms, and pool halls (as they can in other states), they must have it reclassified as "not a drug."
>
> In any case, society as a whole ultimately gets, on all issues of wide public importance, the classification it wants, even if it has to wait until all the members of the Supreme Court are dead and an entirely new court has been appointed. *In short, society regards as "true" those systems of classification that produce the desired results.*
>
> The scientific test of truth, like the social test, is strictly practical, except for the fact that the "desired results" are more severely limited. The results... decided by scientists are only that our systems produce predictable results. Classifications, as already indicated, determine our attitudes and behavior toward the object or event classified. When lightning was classified as "evidence of divine wrath," no courses of action other than prayer were suggested to prevent one's being struck by lightning. As soon, however, as it was classified as "electricity," Benjamin Franklin achieved a measure of control over it by his invention of the lightning rod. Certain

physical disorders were formerly classified as "demonic possession," and this suggested that we "drive the demons out" by whatever spells or incantations we could think of. The results were uncertain. But when those disorders were classified as "bacillus infections," courses of action were suggested that led to more predictable results.

Science seeks only the most generally useful systems of classification; these it regards for the time being, until more useful classifications are invented, as "true."[2]

## Making Interpretations

Classification is a straightforward operation but becomes problematic when creatures or phenomena fall between the borders of established categories. What happens when a subject has traits that belong to more than one class? How do you decide which class it fits into?

California Sheephead are a type of fish which, in the course of their lives, take on both sexes. They are female until they are seven or eight years old and then the ovaries become testes, and the female becomes male. What would be the gender of a sheephead at the age of seven and one-half?

Is a virus more like a living creature or more like a non-living creature? Is a platypus more like a bird or more like a mammal? In determining which criteria are most applicable, you have to make a reasoned interpretation. Very frequently in science, you will find that scientific innovations come about because the classification of data changes or the applicable set of criteria shifts. *The data stays the same but the interpretation of the data changes;* this is has come to be called a "paradigm shift." Since we look at the world through certain models or structures, what Kuhn called a paradigm, a change in perception can bring about a corresponding change in interpretation. Many changes in science came about as a result of a change in paradigms.

Intransigent elements—whether they be the platypus, the virus, or light particles—offer an important path way to changes in science. The behavior of the virus enabled us to raise two questions: (1) Were the current modes of classification sufficient to account for an organism that manifests traits of non-living and living beings? (2) Did this organism require a new taxonomy to accommodate it?

Be alert to the way that classification defines what and how you see. Do not feel that you have to automatically accept orthodox classifications. In your mind, ask questions.

### How to Classify

1. Put like items together. Make a set. Group like with like.

2. Name the group. (Name the set. The name of the set differs from the items in the set.
3. Identify the principle which defines the inclusion or exclusion of other items from the class.

*1. Group Like with Like.*

[Ford, Chrysler, Mazda, Toyota] comprise a set of automobile types. This set could be named a class of automobile manufacturers. You could take any item from this set, Toyota, for instance, subdivide it, and create another set on the basis of kinds of cars: Toyota makes [four-door sedans, two-door sedans, sports coupes]. You could take "sports coupe" and, in turn, make it the name of a set whose elements include [MG, Fiat, Mazda].

Cars are an easy choice here. But how would you classify a virus? In the early history of microbiology, scientists were tentative about specifying the nature of viruses because viruses exhibit the behavior of both living and non-living things. Similarly, the duckbill platypus initially posed a problem for taxonomists because it possessed some traits specific to birds and some traits specific to mammals: like a bird, the platypus has a beak and produces young by laying eggs; like a mammal, the platypus is warm-blooded and suckles its young. To which group did the platypus belong?

The platypus and the virus are not the only creatures that represent elements that straddle the border of conventional categories. The prehistoric creature, *Archaeopteryx*, seems part bird and part lizard; how would it fit into our understanding of evolution? Was light a particle or a wave? Was electricity a type of fluid or a type of air? Classification is important, in each instance, because the class prescribed the kind of physical laws that could be applied to it.

When Newton derived his understanding of gravitation, he recognized a pattern. He classified two previously unconnected motions as expressions of the same pattern: the falling of an apple with the orbit of the moon.

*2. Name the set.*

Naming the set is important because it tells the reader what you think the items have in common. The name of the set is not included in the set; it exists as a broader and more comprehensive element than the set. The name of the set helps the reader to understand what the items have in common. The name of the set is a name of a whole; the elements in the set are the parts of the whole.

*3. Specify the ordering principle.*

The ordering principle specifies what the set items have in common. Set A—[2, 4, 6, 8 . . .]—is the set of even numbers; even numbers is the

ordering principle, the principle that establishes the pattern. The principles which describes the common elements in the set can also function as the principle which is invoked to determine if other elements outside the set fit into the set.

For example, does Set B—[3, 5]—fit into Set A? Because Set A= even numbers, and Set B contains odd numbers, the ordering principle prohibits this inclusion. The ordering principle is the rule which you apply to other items in order to determine whether or not they fit into the already-formed set. Take, for instance, the duckbill platypus. This creature has the beak of a bird—thus its name *duckbill*—but it also possesses hair, suckles its young, and is warm-blooded—all the traits of a mammal. Which set of criteria—those which define "bird" or those which define "mammal"—applies to the duckbill platypus?

Note: The elements in a set should have more in common than simply their inclusion in a class. For instance, take the following items:

Set A [ultra-violet, hoof, Borges, pi]

What do the elements of Set A have in common? Is there anything which connects ultra-violet, hoof, Borges, and pi? There is no discernible pattern of similarity apart from the fact that they are all included in Set A. Set A is a class of miscellaneous elements.

### Extended Example

Among the many accomplishments of the Italian painter Leonardo da Vinci (1452–1519) was his detailed anatomy studies. The following passage, an excerpt from his anatomy notes, shows how he organized his prospective work through classification. He planned to make annotated sketches of the following:

> *(A)* Man. The description of man, which includes that of such creatures as are almost of the same species, as apes, monkeys, and the like, which are many.
> *(B)* The Lion, and its kindred, as panthers, ounces, tigers, leopards, wolves, lynxes, Spanish cats, common cats, and the like.
> *(C)* The Horse and its kindred, as mule, ass, and the like, with incisor teeth above and below.
> *(D)* The Bull and its allies with horns and without upper incisors, as the buffalo, stag, fallow deer, roebuck, sheep, goat, wild goats, musk deer, chamois, giraffe.[3]

What do the items in each set have in common?

If you study Leonardo's classification carefully, you might notice that he places "wolf" in the same category as "tiger" (Set B), and he places

"giraffe" in the same category as "sheep" (Set D). The reasons for the classification in Set B may not be entirely clear to us. In fact, Set B may look something you've seen on a test:

Which one of these does not fit into the group:

(1) tiger, (2) wolf, (3) lion, (4) common cat

If you had seen this list on a test, you could answer that "wolf" (2) does not fit into this list because all of the other animals are felines and a wolf is not a feline. But you could also answer that "common cat" (4) does not fit into this group because the common cat is a domesticated animal whereas tigers, wolves, and lions are wild animals. Unfortunately, there is no way to make a firm determination because the set is not named.

*If the Name of the Set is Felines...*

You might have chosen *wolf* as the inappropriate element because the other categories suggest that da Vinci was really trying to come up with taxonomic categories. The grouping of items in the set suggests that he has differentiated primate, feline, equine, and bovine classes. We know that a wolf is *Canis lupus*, a type of dog rather than a type of cat. A greater morphological difference exists between a wolf and a lion than exists between a cat and a lion. In addition, the series starts with *lion*, a word that could be used to name a set of types of felines or a term which names a class of wild animals.

*If the Name of the Set is Wild Animals...*

Yet, if we thought that the class was made by a collection of wild animals, *wolf* would have more in common with *tiger* and *lion* than *cat* would, because a cat is typically a house pet. The common cat would not fit into this category of wild creatures. The difference between a wild animal and tame animal is to some extent a behavioral difference.

The point here is that for Set B we do not know what principle organizes the examples. The name of the set is an item in the set, so we do not receive much of a clue from the name. What was Leonardo da Vinci thinking when he put *wolf* in the same group with *cat* and *tiger*? We do not know. He does not tell us. He has not given us his ordering principle. He may even have blended two ordering principles in that series.

But we do understand da Vinci's reasoning for the other set, Set D. Da Vinci gives us his ordering principle in that one. Even though we might think it is strange to place a giraffe and a goat in the same group, we understand the reasoning that stands behind this grouping. He tells us: this group is made up of creatures with horns and without upper incisors. Set D has a specified ordering principle, but set B does not.

What is the ordering principle for Set C? For Set A?

Important Rule: Do not mix up separate ordering principles or sets of criteria.

## Applications

### Pre-Writing: Before you Write

Classification offers a useful tool in helping you get started when you start to write a paper, because organizing knowledge in the form of a paper requires that you make categories.

### Finding Your Topic

Your teacher has just assigned you to write a paper for the class and that is all you know at the moment. What will be the subject of your report? Where do you start? The substance of this discussion will direct you to (1) picking your subject and (2) deciding the treatment of the subject.

*Step One: Start with what you already know.*

First of all, you are in a science course, so you know that you should write a paper on a scientific subject. From Chapter 2, you recall that *any* topic may be treated technically. Although you are in a science class and any subject is open, you know that you will not be writing a poem, or a letter, or a stylistic analysis of a Shakespearean soliloquy. You know the genre, or kind, of writing you will engage in.

*Step Two: Pick your topic.*

Decide what you are already interested in or what you would like to learn more about. You are better off writing about something you like or are interested in than in feeling as if you have been forced into an odious and horrible task.

You do not have to have a lot of ideas about the topic—just pick something that you are generally interested in.

*Step Three: Brainstorm.*

Do not try to organize while brainstorming. Write down every bit of knowledge at your disposal. Write down what you do not know. Jot down notes. Write on your napkin at lunch, on a concert ticket, or on a deposit slip. Take time to make free associations.

Let us say you wanted to write an essay about water. That is the starting point. The topic of water.

What do you know about water?

Water is wet. It has hydrogen and oxygen. It melts and freezes at certain temperatures. It feels good to take a warm bath. Most of the earth is water. Most of your body is water. Water is everywhere. Is it everywhere?

*Step Four: Interrogate your notes.*

After you write down everything you know, go back and ask yourself questions.

- *Water is wet.* What does wet mean? Can other things be wet? Some things are more wettable than others; why is that true? Does this have to do with the way that water is a universal solvent? Does it have to do with the surface tension of water? Are other things wet like water? Are all liquids wet? Is everything that is wet also a liquid—do wet solids or wet gases exist?
- *It has hydrogen and oxygen.* There are two hydrogens for one oxygen but the molecule is not balanced. What is the significance of the charged molecule? What is the nature of the hydrogen bond? How does the hydrogen bond relate to capillary action?
- *It melts and freezes at certain temperatures.* Is this always true? Under what conditions would it not be true? What if you tried to make ice in space? What is the ice crystal like? Why does water expand when it freezes? Does anything else make a crystal structure like water? Why? Would water freeze at the same temperature if there were something else in it?
- *It feels good to take a warm bath.* How do other substances respond to water? Why do your fingers shrivel in water? What happens if you put one hand in a pan of warm water and the other hand in a pan of cold water? What happens to your blood when the warmed blood from the warm water and cool blood from the cold water meet inside your body? Why can't humans be frozen and defrosted with injury? Why can sperm be frozen but persons cannot?
- *Most of the earth is water. Most of my body is water. Water is everywhere.* Is there water on the moon? Is there water inside of rock? Is there water in your bones? Is your body really filled with water? Isn't there some empty space inside your abdomen?

*Step Five: Make categories.*

Some of the questions fall into the category of the chemistry of water: its structure in all states and the importance of that structure.

Another category might be how water reacts with other substances: with other water, with chemicals.

Another category might be the way that water is the biological basis of life and it is important for the way that electrolytes may be transmitted through the medium.

Wetness emerged as a category. Who would be interested in wetness? Farmers or entomologists who use pesticides know that some powders require the addition of a wetting agent in order to make the insecticide powder soluble.

***Step Six: Pick a category.***

Choose an approach that interests you: a biochemical approach, a sociological approach, a medical approach, an engineering approach, a physics approach. In other words, after you have derived the topic, choose an aspect of the topic to develop. Phrase your topic as a complete sentence.

***Step Seven: Turn your topic into a specific question.***

A question narrows your topic further.

To provide guidance in your literature search, turn the statement into a question. This can be a *what?* a *why?* a *how much?* or *how many?* or a *how?* question. The kind of question you ask will determine your orientation the subject. A *what* question deals with issues of substance and structure. A *why* question deals with cause-effect. A *how much/how many* question points you to quantitative analysis. A *how* question is a question of means; through what means does something occur?

If at this point, you have identified a topic and an approach to your topic, you will have classified your topic through a process of excluding other possible avenues to explore. The next step in this procedure is the trip to the library, but before you go, write down your question. By writing the question, you have defined an ordering principle. This principle will be the basis for your excluding certain texts from your search.

## The Library Search

Armed with your question, you will be relieved to discover that libraries use regular systems of classification. For your research, you may be interested in two categories of source material: old knowledge and new knowledge. When you look up your topic in books, you are dealing with old knowledge in part because books are often published as long as a year after they've been written. For new knowledge, go to journals, periodicals, or other monthly or quarterly publications. If you have access to computer information links, you may be able to get source material from the com-

puter. If you need more clarification on your topic, start with the encyclopedia.

Using the computer search system or a card catalog, search for your topic as it is classified by subject, by author, or by title. Subject searches are sometimes organized by key words. If you cannot bring up the subject you need, check with the librarian or look around for a list of key words used by the computer. Match your classification to the library's system of classification to generate a list of useful titles. Generate related words and search again.

For journals or articles, you will need to consult indexes unless you already have particular citations to look up.

### Choosing Your Texts

With your topic phrased as a question, you have an ordering principle to help you in your search. As you go through the lists of titles or articles, ask yourself if this book or this article will help to answer the question.

What if there are lot of books generally dealing with your question? Do you have to read all of them?

Obviously you want to strive for some kind of completeness, but it is better to gear your search toward those works which are most relevant to your concerns. So in your mind, define some more categories:

*Directly relevant* to my study
*Indirectly relevant*: some parts may pertain to my study
*Indeterminate relevance*: parts may be relevant but you would have to do a lot of work just to find that out.

Then look up those books and articles in the order of most relevant to least relevant.

### Classification in the Literature Search

As you read through the related work on your topic, categorize the works you read with respect to your topic. As your work, you will notice that your topic includes sub-topics. If you are engaging in research for an experiment, you readings will include will research on the methodology, on the background of the subject, on related theoretical studies, on related experimental studies. Make these into categories.

Methods

> conventional method [1, 2]
> conventional method with significant variations [3, 4, 5, 6, 7]

Results

> analogous studies which corroborate my results: [A, B, C]
> analogous studies which qualify my results: [D, E]
> analogous studies which contradict my results: [F]
> unrelated studies which corroborate my results: [G, H, I]

While you may find a number of studies that corroborate your results, you may also find a contradictory study that limits the implications of your findings. Even though only one article exists to this effect, one article goes into the set of analogous studies which contradict results.

As you come to write up the literature section, you will integrate these notes by the organizing principle.

> While the contemporary view has noted that . . . [A, B, C], this view has not been received unequivocally. Some research has indicated the opposite [F].

## Exercises

**1. The Cownose Ray**

The following paragraphs offer two descriptions of the same creature, a cownose ray. One description comes from a sixteenth-century book, Ambroise Paré's *On Monsters and Marvels*. The modern description comes from the *Audubon Society Field Guide to North American Fishes, Whales & Dolphins*.

Read each of these descriptions carefully. The Audubon guide is a field guide enabling the reader to identify a creature in the wild. Paré explains the ray is "a thing that never [before] been seen."

In a three to five page essay, analyze the connection between classification and identification. Consider how each work classifies the cownose ray, and on the basis of that classification, provides relevant detail. Make sure you discuss the graphics and the format of each selection.

An ell = four feet. Quioze is Chioggia in the Gulf of Venice.

### Example 1: A Monstrous Flying Fish

Between Venice and Ravenna, one league [two miles] above Quioze in the sea of the Venetians in the year 1550, a flying fish was caught that was frightening and gave marvel to see, [being] four feet more in length and twice as much in width from one tip to the other of its wings, and a good square foot in thickness. Its head was wondrously thick, having two eyes, one on top of the other, in a line; two large ears and two mouths; its snout was very fleshy, green in color; its wings were double; on its throat it had five holes in the fashion of a Lamprey; its tail was an ell long, on top of which were two little wings. It was brought quite alive to said city Quioze, and presented to the lords of latter, as a thing that had never [before] been seen.

### Example 2: The Cownose Ray*

(*Rhinoptera bonasus*)

Description:

To 3' (91) cm. wide. Disc about 1 1/2 times wider than long, front edges nearly straight, posterior edges of disc concave, outer corners falcate. Brownish, above, whitish or yellow-whitish below. Front of head moderately concave, *subrostral fin deeply notched in the middle, forming 2 lobes paired at back,* head and subrostral lobes form shape resembling a cow's nose. Tooth plates usually of 7 series of teeth. Tail spine immediately behind dorsal fin; skin smooth.

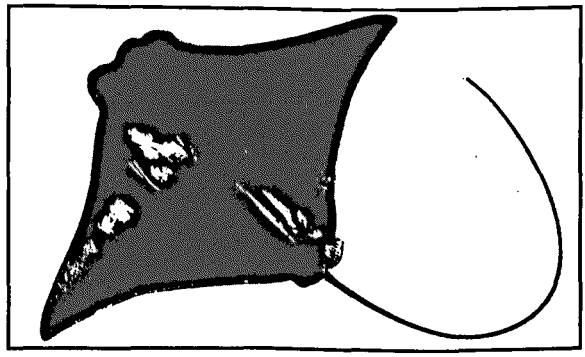
Habitat:

Primarily bottom of shallow bays and inshore shelf.

Range: From New England to Brazil. Caribbean and the Gulf of Mexico.

Comments:

Cownose rays feed primarily on hard-shelled mollusks that they crush with their powerful tooth plates. They sometimes occur in bays during the summer and disappear in the winter. Their stinging spines make them potentially dangerous.



* *The Audubon Society Field Guide to North American Fishes, Whales, and Dolphins* (New York: Alfred A. Knopf, 1983), p. 360).

**2. Virus: Living or Not?**

In the Reading Selections, turn to M. W. Beijerinck's essay, "A *Contagium vivum fluidium* as the Cause of the Mosaic Diseases of Tobacco Leaves," and analyze his efforts to assign a classification.

**3. Hippocrates on Epidemics**

Turn to Hippocrates, "Epidemics," in the Reading Selections. What do the sufferers of *causus* have in common besides the illness? Does Hippocrates use more than one ordering principle? Does he mix ordering principles?

**4. Anomalies**

The following abstract describes the nature and significance of anomalies. Identify a past or present anomaly in your field, and explain the significance it holds for past or current theories.

> An anomaly in science is an observed fact that is difficult to explain in terms of the existing conceptual framework. Anomalies often point to the inadequacy of the current theory and herald a new one. It is argued here that certain scientific anomalies are recognized as anomalies only after they are given compelling explanations within a new conceptual framework. Such a "retrorecognition" phenomenon reveals not only a significant feature of the process of scientific discovery but also an important aspect of human psychology. —Alan Lightman and Owen Gingerich, "When Do Anomalies Begin?" *Science* 255 (7 Feb. 1992): 690–94.

**5. Territorial Differences**

Identify an issue in the history of science of which has been "claimed" as the territory of two different disciplines. (How do paleontologists and biologists define "species"?) Discuss how each field has treated that subject, and speculate on the possibility of finding a common ground.

**6. A Flying Machine**

When designing his flying machine, Leonardo da Vinci turned to birds as his models for flight. His interest in them was determined by his research into flying machines. When he classified bird, he did not employ a taxonomic categorization. He wrote

> A bird is an instrument working according to mathematical law, which instrument is in the capacity of man to reproduce with all its movements but with as much strength, though it is only deficient in the power of maintaining equilibrium.[4]

Analyze da Vinci's classification.

## References

*Audubon Society Field Guide to North American Fishes, Whales & Dolphins.* New York: Alfred A. Knopf, 1983.

Hayakawa, S. I. "Classification," in *Language in Thought and Action.* Harcourt, Brace, & Co., 1941, 1949.

Paré, Ambroise. *On Monsters and Marvels*. Translated by Janis Pallister. University of Chicago Press, 1982.

## Notes

1. Ferdinand Schoeman, "AIDS and Privacy," in *AIDS and Ethics*, edited by Frederick G. Reamer. (New York: Columbia University Press, 1991), p. 244.
2. S. I. Hayakawa, "Classification," in *Language in Thought and Action* (New York: Harcourt, Brace, & Co., 1941, 1949), pp. 215–17.
3. *The Notebooks of Leonardo Da Vinci*, ed. Pamela Taylor (New York, London, Scarborough: New American Library, 1960), pp. 115–16.
4. *The Notebooks of Leonardo Da Vinci*, pp. 101–2.