

Chapter 5

Defining

5.1 Clarifying the Meanings of Words

Suppose KP claims in his class that he has exactly four fingers on his right hand, no more, no less. To check if this claim is correct, the students ask him to hold up his right hand, and he does so. Here is a photograph of his right hand:



The students count the number of digits on the hand, and say, “You’re wrong; there are five fingers on your hand, not four.”

A surprised KP insists, “No, no, I have exactly four fingers on my hand, like most other humans. See (he counts): one (little finger), two (ring finger), three (middle finger), and four (pointing finger). That’s four.”

The students object, “But you didn’t count your thumb!”

“Oh,” KP says, “The thumb is not a finger.”

If we don’t include the thumb as a finger, then KP’s claim is true: he has four fingers. But if we include the thumb, he is wrong. As it happens, the English word ‘finger’ is ambiguous: it can refer either to all the digits on the hand, or to the digits on the hand excluding the thumb. This means that, to critically evaluate the truth of the statement expressed by the English sentence: “KP has exactly four fingers on his right hand,” we need to know the intended meaning of the word ‘finger’.

Take another situation. TM, sitting at her desk, says, “There is an animal on my desk.” KP looks at the desk and says, “I see no animal there.” “Don’t you see that orange moth?” says TM, pointing to the far corner of the desk. “Moth?” says KP, “But a moth is not an animal.”

In the terminology of biology, the word ‘animal’ includes not only cats and dogs, and also humans, worms, moths, fish, and birds. But in ordinary English, humans, worms, and moths are not animals. So if TM is using the word ‘animal’ as a technical term in biology, her claim is true. But if she is using it as an ordinary English word, her claim is false. Again, we need to clarify the intended meaning of the word.

Our final example comes from the word ‘planet’. In Ptolemy’s *geocentric* theory, the sun is a planet going around the earth. In Copernicus’s *heliocentric* theory, the sun is not a planet, and it is the earth that goes around the sun. Suppose Ptolemy and Copernicus were standing on a terrace on a winter morning, and Ptolemy were to remark, “I see a planet in the sky.” Copernicus would look, and seeing only the sun, would say, “There is no planet in the sky now.” They are both looking at the same object, but they *appear to* disagree on what they observe. One solution to this problem would be for Ptolemy to say, “Look, I’m talking about the sun. When I say ‘planet’, I include not only Mercury, Jupiter, Venus, and so on, but also the sun.”

In each of these cases, the apparent disagreement rests simply on the difference in meanings we assign to the words. Once the meaning of the term is clarified, what appears to be a disagreement vanishes.

5.2 The Need for Definitions in Academia

Mathematics, physics, chemistry, biology, linguistics, psychology, economics, sociology, history, philosophy, and so on are part of what we call ‘academic knowledge’; it is a body of *collective* knowledge that the academic *community* constructs, justifies, and critically evaluates. Because it is

collectively investigated, it is crucial that when advancing a claim as ‘knowledge’, we express it in a way that the words we use are clearly defined. Only a commitment to clarity and precision in using words will allow us to check for ourselves whether or not a claim is true.

Consider the following statements, culled from wikipedia entries:

- (1) a. Amniotes have four limbs.
- b. Mammals, reptiles, and birds are amniotes.
- c. Humans, dogs, mice, whales, bats, and platypus are mammals.

From (a) and (b), we deduce that birds have four limbs. Now, if we include arms and legs under limbs, but don’t include wings as limbs, then this prediction is false: birds have only two limbs: two legs and no arms. However, if we count wings as limbs, then the prediction is true. But then, butterflies have ten limbs: six legs and four wings! (Biologists won’t, of course, agree with the statement that butterfly wings are limbs.)

To resolve this problem, we need to have a DEFINITION of ‘limb’. Here is a possible candidate:

- (2) *A limb is an organ composed of bones and muscles, used for locomotion or manipulation.*

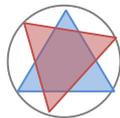
Given (2), birds’ wings are limbs. Butterfly wings are not limbs, because they are not composed of bones and muscles. The contradiction in (1a-b) disappears.

Let us take a different example. Are the following statements true?

- (3) a. For every circle, there exists one and only one equilateral triangle that it circumscribes.
- b. For every circle, there exists one and only one equilateral triangle that circumscribes it.

Most of us would probably say that the statements are true. But then, to judge their truthhood, we need to first understand what the sentence is saying. Take the expression, “one and only one equilateral triangle.” Do the blue and red triangles in (4) count as the same triangle, such that this figure is consistent with (3a), or do they count as distinct triangles, thereby posing a *counterexample* to (3a)?

(4)



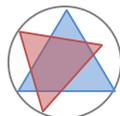
A *counterexample* to a statement is an example that shows that the statement is false. Suppose we say that all birds can fly. Penguins and ostriches are counterexamples to this statement, because they are birds, but can’t fly.

The question is this: if we rotate a geometric object, does it become a different object? Suppose we say that it remains the same object. The general criterion for this judgment can be given as: “When a linear transformation (translation, rotation, or reflection) is applied to a geometric object, the object remains the same.” Another way to say this is:

- (5) Shapes A and B count as the same shape if they are congruent.

Given (5), it is possible to investigate the truth of (3). However, we still need to know what the term ‘circumscribe’ means. For instance, does the circle in (6) circumscribe both the red and the blue triangles, or only one of them? Given that they are not congruent, if the circle circumscribes both, (3a) is false.

(6)



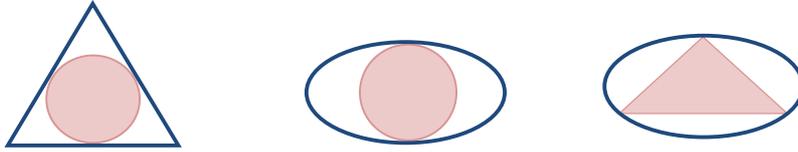
If you have been exposed to elementary school geometry, your intuition would be that the circle circumscribes the blue triangle, but not the red one. But how do we define ‘circumscription’ such that the conclusion follows from the definition?

Given below is the textbook definition:

- (7) Shape A circumscribes shape B if and only if the vertices of B lie on the circumference of A.

What about a triangle, or to generalize, a polygon, circumscribing a circle? What about a circle circumscribing an ellipse, or an ellipse circumscribing a circle or a triangle?

(8)



Do circles and ellipses have vertices? If we say that circles and ellipses do have vertices, we are forced to say that every point on the circumference is a vertex, so that they have infinitely many vertices. If, on the other hand, we say that they don't have any vertices, then it is impossible for them to satisfy the condition that their vertices lie on any circumference. The logical consequence of (7) then is that circles and ellipses cannot be circumscribed. Hence, if we want to extend the concept of circumscription to circles and ellipses, we must look for a different definition.

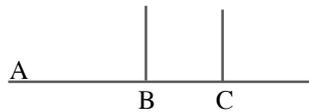
EXERCISE 1

Come up with a definition of circumscription that fits both (4) and (8).

EXERCISE 2

Consider the following statement:

Given a line A, if lines B and C are both perpendicular to it, then B and C are parallel to each other.



To find out if this statement is true, we need to define 'parallel lines' and 'perpendicular'.

Formulate definitions of *parallel lines* and *perpendicular to*.

EXERCISE 3

Suppose we define parallel lines as:

Two lines are parallel if and only if they are equidistant (the distance between them is constant).

Given this definition, would the claim in Ex. 2 be true?

EXERCISE 4

Suppose we make the following claim:

Every mammal has four limbs, a torso, a neck, and a head.

This sentence asserts several propositions:

"every mammal has four limbs;"

"every mammal has a torso;"

"every mammal has a neck;" and

"every mammal has a head."

To critically evaluate these propositions, we need to define 'mammal'.

Suppose someone were to argue, on the grounds that whales don't have four limbs, that the claim that mammals have four limbs is false.

1. How would you respond?

2. How would you define *mammal* such that shark is not a mammal, while bat and whale are?

EXERCISE 5

Consider the following definitions of democracy:

“Democracy is a system

- a) in which the adult citizens of a country have the right to elect their leaders.”
- b) of government in which people choose their rulers by voting.”
- c) in which everyone is treated equally and has equal rights.”
- d) of government in which all eligible citizens participate equally in decision-making (whether directly or through elected representatives).”
- e) in which everyone who is affected by a decision has the opportunity to influence the decision.”

Choose the definition that you think is the best one. In doing so, consider the the following questions:

1. Does the term ‘democracy’ apply to schools? If the answer is yes, what would be some of the examples of democratic or undemocratic practices in a classroom, and in educational policies?
2. If a teacher or school principal can be democratic, can a monarch be democratic?
3. Do you think there is democracy in India or the USA? Why/Why not?

EXERCISE 6

Suppose a country, Aranya, rules over an island, Parumbi. The people of Parumbi don’t want Aranya to govern them, but the people of Aranya want Parumbi under them. If the Parumbians take up arms to achieve their goal, their supporters will describe them as ‘freedom fighters’, and their activity as an ‘independence struggle’. Supporters of Aranya will describe them as ‘terrorists’, and their activity as ‘terrorism’.

This hypothetical situation is found in the real world too. For instance, on 10 August 2001, *The Times of India* reported that the External Affairs Minister Jaswant Singh said that India should not accept "Islamabad's attempt to confer cross-border terrorism a kind of diplomatic legitimacy or a pre-dialogue tactics," rejecting Islamabad's description of the activity in Jammu and Kashmir as a freedom struggle. (<http://timesofindia.indiatimes.com/india/Terrorism-not-freedom-struggle-Jaswant/articleshow/1086523490.cms>). Pakistan’s newspaper *Business Recorder* expresses the opposite view: “In his message to the Congress on August 8, 1950, Harry Truman warned that "once a government is committed to silencing the voice of dissent, it has only one way to go. To employ increasingly repressive measures, until it becomes a source of terror to all its citizens and creates a country where everyone lives in fear." Nothing illustrates the Indian policy, vis-à-vis occupied Kashmir, better than the above quoted remark of the American leader.”

How would we distinguish between ‘freedom fighters’ and ‘terrorists’? Define ‘terrorism’ and ‘independence struggle’ such that we can engage in a rational debate on whether a particular movement qualifies as an independence struggle or as terrorism?

In Chapter 2, we developed the concepts of observation and observational report, and moved to observational generalizations in Chapter 3. Generalizing from particular observations to populations requires classification, and classification calls for concepts and the definitions of concepts. This is what we have explored in Chapter 4 and Chapter 5.

Conceptual understanding — the understanding of the concepts that go into the building of the web of what we call ‘knowledge’ — lies at the very core of academic knowledge and inquiry. What we have done in Chapter 5 is just the very first step in this direction.