Chapter One: Definitions of Logic

Logic is known as the science of thought, and because its principles and methods can be applied by all other sciences, it is referred to as the science of sciences. Logic is the most general of all sciences and is essentially concerned with correct ways of reasoning. It involves methods of evaluating the correctness of the completed process of reasoning rather than the process itself; how we reason is more of a consideration for the science of psychology. And since logical analysis involves working with the general and formal relationships between entities, objects or events, it can be effectively applied to all fields of study.

The word *logic* is derived from the Greek word logos, meaning *thought* or *word*, and logos comes from the word *lego*, which means *to say*. Naturally, there exists a close relationship between the science of logic and language since we think in terms of symbols such as words or signs. In order to communicate meaning efficiently, we make extensive use of various symbols in not only language but also logic and all other sciences.

The starting place for studying most topics in logic is of a philosophical (contemplative) nature, employing ordinary language. However, in order to move from that level of verbal reasoning to a higher level of abstract reasoning, we must employ more refined methods that involve specific logical symbol systems developed into artificial languages. Thus, logic relies on both natural and artificial language.

Logic is an area of study in the very vast field of science called philosophy, which has many divisions. *Philosophy* is a Greek word that literally means *love of wisdom*, or *love of knowledge*, and, as a science, it is concerned with the nature and source of human knowledge.

A philosopher is, of course, someone who offers theories and opinions on questions pertaining to most all fields of study, such as logic, mathematics, language, ethics, law, education, etc. (et cetera). And, just as there are numerous subjects of interest in philosophy, there are many types of philosophers – like

logicians, who are skilled at logic and applying its various methods in order to advance science and knowledge.

Most scientists are concerned with developing theories and knowledge from facts gathered through observation and research. In addition to this, philosophers explore word and concept meanings along with the impressions and assumptions of reasoning. They are interested in meanings, truths and knowing in the form of rational investigation into principles of knowledge, conduct and being. In this way, philosophers study the various concepts within each particular branch of philosophy, such as logic, in an effort to learn and obtain an understanding of reality.

Logic, in regard to other sciences, is related more to psychology and mathematics. While psychology is concerned with the process of *how* people think and reason, logic is interested in how people *should* reason, especially how we should reason most correctly.

Logic is closely related to mathematics because mathematics is basically a system of formal logic. Both employ precise symbol systems and are very reliable as instruments of science. Their closeness is reflected by the fact that mathematics can be deductive and reduced to pure logic. And like many other sciences, they are interested in the relationships between symbols and how they may be manipulated, plus they both follow formal rules in order to express the uniform relationships between entities (including objects) or events.

Considering that we naturally reason and cannot escape it – even in its most simplistic forms, we can benefit greatly by learning to reason to the best of our ability. Logic is a tool that assists us in learning to reason accurately and is used to design systems that help us reason correctly in order to avoid errors (fallacies).

Logic, as a science, is concerned with proofs for our claims about knowledge. It asks if our conclusions are justified by our evidence and instructs us that sound reasoning involves evidence that proves conclusions.

Logic is also a method used in defining the terms applied in science and discussion. Scientists employ logic in their investigations in order to more quickly advance human knowledge and understanding. It can produce models that test our perceptions of the universe, like other scientific methods, which means that we cannot only have knowledge through sense-perception and experience, but also from logical reasoning. In general, logic can help us to detect and explore new scientific discoveries and greater possibilities of knowledge.

FORMAL AND INFORMAL LOGIC

There are two major categories that logic can be divided into: formal and informal. Formal logic is more abstract and assumes some atomic (basic) definitions and knowledge in order to proceed toward its methods and rules. Informal logic leaves many questions unanswered as to the concepts and definitions involved with it and its application, but it is a more concrete and practical logic used to understand facts and apply them to problem solving.

As animals of higher intelligence, people are largely involved in problem solving, which can be made easier through the use of logical methods that produce correct reasoning. Since reasoning is used in most human activities, it is very important that we learn to reason correctly. Logic helps enhance our learning power and knowledge; thus, leading us to a more satisfying life.

One serious limitation on logic, though, is having enough information to support our conclusions (claims or beliefs about knowledge). We need facts in order to prove our conclusions or refute those we believe to be in error. Facts provide the necessary evidence for our premises (statements that lend support for a conclusion). In reasoning, we form a conclusion about what is stated in our premises, but sometimes we are limited by not having enough data to prove our premises. Consequently, any conclusion is only as good as its premises since it is derived from them.

Naturally, the more we use logic, the easier it is for us to employ its methods and organize ideas within our minds. Also, through logical processes, we are able to develop reasoning systems that are reliable and independent of our sense-

perceptions, which can help clarify reality and understanding. However, whether or not we are employing formal or informal logic, we have to produce consistent conclusions since sound reasoning is based on compatible results. Therefore, in order to gain knowledge and truth, we must be careful in our final conclusions so as not to be contradictory.

Formal logic, for the most part, is abstract and essentially a general study of pure mathematics. Similar to algebra, it involves the manipulation of various symbols and the study of the relationships between them. Symbolic logic is a development of formal logic which applies a special symbolism (notation) that is manipulated according to formal rules. Also called mathematical logic, it uses symbols and exact formal methods in order to gain objectivity in explaining science, facts and reality. Thus, via mathematics and logic, we can gain an accurate view of our world and arrive at truth – truth being reality, or the objective way that our universe exists.

In the process of reasoning, formal logic considers properties (characteristics) of individuals and the relationships between classes (groups) as well as individual members of classes. It is interested in the structure of the different relationships and how the general forms can be applied to other subjects. Hence, formal logic is a deductive reasoning process concerned with the *forms* (patterns) of statements used in reasoning rather than their contents (subject matter) since the validity of any formal reasoning process depends upon its specific form.

In formal logic, we apply a process of deductive reasoning (inference) in which conclusions are drawn from premises, which supply the evidence. The true or false statements that make up the premises and conclusions are commonly called propositions. And if all the propositions are true, then the reasoning is correct by the *contents* of the deduction.

Nevertheless, formal logic is most concerned with whether or not the conclusion of a deduction is a *valid* consequent of the premises. If the conclusion follows from the premises by correct form, then the reasoning is valid. Furthermore, if the inference is both correct by content *and* form, then the reasoning is sound (logical).

Basic propositions assert or deny a relationship between classes, such as *All people are animals*, *Some philosophers are logicians*, *Some people are not teachers*, *No A are B*, etc. They are sentences that are either true or false statements; consequently, they do not question or exclaim! All statements are sentences but not visa versa since some sentences do more than make statements. A true proposition states what *is* or what *is not* while a false proposition states what is *is not* and that what is not *is*.

In contrast, informal logic does not follow as strict a reasoning process as formal logic. It is a broader type of logic concerned more with content than form, and applies a variety of common scientific techniques in its less rigid investigations. Part of informal logic includes reflective thinking and recognizing assumptions, which can be either stated or implied. Reflective thinking is creative-thinking logic, for which no proof is offered, and can be a beginning point for discovery.

Informal logic involves inductive reasoning in which premises provide only *some* evidence for their conclusions. Thus, the evidence furnished is not absolute, as in formal logic, and, as a result, the conclusion is merely probable. In inductive reasoning, then, we examine evidence in order to form generalized conclusions, which is the opposite of deductive reasoning where we form specific conclusions. So, the main question in inductive reasoning is: how much evidence is needed for a highly probable conclusion? And, of course, that varies with the subject matter and data available.

Anyway, both the formal and informal methods of reasoning provide the foundation for logic and other fields of study. Indeed, they each have their place in science and are most effective when applied to the particular cases they are best suited for. In applying either procedure, we must be objective and develop our evidence from facts; otherwise, we run the risk of developing incorrect conclusions.

Logic is one of the many subjects that *can* be discussed on a non-emotional level, similar to algebra, physics, chemistry, etc. It is most always best to exclude personal feelings and biases when approaching subjects like logic or we may jeopardize clarity and objectivity, which can produce errors. More often than not,

our emotional thinking prevents us from rational decision making and can lead to fallacy (false reasoning). Thus, logic is said to involve less complex thinking processes because our emotional biases are preferably deleted. Unfortunately, though, we often make ourselves believe that we are thinking rationally when we actually are not.

Clear, logical thinking, then, can be easily clouded by a number of different biases that could lead us astray. Biases, like those caused by instincts, interests, experiences, and previous learning, can hinder our rational thinking processes. So, when reasoning, we *must* allow fact and form to guide us and avoid our biases as much as humanly possible.

Rational thinking is also promoted by combining ideas in various ways, such as through coherence, difference, similarity, identity and correlation, which provides the necessary connections for sound reasoning. And, naturally, we are assured that our ideas are more acceptable to reason when connected by logic because they are then more organized. Thus, logic is thought of as an instrument for common understanding and communication.

Since our viewpoint affects the way we reason, we can benefit by looking at a situation or problem from as many different viewpoints as possible. Humans have a perspective and can consider many individual perspectives, whereas problems have a frame-of-reference that provides them with natural boundaries. Our varying perspectives are limitless, but problems are confined within specific territories. This arrangement, thus, gives us an advantage over many problems when we develop solutions in a logical manner.

In summary, logic, as a systemized study of reasoning, is used to clarify reasoning processes and problem-solve. The techniques of logic provide us with the standards to recognize sound (valid and correct) reasoning as well as design solutions to problems. So, our concepts can be analyzed for consistency by employing logical methods; thus, what is logical agrees with logical principles.