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# ESSAY IN PHILOSOPHY

EPISTEMOLOGY AND METHODOLOGY: MAIN TRENDS AND ENDS.

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**Epistemology.**

Epistemology is one of the main branches of philosophy; its subject matter concerns the nature, origin, scope, and limits of human knowledge. The name is derived from the Greek terms *episteme* (knowledge) and *logos* (theory), and accordingly this branch of philosophy is also referred to as the theory of knowledge.

It is the branch of philosophy that investigates the basic nature of knowledge, including its sources and validation. Epistemology is concerned with the basic relationship between man’s mind and reality, and with the basic operations of human reason. It therefore sets the standards for the validation of all knowledge; it is the fundamental arbiter of cognitive method.

Epistemology as a term in philosophy wa**s** prob­ably first applied, by J. F. Ferrier, to that department of thought whose subject matter is the nature and validity of knowledge (Gr. *epistimum,* knowledge, and *logos,* theory, account; Ger. *Erkenntnistheorie).* It is thus contrasted with metaphysics, which considers the nature of reality, and with psychology, which deals with the objective part of cognition, and, as Prof. James Ward said, "is essentially genetic in its method." Epistemology is con­cerned rather with the possibility of knowledge in the abstract. In the evolution of thought epistemological inquiry succeeded the speculations of the early thinkers, who concerned themselves primarily with attempts to explain existence. The differences of opinion, which arose on this problem naturally, led to the inquiry as to whether any universally valid statement was possible. The Sophists and the Sceptics, Plato and Aristotle, the Stoics and the Epicureans took up the question and from the time of Locke and Kant it has been prominent in modern philosophy. It is extremely difficult, if not impossible, to draw a hard and fast line between epistemology and other branches of philosophy. If, for example, philosophy is divided into the theory of knowing and the theory of being, it is impossible entirely to separate the latter (Ontology) from the analysis of knowledge (Epistemology), so close is the connection 'between the two. Again, the relation between logic in its widest sense and the theory of knowledge is extremely close. Some thinkers have identified the two, while others regard Epistemology as a subdivision of logic; others de­marcate their relative spheres by confining logic to the science of the laws of thought, *i.e.,* to formal logic. An attempt has been made by some philosophers to substitute "Gnosiology" for "Epistemology" as a special term for that part of Epistemology which is confined to "systematic analysis of the conceptions employed by ordinary and scientific thought in inter­preting the world, and including an investigation of the art of knowledge, or the nature of knowledge as such." "Epistemology" would thus be reserved for the broad questions of "the origin, nature and limits of knowledge". The term Gnosiology has not come into general use.

### History.

Epistemological issues have been discussed throughout the history of philosophy. Among the ancient Greeks, questions of knowledge were raised by Plato and Aristotle, as well as by the Sophists and the Sceptics, and many of the chief issues, positions and arguments were explored at this time. In the systems of Plato and Aristotle, however, epistemological questions were largely subordinated to metaphysical ones, and epistemology did not emerge as a distinct area of inquiry.

The scholastics of the late medieval period were especially concerned with two epistemological questions: the relationship between reason and faith, and the nature of concepts and universals. The major positions on the latter issue—realism, nominalism, and conceptualism—were defined during this period.

The Reformation and the rise of modern science raised questions about cognitive methodology, and gave rise to a rebirth of sceptical doctrines, trends that culminated in the writings of Rene Descartes (1596-1650).

During the modern period, from Descartes to Immanuel Kant (1724-1804), epistemological concerns were at the forefront of philosophy, as thinkers attempted to understand the implications of the new science. They also attempted, unsuccessfully, to deal with sceptical attacks on the validity of sense perception, concepts, and induction. In the 19th and 20th centuries, epistemological issues continued to receive attention from philosophers of various schools, including Idealism, Logical Positivism, and Linguistic Analysis.

A familiarity with the history of philosophy provides the best introduction to epistemology. The following works are of special importance for epistemology:

1. Plato, Theaetetus
2. Aristotle, Posterior Analytics
3. Rene Descartes, Meditations
4. John Locke, Essay Concerning Human Understanding
5. David Hume, An Inquiry Concerning Human Understanding
6. Immanuel Kant, Prolegomena to Any Future Metaphysics

Epistemology as a discipline.

Why should there be such a subject as epistemology? Aristotle provided the answer when he said that philosophy begins in wonder, in a kind of puzzlement about things. Nearly all human beings wish to comprehend the world they live in, a world that includes the individual as well as other persons, and most people construct hypotheses of varying degrees of sophistication to help them make sense of that world. No conjectures would be necessary if the world were simple; but its features and events defy easy explanation. The ordinary person is likely to give up somewhere in the process of trying to develop a coherent account of things and to rest content with whatever degree of understanding he has managed to achieve.

Philosophers, in contrast, are struck by, even obsessed by, matters that are not immediately comprehensible. Philosophers are, of course, ordinary persons in all respects except perhaps one. They aim to construct theories about the world and its inhabitants that are consistent, synoptic, true to the facts and that possess explanatory power. They thus carry the process of inquiry further than people generally tend to do, and this is what saying that they have developed a philosophy about these matters means. Epistemologists, in particular, are philosophers whose theories deal with puzzles about the nature, scope, and limits of human knowledge.

Like ordinary persons, epistemologists usually start from the assumption that they have plenty of knowledge about the world and its multifarious features. Yet, as they reflect upon what is presumably known, epistemologists begin to discover that commonly accepted convictions are less secure than originally assumed and that many of man's firmest beliefs are dubious or possibly even chimerical. Anomalous features of the world that most people notice but tend to minimise or ignore cause such doubts and hesitations. Epistemologists notice these things too, but, in wondering about them, they come to realise that they provide profound challenges to the knowledge claims that most individuals blithely and unreflectingly accept as true.

What then are these puzzling issues? While there is a vast array of anomalies and perplexities, two of these issues will be briefly described in order to illustrate why such difficulties call into question common claims to have knowledge about the world.

TWO EPISTEMOLOGICAL PROBLEMS

"Our knowledge of the external world".

Most people have noticed that vision can play tricks on them. A straight stick put in water looks bent to them, but they know it is not; railroad tracks are seen to be converging in the distance, yet one knows that they are not; the wheels of wagons on a movie screen appear to be going backward, but one knows that they are not; and the pages of English-language books reflected in mirrors cannot be read from left to right, yet one knows that they were printed to be read that way. Each of these phenomena is thus misleading in some way. If human beings were to accept the world as being exactly as it looks, they would be mistaken about how things really are. They would think the stick in water really to be bent, the railway tracks really to be convergent, and the writing on pages really to be reversed. These are visual anomalies, and they produce the sorts of epistemological disquietudes referred to above. Though they may seem to the ordinary person to be simple problems, not worth serious notice, for those who ponder them they pose difficult questions. For instance, human beings claim to know that the stick is not really bent and the tracks not really convergent. But how do they know that these things are so?

Suppose one says that this is known because, when the stick is removed from the water, one can see that it is not bent. But does seeing a straight stick out of water provide a good reason for thinking that it is not bent when seen in water? How does one know that, when the stick is put into the water, it does not bend? Suppose one says that the tracks do not really converge because the train passes over them at that point. How does one know that the wheels on the train do not happen to converge at that point? What justifies opposing some beliefs to others, especially when all of them are based upon what is seen? One sees that the stick in water is bent and also that the stick out of the water is not bent. Why is the stick declared really to be straight; why in effect is priority given to one perception over another?

One possible response to these queries is that vision is not sufficient to give knowledge of how things are. One needs to correct vision in some other way in order to arrive at the judgement that the stick is really straight and not bent. Suppose a person asserts that his reason for believing the stick in water is not bent is that he can feel it with his hands to be straight when it is in the water. Feeling or touching is a mode of sense perception, although different from vision. What, however, justifies accepting one mode of perception as more accurate than another? After all, there are good reasons for believing that the tactile sense gives rise to misperception in just the way that vision does. If a person chills one hand and warms the other, for example, and inserts both into a tub of water having a uniform medium temperature, the same water will feel warm to the cold hand and cold to the warm hand. Thus, the tactile sense cannot be trusted either and surely cannot by itself be counted on to resolve these difficulties.

Another possible response is that no mode of perception is sufficient to guarantee that one can discover how things are. Thus, it might be affirmed that one needs to correct all modes of perception by some other form of awareness in order to arrive at the judgement, say, that the stick is really straight. Perhaps that other way is the use of reason. But why should reason be accepted as infallible? It also suffers from various liabilities, such as forgetting, misestimating, or jumping to conclusions. And why should one trust reason if its conclusions run counter to those gained through perception, since it is obvious that much of what is known about the world derives from perception?

Clearly there is a network of difficulties here, and one will have to think hard in order to arrive at a clear and defensible explanation of the apparently simple claim that the stick is really straight. A person who accepts the challenge will, in effect, be developing a theory for grappling with the famous problem called "our knowledge of the external world." That problem turns on two issues, namely, whether there is a reality that exists independently of the individual's perception of it--in other words, if the evidence one has for the existence of anything is what one perceives, how can one know that anything exists unperceived?--and, second, how one can know what anything is really like, if the perceptual evidence one has is conflicting.

The "other minds" problem."

The second problem also involves seeing but in a somewhat unusual way. It deals with that which one cannot see, namely the mind of another. Suppose a woman is scheduled to have an operation on her right knee and her surgeon tells her that when she wakes up she will feel a sharp pain in her knee. When she wakes up, she does feel the pain the surgeon alluded to. He can hear her groaning and see certain contortions on her face. But he cannot feel what she is feeling. There is thus a sense in which he cannot know what she knows. What he claims to know, he knows because of what others who have undergone operations tell him they have experienced. But, unless he has had a similar operation, he cannot know what it is that she feels.

Indeed, the situation is still more complicated; for, even if the doctor has had such a surgical intervention, he cannot know that what he is feeling after his operation is exactly the same sensation that the woman is feeling. Because each person's sensation is private, the surgeon cannot really know that what the woman is describing as a pain and what he is describing as a pain are really the same thing. For all he knows, she could be referring to a sensation that is wholly different from the one to which he is alluding.

In short, though another person can perceive the physical manifestations the woman exhibits, such as facial grimaces and various sorts of behaviour, it seems that only she can have knowledge of the contents of her mind. If this assessment of the situation is correct, it follows that it is impossible for one person to know what is going on in another person's mind. One can conjecture that a person is experiencing a certain sensation, but one cannot, in a strict sense of the term, know it to be the case.

If this analysis is correct, one can conclude that each human being is inevitably and even in principle cut off from having knowledge of the mind of another. Most people, conditioned by the great advances of modern technology, believe that in principle there is nothing in the world of fact about which science cannot obtain knowledge. But the "other-minds problem" suggests the contrary--namely, that there is a whole domain of private human experience that is resistant to any sort of external inquiry. Thus, one is faced with a profound puzzle, one of whose implications is that there can never be a science of the human mind.

Implications.

These two problems resemble each other in certain ways and differ in others, but both have important implications for epistemology.

First, as the divergent perceptions about the stick indicate, things cannot just be, as they appear to be. People believe that the stick, which looks bent when it is in the water, is really straight, and they also believe that the stick, which looks straight when it is out of the water, is really straight. But, if the belief that the stick in water is really straight is correct, then it follows that the perception human beings have when they see the stick in water cannot be correct. That particular perception is misleading with respect to the real shape of the stick. Hence, one has to conclude that things are not always, as they appear to be.

It is possible to derive a similar conclusion with respect to the mind of another. A person can exhibit all the signs of being in pain, but he may not be. He may be pretending. On the basis of what can be observed, it cannot be known with certitude that he is or that he is not in pain. The way he appears to be may be misleading with respect to the way he actually is. Once again vision can be misleading.

Both problems thus force one to distinguish between the way things appear and the way they really are. This is the famous philosophical distinction between appearance and reality. But, once that distinction is drawn, profound difficulties arise about how to distinguish reality from mere appearance. As will be shown, innumerable theories have been presented by philosophers attempting to answer this question since time immemorial.

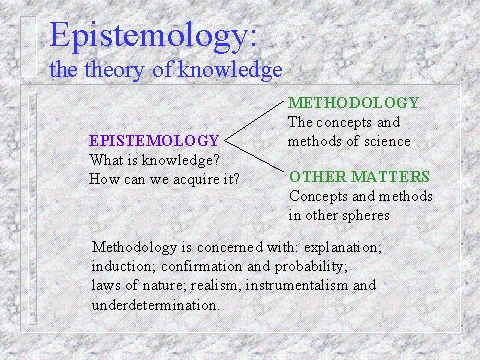
Second, there is the question of what is meant by "knowledge." People claim to know that the stick is really straight even when it is half-submerged in water. But, as indicated earlier, if this claim is correct, then knowledge cannot simply be identical with perception. For whatever theory about the nature of knowledge one develops, the theory cannot have as a consequence that knowing something to be the case can sometimes be mistaken or misleading.

Third, even if knowledge is not simply to be identified with perception, there nevertheless must be some important relationship between knowledge and perception. After all, how could one know that the stick is really straight unless under some conditions it looked straight? And sometimes a person who is in pain exhibits that pain by his behaviour; thus there are conditions that genuinely involve the behaviour of pain. But what are those conditions? It seems evident that the knowledge that a stick is straight or that one is in great pain must come from what is seen in certain circumstances: perception must somehow be a fundamental element in the knowledge human beings have. It is evident that one needs a theory to explain what the relationship is--and a theory of this sort, as the history of the subject all too well indicates, is extraordinarily difficult to develop.

The two problems also differ in certain respects. The problem of man's knowledge of the external world raises a unique difficulty that some of the best philosophical minds of the 20th century (among them, Bertrand Russell, H.H. Price, C.D. Broad, and G.E. Moore) spent their careers trying to solve. The perplexity arises with respect to the status of the entity one sees when one sees a bent stick in water. In such a case, there exists an entity--a bent stick in water--that one perceives and that appears to be exactly where the genuinely straight stick is. But clearly it cannot be; for the entity that exists exactly where the straight stick is is the stick itself, an entity that is not bent. Thus, the question arises as to what kind of a thing this bent-stick-in-water is and where it exists.

The responses to these questions have been innumerable, and nearly all of them raise further difficulties. Some theorists have denied that what one sees in such a case is an existent entity at all but have found it difficult to explain why one seems to see such an entity. Still others have suggested that the image seen in such a case is in one's mind and not really in space. But then what is it for something to be in one's mind, where in the mind is it, and why, if it is in the mind, does it appear to be "out there," in space where the stick is? And above all, how does one decide these questions? The various questions posed above only suggest the vast network of difficulties, and in order to straighten out its tangles it becomes indispensable to develop theories.

**Methodology.**



In accordance with a proposal made above, epistemology, or thelogic of scientific discovery, -should be identified with the theory of scientific method. The theory of method, in so far as it goes beyond the purely logical analysis of the relations between scientific statements, is concerned with the choice of methods*—*with decisions about the way in which scientific statements are to be dealt with. These decisions will of course depend in their turn upon the aim, which we choose from among a number of possible aims.

*Methodology* or a*scientific**method* is a collective term denoting the various processes by the aid of which the sciences are built up. In a wide sense, any mode of investigation by which scientific or other impartial and systematic knowledge is acquired is called a scientific method.

What are the rules of scientific method, and why do we need them? Can there be a theory of such rules, a methodology? The way in which one answers these questions will largely depend upon one’s attitude to science. The way in which one answers these questions will largely depend upon one's attitude to science. Those who, like the positivists, see empirical science as a system of statements, which satisfy certain *logical criteria,* such as meaningfulness or verifiability, will give one-answer. A very different answer will be given by those who tend to see the distinguishing characteristic of empirical statements in their susceptibility to revision—in the fact that they can be criticised,-and superseded by better ones; and who regard it as their task to analyse the characteristic ability of science to advance, and the characteristic manner in which a choice is made, in crucial cases, between conflicting systems of theories.

Such methods, as it was mentioned above, are of two principal types— *technical* and *logical*. A *technical* or technological method is a method of manipulating the phenomena under investigation, measuring them with precision, and determining the conditions under which they occur, so as to be able to observe them in a favourable and fruitful manner. A *logical method* is a method of reasoning about the phenomena investigated, a method of drawing inferences from the conditions under which they occur, so as to interpret them as accurately as possible. The term "scientific method" in the first instance probably suggests to most minds the technical methods of manipulation and measurement. These technical methods are very numerous and they are different in the different sciences. Few men ever master the technical methods of more than one science or one group of closely connected sciences. An account of the most important technical methods is usually given in connection with the several sciences. It would be impossible, even if it were desirable, to give a useful survey of all, or even of the most important, technical methods of science. It is different with the logical methods of science. These methods of reasoning from the available evidence are not really numerous, and are essentially the same in all the sciences. It is both possible and desirable to survey them in outline. Moreover, these logical methods of science are in a very real sense the soul of the technical methods.

In pure science the technical methods are not regarded as an end in themselves, but merely as a means to the discovery of the nature of the phenomena under investigation. This is done by drawing conclusions from the observations and experiments, which the technical methods render possible. Sometimes the technical methods make it possible for the expert investigator to observe and measure certain phenomena, which otherwise could either not be observed and measured at all, or not so accurately. Sometimes they enable him so to determine the conditions of their occurrence that he can draw reliable conclusions about them, instead of hav­ing to be content with unverified conjectures. The highly specu­lative, mainly conjectural character of early science was no doubt due entirely to the lack of suitable technical methods and scientific instruments. In a sense; therefore, it may be said that the techni­cal methods of science are auxiliary to the logical methods, or methods of reasoning. And it is these methods that are to be con­sidered in the present article. The technical methods of science, as ought to be clear from the preceding remarks, are of first rate importance, 'and we have not the remotest desire to underrate them; but it would be futile to attempt to survey them here.

**Some Mental Activities Common to All Methods.**

There are certain mental activities, which are so absolutely indispensable to science that they are practically always employed in scientific investigations, however much these may vary in other respects. In a wide sense these mental activities might consequently be called methods of science, and they are frequently so called. But this practice is objectionable, because it leads to cross division and confusion. What is common to all methods should not itself be called a method, for it only encourages the effacing of important differences; and when there are many such factors common to all the methods, or most of them, confusion is inevitable. When the mental activities involved are more or less common to the methods, these must be differentiated by reference to other, variable factors—such as the different types of data from which the inferences are drawn, and the different types of order sought or discovered in the different kinds, of phenomena investigated— the two sets of differences being, of course, intimately connected. The mental activities referred to are the following: Observation (including experiment), analysis and synthesis, imagination, sup­position and idealisation, inference (inductive and deductive), and comparison (including analogy). A few words must be said about each of these; but no significance should be attached to the order in which they are dealt with.

**Observation and Experiment.**

Observation is the act of apprehending things and events, their attributes and their con­crete relationships. From the point of view of scientific interest two types of observation may be distinguished, namely: (1) The *bare observation* of phenomena under conditions which are beyond the control of the investigator, and (2) *experiment,* that is, the observation of phenomena under conditions controlled by the in­vestigator. What distinguishes experiment from bare observation is *control* over what is observed, not the use of scientific apparatus, nor the amount of trouble taken. The mere use of telescopes or microscopes, etc., even the selection of specially suitable times and places of observation, does not constitute an experiment, if there is no control over the phenomenon observed. On the other hand, where there is such control, there is experiment, even if next to no apparatus be used, and the amount of trouble involved be negligible. The making of experiments usually demands the employment of technical methods, but the main interest centres in the observations made possible thereby. The great advantage of experiment over bare observation is that it renders possible a more reliable analysis of complex phenomena, and more reliable inferences about their connections, by the variation of circum­stances, which it effects. Its importance is so great that people commonly speak of "experimental method." The objection to this is that experiment may be, and is, used in connection with various methods, which are differentiated on other, and more legitimate, grounds. To speak of a method of observation is even less permissible, seeing that no method can be employed without it.

Analysis and Synthesis.

The phenomena of nature are very complex and, to all appearances, very confused. The discovery of any kind of order in them is only rendered possible by processes of analysis and synthesis. These are as essential to all scientific investigation as is observation itself. The process of analysis is helped by the comparison of two or more objects or events that are similar in some respects and different in others. But while comparison is a necessary instrument of analysis, analysis, in its turn, renders possible more exact comparison. After analysing some complex whole into its parts or aspects, we may tentatively connect one of these with another in order to discover a law of connection, or we may, in imagination, combine again some of them and so form an idea of what may be common to many objects or events, or to whole classes of them. Some combinations so obtained may not correspond to anything that has ever been observed. In this way analysis and synthesis, even though they are merely mental in the first instance, prepare the way for experiment, for discovery and invention.

**Imagination, Supposition and Idealisation.**

Such order as may be inherent in the phenomena of nature is not obvious on the face of them. It has to be sought out by an active interrogation of nature. The interrogation takes the form of making tentative suppositions, with the aid of imagination, as to what kind of order might prevail in the phenomena under investigation. Such suppositions are usually known as hypotheses, and the formation of fruitful hypotheses requires imagination and originality, as well as familiarity with the facts investigated. Without the guidance of such hypotheses observation itself would be barren in science for we should not know what to look for. Mere staring at facts is not yet scientific observation of them. Hence for science any hypothesis, provided it can be put to the test of observation or experiment, is better than none. For observation not guided by ideas is blind, just as ideas not tested by observations are empty. Hypotheses that can be put to the test, even if they should turn out to be false, are called "fruitful"; those that cannot be so tested even if they should eventually be found to be true, are for the time being called "barren." Intimately connected with the processes of imagination and supposition is the process of idealisation, that is, the process of conceiving the ideal form or ideal limit of something which may be observable but always falls short, in its observed forms, of the ideal. The use of limiting cases in mathematics, and of conceptions like those of an "economic man" in science are examples of such idealisation.

**Inference.**

This is the process of forming judgements or opinions on the ground of other judgements or on the evidence of observation. The evidence may be merely supposed for the sake of argument, or with a view to the further consideration of the con-sequences, which follow from it. It is not always easy to draw the line between direct observation and inference. People, eventrained people, do not always realise, *e.g.,* when they pass from the observation of a number of facts to a generalisation which, at best, can only be regarded as an inference from them. But the difficulty need not be exaggerated. There are two principal types of inference, namely deductive and inductive. *Inductive inference* is the process of inferring some kind of order among phenomena from observations made. *Deductive inference* is the process of applying general truths or concepts to suitable instances. In science inductive inference plays the most important role, and the methods of sciences are mainly instruments of induction or auxiliaries thereto. But deductive inference is also necessary to science, and is, in fact, a part of nearly all complete inductive investigations. Still, marked inductive ability is very rare. There are thousands who can more or less correctly apply a discovery for one who can make it.

**Comparison and Analogy.**

Reference has already been made to the importance of the process of comparison in the mental analysis of observed phenomena. The observation of similarities and differences, aided by the processes of analysis and synthesis, is one of the first steps to knowledge of every kind, and continues to be indispensable to the pursuit of science throughout its progress. But there are degrees of similarity. Things may be so alike that they are at once treated as instances of the same kind or class. And the formulation and application of generalisations of all kinds are based upon this possibility of apprehending such class resemblances. On the other hand, there is a likeness, which stops short of such close class likeness. Such similarity is usually called analogy. The term is applied to similarity of structure or of function or of relationship, in fact, to similarity of almost every kind except that which characterises members of the same class, in the strict sense of the term. And analogy plays very important part in the work of science, especially in suggesting those suppositions or hypotheses which, as already explained, are so essential to scientific research and discovery.

After this brief survey of various mental activities which are more or less involved in the pursuit of every kind of knowledge, and consequently from no suitable bases for the differentiation of the various methods of science, we may now proceed to the consideration of the several scientific methods properly so called.

**Classification.**

This may be described as the oldest and simplest of scientific methods. The observation of similarities be­tween certain things, and classing them together, marks the earliest attempt to discover some kind of order in the apparently chaotic jumble of things that confront the human mind. Language bears witness to the vast number of classifications made spontaneously by pre-scientific man. For every common noun expresses the recognition of a class; and language is much older than science. The first classifications subserved strictly practical purposes, and had reference mainly to the uses which man could make of the things classified. They were frequently also based on superficial resemblances, which veiled deeper differences, or were influenced by superficial differences, which diverted attention from deeper similarities. But with the growth of the scientific spirit classifica­tions became more objective or more natural, attention being paid to the objective nature of the things themselves rather than to their human uses. Even now scientific classification rarely begins at the beginning, but sets out from current classifications embodied in language. It has frequent occasion to correct popular classifica­tions. At the same time it has difficulties of its own, and more than one science has been held up for centuries for want of a really satisfactory scheme or classification of the phenomena constituting its field of investigation. To recognise a class is to recognise the unity of essential attributes in a multiplicity of instances; it is a recognition of the one in the many. To that extent it is a dis­covery of order in things. And although it is the simplest method of science, and can be applied before any other method, it is also the fundamental method, inasmuch as its results are usually as­sumed when the other methods are applied. For science is not, as a rule, concerned with individuals as such, but with kinds or classes. This means that the investigator usually assumes the accuracy of the classification of the phenomena, which he is study­ing. Of course, this does not always turn out to be the case. And the final outcome of the application of other methods of science to certain kinds of phenomena may be a new classification of them.

**Inductive and deductive methods.**

Below is the summary of contrasts in the major tenets of inductivism and of Popper's deductivism.*.* I begin with a caricature of inductivism in the form of eight theses:

1. Science strives for justified, proven knowledge, for certain truth.

2. All scientific inquiry begins with observations or experiments.

3. The observational or experimental data are organised into a hypothesis, which is not yet proven (context of discovery).

4. The observations or experiments are repeated many times.

5. The greater the number of successful repetitions, the higher the probability of the truth of the hypothesis (context of justifica­tion).

6. As soon as we are satisfied that we have reached certainty in that manner we lay the issue aside forever as a proven law of nature.

7. We then turn to the next observation or experiment with which we proceed in the same manner.

8. With the conjunction of all these proven theories we build the edifice of justified and certain science.

In summary, the inductivist believes that science moves from the particulars to the general and that the truth of the particular data is transmitted to the general theory.

Now we will observe a caricature of Popper's theory of deduc-tivism, again in the form of eight theses:

1. Science strives for absolute and objective truth, but it can never reach certainty.

2. All scientific inquiry begins with a rich context of background knowledge and with the problems within this context and with metaphysical research programmes.

3. A theory, that is, a hypothetical answer to a problem, is freely invented within the metaphysical research programme: it explains the observable by the unobservable.

4. Experimentally testable consequences, daring consequences that is, are deduced from the theory and corresponding experi­ments are carried out to test the predictions.

5. If an experimental result comes out as predicted, it is taken as a value in itself and as an encouragement to continue with the theory, but it is not taken as an element of proof of the theory of the unobservable.

6. As soon as an experimental result comes out against the pre­diction and we arc satisfied that it is not a blunder we decide to consider the theory falsified, but only tentatively so.

7. With this we gain a deeper understanding of our problem and proceed to invent our next hypothetical theory for solving it, which we treat again in the same way.

8. The concatenation of all these conjectures and refutations constitutes the dynamics of scientific progress, moving ever closer to the truth, but never reaching certainty.

In summary, the Popperian deductivist believes that science moves from the general to the particulars and back to the general— a process without end. Let me inject a metaphor. I might liken the Popperian view of science to that of a carriage with two horses. The experimental horse is strong, but blind. The theoretical horse can see, but it cannot pull. Only both together can bring the car­riage forward. And behind it leaves a track bearing witness to the incessant struggle of trial and error.

**The Deductive-inductive Method.**

Just as money makes money, so knowledge already acquired facilitates the acquisition of more knowledge. It is equally evident in the case of the method, which will now engage our attention. The progress of science, and of knowledge generally, is frequently facilitated by supplementing the simpler inductive methods by deductive reasoning from knowledge already acquired. Such a combination of deduction with induction, J. S. Mill called the "Deductive Method," by which he really meant the "Deduc­tive Method of Induction." To avoid the confusion of the "De­ductive Method" with mere deduction, which is only one part of the whole method, it is better to describe it as the "Deductive-Inductive Method" or the "Inductive-Deductive Method." Mill distinguished two principal forms of this method as applied to the study of natural phenomena, -namely, (1) that form of it in which deduction precedes induction, and (2) that in which induc­tion precedes deduction. The first of these (1) he called the "Physical Method"; the second (2) he called the "Historical Method."

These names are rather misleading, inasmuch as both forms of the method are frequently employed in physics, where some­times, say in the study of light, mathematical (*i.e.,* deductive) calculations precede and suggest physical experiments *(i.e.,* induc­tion), and sometimes the inductive results of observation or ex­periment provide the occasion or stimulus for mathematical de­ductions. In any case, the differences in order of sequence are of no great importance, and hardly deserve separate names. What is of importance is to note the principal kinds of occasion, which call for the use of this combined method. They are mainly three in number: (1) When an hypothesis cannot be verified *(i.e.,* tested) directly, but only indirectly; (2) when it is possible to systematise a number of already established inductions, or laws, under more comprehensive laws or theories; (3) when, owing to the difficulties of certain problems, or on account of the lack of sufficient and suitable instances of the phenomena under in­vestigation, it is considered desirable either to confirm an induc­tive result by independent deductive reasoning from the nature of the case in the light of previous knowledge, or to confirm a deductive conclusion by independent inductive investigation.

An example of each of these types may help to make them clear. (1) When Galileo was investigating the law of the velocity of falling bodies he eventually formed the hypothesis that a body starting from rest falls with a uniform acceleration, and that its velocity varies with the time of its fall. But he could not devise any method for the direct verification of this hypothesis. By mathematical deduction, however, he arrived at the conclusion that a body falling according to his hypothetical law would fall through a distance proportionate to the time of its fall. This consequence could be tested by comparing the distances and the time of falling bodies, which thus served as an indirect verifica­tion of his hypothesis. (2) By inductions from numerous astro­nomical observations made by Tycho Brahe and himself, Kepler discovered the three familiar laws called by his name, namely, (a) that the planets move in elliptic orbits which have the sun for one of their foci; (6) that the velocity of a planet is such that the radius vector *(i.e.,* an imaginary line joining the moving planet to the sun) sweeps out equal areas in equal periods of time; and (c) that the squares of the periodic times of any two planets (that is, the times which they take to complete their revolutions round the sun) are proportional to the cubes of their mean distances from the sun. These three laws appeared to be quite independent of each other. But Newton systematised them all in the more comprehensive induction, or theory, of celestial gravitation. He showed that they could all be deduced from the one law that the planets tend to move towards each other with a force varying directly with the product of their masses, and inversely with the square of the distances between them. (3) H. Spencer, by comparing a number of predominantly industrial States and also, of predominantly military States, ancient and modern, inferred inductively that the former type of State is democratic and gives rise to free institutions, whereas the latter type is undemocratic and tends to oppression. As the sparse evidence hardly permitted of a rigorous application of any of .the inductive methods, Spencer tried to confirm his conclusion by deductive reasoning from the nature of the case in the light of what is known about the human mind. He pointed out that in a type of society, which is predominantly industrial, the trading relations between individuals are the predominant relations, and these train them to humour and consider others. The result is a democratic attitude in all. In a State, which is predominantly military, the relations which are most common among its members are those of authority, on the one part, and of subordination on the other. The result is the reverse of a democratic atmosphere.

RELATION OF EPISTEMOLOGY TO OTHER BRANCHES OF PHILOSOPHY

In conclusion, I would like to discuss the relation of epistemology to other branches of philosophy. Philosophy viewed in the broadest possible terms divides into many branches: metaphysics, ethics, aesthetics, logic, philosophy of language, philosophy of mind, philosophy of science, and a gamut of others. Each of these disciplines has its special subject matter: for metaphysics it is the ultimate nature of the world; for ethics, the nature of the good life and how people ideally ought to comport themselves in their relations with others; and for philosophy of science, the methodology and results of scientific activity. Each of these disciplines attempts to arrive at a systematic understanding of the issues that arise in its particular domain. The word systematic is important in this connection, referring, as explained earlier, to the construction of sets of principles or theories that are broad-ranging, consistent, and rationally defensible. In effect, such theories can be regarded as sets of complex claims about the various matters that are under consideration.

Epistemology stands in a close and special relationship to each of these disciplines. Though the various divisions of philosophy differ in their subject matter and often in the approaches taken by philosophers to their characteristic questions, they have one feature in common: the desire to arrive at the truth about that with which they are concerned--say, about the fundamental ingredients of the world or about the nature of the good life for man. If no such claims were asserted, there would be no need for epistemology. But, once theses have been advanced, positions staked out, and theories proposed, the characteristic questions of epistemology inexorably follow. How can one know that any such claim is true? What is the evidence in favour of (or against) it? Can the claim be proven? Virtually all of the branches of philosophy thus give rise to epistemological ponderings.

These ponderings may be described as first-order queries. They in turn inevitably generate others that are, as it were, second-order queries, and which are equally or more troubling. What is it to know something? What counts as evidence for or against a particular theory? What is meant by a proof? Or even, as the Greek Sceptics asked, is human knowledge possible at all, or is human access to the world such that no knowledge and no certitude about it is possible? The answers to these second-order questions also require the construction of theories, and in this respect epistemology is no different from the other branches of philosophy. One can thus define or characterise epistemology as that branch of philosophy, which is dedicated to the resolution of such first- and second-order queries.

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