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HISTORY OF COGNITIVE SCIENCE — A CRITICAL ANALYSIS

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Cognitive science has its origin in philosophy. It deals with the fundamental questions of knowledge. It is one of the important branches of philosophy. In earlier times, the branch of cognitive science was basically included in philosophy. Similarly, the philosophy of mind was also included in philosophy. Later on, after the evolution of psychology as an independent discipline, the cognitive science became one of the branches of psychological studies. However, its relationship with philosophy continued and it is very difficult to make a water-tight compartment of cognitive science as separate from philosophy and psychology. It is intertwined with philosophy and psychology and later on cognitive science emerged as an independent discipline in the history of educational sciences. In this paper, an attempt has been made to analyze a historical development of cognitive science in a broader perspective.

The study of mind has always been most adventurous for man, for Norman Cousins aptly stated “the growth of the human mind is still high adventure, in many ways the highest adventure on earth”. Cognitive science has emerged as a discipline which has taken to bear this most adventurous task with an interdisciplinary approach. It is the intersection of the ‘study of mind’ in philosophy, psychology, anthropology, linguistics, neuroscience and artificial intelligence.

In philosophy, the study of mind comes under the epistemological branch as it is concerned with 'cognition', the knowing aspect. So, in another way, we can say cognitive science as the science of knowing. Philosophy has a great bearing on the foundational aspect of cognitive science. Many questions considered by philosophy in epistemology, logic, philosophy of mind and philosophy of science have a significant bearing on the theory and modeling of intelligent systems. It can be said that the evolution of cognitive science as a discipline contains more philosophical discussions than any other.

Though the quests for mind, knowledge, reality, existence, etc. have haunted the human race through ages, the study can be started from the views of great philosophers and scholars like Socrates, Plato, Aristotle, Descartes, Spinoza, Locke, Leibniz, Berkeley, Hume, etc. Their debates on epistemological issues ultimately lead to the emergence of a new science — cognitive science.

Socrates' (469-399 BC) view was that knowledge of the cosmos and the ultimate nature of things is unattainable. He argued that wisdom consists precisely in attaining an accurate view of our own ignorance, in a critical ability to deconstruct false beliefs in ourselves and in others. He claimed that this critical, penetrating self-knowledge would lead to the pursuit of virtue.

For Plato (427-347 BC), learning and knowledge acquisition in the ordinary sense is impossible. If knowledge is attainable, that knowledge must be "infallible" as well as "of the real". Any state of mind that cannot justify its claim to both these characteristics cannot be true knowledge. In Plato's view, knowledge is merely an awareness of absolute universal Ideas or Forms existing independent of any subject trying to apprehend to them. His basic idea is that—just as there are objects which the senses experience, so there are objects which the mind experiences. These objects

are Ideas or Forms. The mind is said to experience these ideas or forms through a process called 'Intuition'. For Plato, knowledge is true belief justified by an account.

Aristotle's (384-322 BC) epistemology is a blend of rationalist and empiricist elements. He accepted the structure of justified true belief but rejected the theory of Forms. As an empiricist, he states the essential role of perception and observation in the acquisition of knowledge. However, he believed that the development of systematic knowledge requires the contribution of reason. He proposed a scientific method: the organized gathering of observations and measurements, followed by taxonomic classification. This was then followed by the application of rational methods: categorization (interpretation) and inference (logic).

Descartes' (1596-1650) views on knowledge were based on straightforward observation and common sense. He strongly believed that no lasting progress could be made in the sciences unless a systematic method could be devised for shifting through our preconceived opinions and establishing which of them, if any, was reliable. He defined knowledge in terms of doubt, which he believes is the contrast of certainty. The requirement that knowledge is to be based in complete, or perfect certainty, amounts to requiring a complete absence of doubt. He believed that our mind is infallible, if left to itself. It naturally possesses two powers—intuitions and deduction. Descartes' Cartesian method guides the power of intuition and deduction, so that the mind is not deflected. He placed the whole structure of knowledge upon the foundation of intuition and deduction.

Spinoza (1632-1677) was also in the line of Descartes in believing that exact knowledge of reality can be achieved by following the method of geometry. He added a highly systematic arrangement of principles and axioms to Descartes' method. He holds that doubt arises only when the mind has two related ideas,

one contradicting the other. He distinguishes three kinds of knowledge and describes how one can move from the lowest to the highest level. By refining the knowledge of things, one can move from imagination to reason and finally to intuition. At the imagination level, the mind is passive, the ideas are concrete and specific, but they are vague and inadequate. At the level of reason, mind can rise above immediate and particular things and deal with abstract ideas. At this level, knowledge is true and adequate. At the intuition level the system of nature can be grasped. Particular things are seen as parts of the whole scheme. This kind of knowledge makes us more and more perfect.

According to Locke (1632-1704), knowledge is restricted to ideas that are generated by objects we experience through senses. He vigorously denied innate knowledge. He said, at birth, the mind is like a blank slate (*Tabula Rasa*). We experience the external world through our senses and the internal world through reflection. But, experience of reflection is not possible until the experience of sensation, i.e.

Sensation Ideas Reflection

He talked about simple and complex ideas. Simple ideas are received passively by the mind through senses. Complex ideas are put together by the mind as a compound of simple ideas. He believes, the extension and validity of knowledge depends upon the relations our ideas have to each other.

Leibniz (1646-1716) is also both an empiricist as well as a rationalist. His rationalism in epistemology is most evident in his account of a priori knowledge. He distinguishes between truths of reason and truths of fact. Truths of reason are known purely by logic whereas truths of facts are known by experience. His account of truth leads to the conclusion that all knowledge is ultimately a priori knowledge. But he himself avoids this conclusion. He claimed that our knowledge of particular contingent truths has its basis in

sense perception. He argued that our knowledge of universal contingent truths cannot be based entirely on simple enumerative inductions, but must be supplemented by the conjectural method, *a priori*.

David Hume (1711-1776), an empiricist, argued against the existence of innate ideas. Instead he concluded that human knowledge consists only of things they directly experience. He developed the position that mental behavior is governed by custom. He distinguishes between impressions and ideas. By 'impressions', he means sensations, while by 'ideas', he means memories and imaginings. The difference between the two is that ideas are less vivacious than impressions. He accepts that ideas may be either the product of mere sensation, or of the imagination working in conjunction with sensation.

Trained in rationalist tradition and influenced by empiricist David Hume, Kant (1724-1804) emerged as a reconciliator. It is realized in his works that there is a distinction between 'understanding' as the general concept and 'understanding' as a faculty of the human mind. Kant deemed it obvious that we have some objective knowledge of the world. But this knowledge relies on synthetic, *a priori* laws of nature, like causality and substance. He believes that objective knowledge is gained through the sensibility, which supplies the mind with intuitions, and there is the understanding which produces judgments of these intuitions and can consider them under categories. These categories lift the intuition up out of the subject's current state of consciousness in general, producing universally necessary knowledge. As the categories are innate in any rational being, so any intuitions thought within a category in one mind will necessarily be subsumed and understood identically in any mind.

The 17th to 19th century debate between the rationalists and the empiricists on the origins of knowledge has contributed a lot

towards the making of the field of cognitive science. Reflecting the empiricists' emphasis on experience as the source of knowledge, early experimental psychology focused on phenomena of sensation and perception.

In the late 18th century, psychology was considered an impossible science, as mind is an immeasurable and immaterial object, as reasoned by Kant. But in less than 50 years, Ernst Weber (in 1834) and Gustav Fechner (in 1860) discovered the first psychophysical laws, Hermann Von Helmholtz performed experiments to understand the mechanisms of distance and motion perception (1856-1866), and Franciscus Donders introduced (in 1868) reaction time as a means of measuring the speed of mental processes (Boring 1950; Woznaik, 1992).

Wilhelm Wundt (1832-1920), a psychologist, believed that only the sciences have methodologies to synthesize our representations, sensible as well as processed into 'facts'. According to him, philosophy's pure task is universal, operating over all scientific domains. He writes, it is 'the general pieces of knowledge' yielded by the particular sciences into a system free of contradiction. Philosophy has no constitutive but merely a regulative role vis-à-vis the sciences. He urged psychology to be a 'true quantitative, experimental natural science'. But in 1885, Ebbinghaus proved Wundt's concept of psychology as "a true quantitative, experimental natural science" wrong by inventing methods for the quantitative, experimental study of memory. In 1896, Mary Whiton Calkins developed paired associate learning, and Pavlov and Thorndike (both 1898) developed similar methods for studying learning in animals. In 1920, Clark Hull adopted Ebbinghaus' methods to study concept formation.

At a time when psychology was ready to address problems in cognition at all levels, behaviorism descended on the field and dominated it. Behaviorists argued that psychology should restric

itself to examining the relation between observable behavioral responses. Mental life was considered inherently subjective and private.

Cognitive science as an interdisciplinary field developed with some notable contributions of various thinkers in different disciplines. During and after World War II, the development of high speed computers, cybernetics and information theory set the stage for the cognitive revolution in psychology. The first electronic computer was developed based on the theoretical principles of Alan Turing (1936) and Claude Shanon (1938). Turing's idea was that a computer could be said to "think" through conversation from a human being. Claude Shanon suggested that electrical circuits could represent fundamental operations of thought. The proximal intellectual root of cognitive science may be situated around the middle of the 20th century with the rise of cybernetics (Weiner, 1948). Weiner studied the feedback principle used in the sophisticated electronics, and developed the concept of self-correcting and self-regulating systems, which formed the field of cybernetics, concerning combination of man and electronics.

A symposium was held on information science at the MIT, Boston on 11th September, 1956. Diverse disciplines like philosophy, psychology, computer science, neuroscience, linguistics and anthropology converged at the symposium (Keysers et al, 1978). This date is often taken to be the birth date of cognitive science, as it brought together thinkers from various disciplines that played significant roles in the emergence of cognitive science. Alan Newell and Herbert Simon presented the first machine generated proof of a theorem in symbolic logic at the symposium. They emphasized not only on demonstrating the machine intelligence, but actually demonstrating the general laws underlying all thinking (Simon, 1969). Noam Chomsky's idea postulated computational transformations across the morphological units of language (Chomsky, 1957). George Miller discussed the limitations of human

information processing. Jerome Bruner stressed that self-reports are crucial to understand complex cognition. In 1960, Bruner and Miller founded the Centre for Cognitive Science at Harvard.

In 1958, Colin Cherry and Donald Broadbent proposed that we think in the same terms as simpler information processing devices are described, as a set of input and output channels with known limited capacities (Broadbent, 1958). In 1969, Ulric Neisser published his book 'Cognitive Psychology'. The Sloan Foundation established a program in cognitive science in 1976. However, the formalization of the enterprise as a properly recognized scientific discipline took place in 1977 with the publication of the journal "Cognitive Science" and the first conference of the Cognitive Science Society at the University of California, San Diego. Thus, an interdisciplinary field of cognitive science was institutionalized. The Sloan Foundation conceived it as "an autonomous science of cognition". Since then, an annual meeting in the form of a conference is held by the Cognitive Science Society, and the developments and prospects in the field of cognitive science are discussed by thinkers and scholars of various disciplines. The Sloan Foundation conceived cognitive science as "an autonomous science of cognition".

The ancient root of cognitive science is implicit in the epistemological discussions of the great philosophers. The subject matter of cognitive science—'cognition' i.e. knowing—is the central point of epistemological discussions in philosophy. The rivalry between the methodologies of pure reason (rationalism) and sense experience (empiricism) as the means for gaining knowledge laid the foundation for cognitive science. Rationalists like Socrates, Plato, Descartes and Spinoza emphasized the importance of self-knowledge and a priori knowledge. The empiricists like Locke and Hume argued against the existence of innate ideas and advocated sense experience as necessary for acquiring true knowledge. Whereas philosophers like Aristotle, Leibniz and Kant represented

a blend of rationalism and empiricism. Empiricists' focus on experience as the source of knowledge led to experimental psychology based on sensation and perception. On this basis, Wundt stressed psychology to be a quantitative, experimental and natural science. This was proved wrong by psychologists like Ebbinghaus, Pavlov, Clark Hull, etc. Just when psychology was about to take 'cognition' issues, behaviorism dominated the field. But again, the 'cognitive revolution' during the World War II brought cognition into focus. Development of computers, cybernetics and particularly information science led towards the emergence of Cognitive Science. Though the Symposium on information science at the MIT, held in 1956, it can be considered as the mother of cognitive science, but its ancient foundations are rooted in the epistemological debates of the philosophers, which constitute the philosophical foundation of cognitive science.

Thus, it appears that a sequential development has taken place in cognitive science starting from ancient philosophers like Socrates, Plato and Aristotle and it leads to modern time with the contributions of Descartes, Spinoza, Locke, Leibniz, etc. which has further extended to 18th century to 20th century by various philosophers like Gustav Fechner, Boring, Wundt, Calkins, Weiner, etc. Thus, cognitive science has made a significant contribution in the field of educational sciences especially it has a special role for development of pedagogical sciences. The implications of cognitive science are for structuring the educational concept in tune with the cognitive exercise of the learners in the field of education and pedagogy.

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