CHAPTER 2

THEORETICAL FRAMEWORK

Foundation of Cognitive Science

Cognitive science as a discipline comes under the epistemological branch of philosophy. The history of cognitive science is practically equivalent to the history of all intellectual efforts to understand human cognition systematically. This would include the history of epistemology and philosophy of mind as well as history of psychology, cognitive anthropology, linguistics, neuroscience and artificial intelligence. But like of any other discipline, philosophical background forms the foundation of cognitive science.

Epistemology is the branch of philosophy which deals with ‗knowledge'. Before going into epistemology, it is necessary to understand what philosophy as a field of study is concerned with. Philosophy is the critical study of the most fundamental questions that arise in the human mind. It asks what the matter of reality is, and what the reality of nature is. Do our perceptions of reality match the actual reality? What does it mean to think? What does it mean to have a mind? How can we know that other minds actually exist? Is there a difference between right and wrong, and if so, how can we prove this? How do we define rules that allow us to apply theoretical ideas of right and wrong in practical situations? What do we mean by the word ‗God'? Does God exist? It deals with the concepts as existence, goodness, knowledge and beauty. It asks ―Is knowledge possible,‖ and if so, ―what is knowledge?‖ Philosophy is the critical, speculative or analytic study of such issues.

The method of philosophy involves formulating problems carefully based on all known facts, and attempting at logical solutions to them, and engaging in a dialectical process to arrive at the truth. This is same as the method of science but without much dependence on physical experimentation. The method of science proceeds by observation, formulation of a hypothesis, and further experimentation. The method of philosophy proceeds by logical formulation of a problem, argument for a solution, and counter argument. These proceed until a solution (truth) is reached. Philosophy has developed more slowly than other sciences. It is because it is solely dependent on cognitive integrity. It does not have a coherent paradigm for determining what kinds of experimental evidence to accept. Thus, it can be said, philosophy is one's integrated view of the world. It includes an understanding of the nature of existence,

man and his role in the world. Philosophy is the foundation of knowledge. It is the standard by which ideas are integrated and understood.

The issues and concerns in philosophy have been divided into three broad categories which forms the branches of philosophy. These are—

- Axiology—It explores i) aesthetics (the study of basic philosophical questions about art and beauty) ii) ethics (the study of what makes actions right or wrong) iii) logic (the study of the standards of correct argumentation).
- Epistemology—It is the study of knowledge and its nature, possibility, and justification.
- Metaphysics—It is the study of the most basic categories of things, such as existence, objects, properties, causality, etc., including ontology.

As the concern of the study is on cognition and knowledge, the focus is on the theory of knowledge—epistemology.

Concept of Epistemology

It is recognized that the world exists in a particular way or pattern. Gaining knowledge about the world and its nature and pattern is important for man to survive in this world. Philosophy provides the framework to understand the world. It provides the premises by which man can discover truth and use his mind to support his life.

Epistemology is the branch of philosophy that studies knowledge. It is also called the theory of knowledge. It is concerned with the nature and scope of knowledge, its presuppositions and basis, and the reliability of claims to knowledge. The epistemological problem is one of the basic problems of philosophy. It attempts to answer the basic questions: what distinguishes true (adequate) knowledge from false (inadequate) knowledge? What are the necessary and sufficient conditions of knowledge? What are its sources? What is the structure of knowledge; and what are its limits? Epistemology is also concerned with the study of justified belief. It aims to answer questions such as: How we are to understand the concept of justification? What makes justified beliefs justified? Is justification internal or external to one‘s own mind? Thus, the issues that surround the general problem of investigating the nature and extent of human knowledge are the problems of epistemology. However, in actual terms, the basic epistemological problem is not that of discerning the true

extent of human knowledge, but that of deciding which of our ordinary knowledge claims can properly be called examples of human knowledge.

History of Epistemology

Philosophers and scholars have dealt with the epistemological questions from different perspectives. Though there are contradictions in epistemological theories, the history of epistemology shows a clear trend. It is evident from the trend that the first theories of knowledge stressed its absolute, permanent character, whereas the later theories put the emphasis on its relativity, its continuous evolution or development, and its active interference with the world and its subjects and objects. The whole trend moves from a static, passive view of knowledge towards a more and more adaptive and active one.

The history of epistemology may be understood from viewpoints of the Greek philosophers, particularly Plato and Aristotle, along with some other distinguished philosophers like Descartes, Spinoza, Locke, Leibniz, Berkeley, etc.

Epistemological Views of Plato (428-348 BC)

It is difficult to find Plato‘s epistemological theory systematically expressed and completely elaborated in any one dialogue. However, the _Theatus‘ considers the problems of knowledge. Here, he endeavoured to disprove false theories of knowledge, specially the theory that knowledge is sense perception.

Plato assumed knowledge to be unattainable. If attainable, he believed, true knowledge is that which is _infallible‘ as well as _of the real‘. True knowledge must possess both these characteristics. Any state of mind that cannot justify its claim to both these characteristics cannot be true. Plato described our acquisition of true knowledge through his allegory of the Cave, his metaphor of the Divided Line and his doctrine of the Forms.

He presented an allegory to show how humans acquire true knowledge and what it is. According to him, most people lives in the darkness of the cave. Their thoughts are oriented around the vague world of shadows inside the cave, which is actually not true knowledge. The men inside the cave keep

thinking the shadows to be their true knowledge of the world. But after coming out of the cave, they gradually realize that the real world is different from the shadows inside the cave. The responsibility of leading man out of the cave into the world of light is beheld on education. Education is not putting knowledge into a person‘s soul that does not possess it. Knowledge is like vision in that it requires an organ capable of receiving it (Stumpf, 1988). It is important to direct the soul towards the right direction to acquire true knowledge rather than only putting light (knowledge) into the soul so that it can see or perceive the true knowledge.

Plato used the metaphor of the Divided Line to demonstrate the stages or levels of knowledge in a systematic form. According to him, the mind moves through four stages of development in the process of discovering true knowledge. At each stage, there is a parallel between the kind of object presented to the mind and the kind of thought this object makes possible (Stumpf, 1988). A continuous vertical line between the modes of cognition (Imagining, Belief, Thinking, and Knowledge) and the corresponding objects (Images, Things, Mathematical Objects, Forms) suggests that there is some degree of knowledge at every point. The line passes through the lowest form of reality (imagining) to the highest (knowledge).

According to his doctrine of Forms, Plato viewed knowledge as an awareness of absolute, universal _Ideas‘ or _Forms‘ existing independent of any subject trying to understand them. His theory of knowledge attempted to separate knowledge from opinion. According to him, knowledge originates in sense experience. His basic idea is that—_just as there are objects which the senses experience, so there are objects which the mind experiences‘. However, these are not objects but _Ideas‘ or _Forms‘. The mind may be said to experience these ideas or forms through a process called _Intuition‘. Thus, Plato gives importance to mind, and not senses in acquiring true knowledge, although he places the origin of knowledge as sense experience.

Epistemological Views of Aristotle (384-322 BC)

The literatures authored by Aristotle suggest very little about epistemology directly. But he also conceives of knowledge as involving systematic

understanding. He thinks that the findings of a properly developed science can be laid out in connected sequences of explanation. In the _Posterior Analytics', Aristotle stated explicit conditions for knowledge. It is Aristotle's major work on the structure of scientific knowledge. It is not an account of how we acquire knowledge, but an account of what we must have acquired if we are to consider as possessing knowledge. He advocated that a scientific theory must be demonstrative for expressing genuine knowledge.

Aristotle believes sense perception to be crucial for the process of knowing. But that sense perception by itself does not constitute knowledge. It only shows us particular objects. Genuine knowledge is about universal characteristics of things. Observation by itself neither provides us with the definitions of things, nor does it give us science as such. Science requires the discovery of a premise, a starting point for reasoning. He emphasized upon deduction and demonstrative reasoning. He analyzed and systematically organized the basic elements of this form of reasoning which is called syllogism. Syllogistic reasoning assures linking of major and minor premises through the agency of the middle term, thereby producing valid conclusions.

Aristotle's epistemological opinion may be inferred from his discussion of the method of inquiry in empirical science and in philosophy. According to him, humans acquire knowledge by means of a process called _Induction'. The empirical inquiry proceeds from perceptual observation through induction until experience. The process of induction involves four different steps—

i. Perception—the acquiring of information through the senses.
ii. Memory—the ability to retain perceptions in the mind.
iii. Experience—by perceiving many times in conjunction with memory, experience is formed.
iv. Knowledge—experience becomes knowledge when the essence of things is understood through this process.

Aristotle recognizes observation and experience not only as the basis for forming theories, but also as a means of testing them; and for this purpose he advocates the collections of new observations (Terrence, 2009). It seems Aristotle is little more in the side of sense perception than Plato, in that, he

regard senses to aid the mind in acquiring knowledge. He believes that knowledge can be reached through the process of induction which includes perception, memory, experience and knowledge.

Epistemological Views of Rene Descartes (1596-1650)

Descartes‘ views on knowledge were influenced by the time in which he lived. It was characterized by questioning of beliefs held for centuries and more reliance on straightforward observation. He strongly believed that a systematic method is essential for establishing a reliable opinion out of various preconceived opinions.

Descartes defines knowledge in terms of doubt. He understands doubt as the contrast of certainty. As our certainty increases, our doubt decreases and as our doubt increases, our certainty decreases. Knowledge is to be based on complete or perfect certainty. This requires a complete absence of doubt—an indubitability. Descartes‘ emphasis on doubt, rather than on certainty, marks an epistemological innovation as _Cartesian method‘. His method of doubt involves a determined effort to test our preconceived opinions or prejudices to the limit by applying a series of deliberate skeptical techniques (Cottingham, 2009).

The Cartesian method means certain and easy rules that will lead to not taking anything false to be true. Descartes points out that mind itself is infallible. But it is deflected from the true path of rational reflection by factors like prejudice, passion, the influence of education, impatience and the over-hasty desire to attain results. This deflection makes the mind unable to employ its natural operations correctly. Hence, Descartes believes in the utility of a set of rules. However, these rules presuppose the mind‘s natural capacities and operations.

Intuition and deduction are natural possessions of our mind. These are mental powers that enable us to arrive at the knowledge of things without illusion. But without regulation, these powers can lead us astray. Therefore, the Cartesian method consists in those rules by which our powers of intuition and deduction are guided in an orderly way. Descartes placed the whole edifice of knowledge upon the foundation of intuition and deduction. By intuition, Descartes means

an intellectual activity or vision of such clarity that it leaves no doubt in mind. Deduction is the ability to recognize a special relation between a set of statements (the premises) and a further statement (the conclusion). The relation being that the conclusion must be true, whenever all the premises are true.

Descartes wanted to rest knowledge upon a starting point that had absolute certainty in the individual‘s own mind. Therefore, knowledge requires the use of intuition and deduction. While intuition gives the first principles, deduction gives the remote conclusions.

Epistemological Views of Spinoza (1632-1677)

Spinoza‘s epistemology is mostly found his _Ethics‘ and in an earlier unfinished work _Treatise on the Emendation of the Intellect‘. According to Spinoza, every idea naturally involves affirmation of its own content. It does not need any validation from any outside entity. An idea can and will be denied or doubted only when the mind has another idea which contradicts or questions the first. He believes the doctrine that truth _requires no sign‘ and is instead _its own standard‘ (Garrett, 2009). For Spinoza, since the truth of true ideas can be determined directly, the true thought is distinguished from a false one chiefly by an intrinsic denomination along with the extrinsic one. He holds that doubt arises only when the mind has two related ideas, at least one of which is doubtful.

Spinoza added a highly systematic arrangement of principles and axioms to Descartes‘ method of determining true knowledge. He provided a complete set of axioms or theorems that would explain the whole system of reality in the same way that geometry explains the relations and movement of things.

Spinoza distinguishes three kinds of knowledge—imagination, reason and intuition. He also describes how we can move from the lowest to the highest level. The beginning is to be made through the things most familiar to us. He says, by refining our knowledge of things, we can move from i) imagination, to ii) reason, and finally to iii) intuition.

At the level of imagination, our ideas are derived from sensation. Here our ideas are very concrete and specific, and the mind is passive. Though our ideas on this level are specific, they are vague and inadequate. It is because we know things only as they affect our senses. Spinoza believes that the ideas formed from experience are useful for daily life, but do not necessarily give true knowledge.

The second level of knowledge is reason. This is scientific knowledge. At this level, man‘s mind can rise above immediate and particular things and deal with abstract ideas, for instance in mathematics and in physics. Knowledge is true and adequate at this level. Spinoza says it is true and adequate because truth validates itself.

The highest level of knowledge is intuition. Through intuition the whole system of nature can be grasped. At the first level, particular things are seen in a disconnected way. At this level, they are seen as parts of the whole scheme. This kind of knowledge ‒proceeds from an adequate idea of the formal essence of certain attributes of God to the adequate knowledge of the essence of things‖ (Garrett, 2009). Intuitive knowledge makes us more and more perfect.

Epistemological Views of John Locke (1632-1704)

John Locke‘s masterpiece, ‗An Essay concerning Human Understanding‘ is an epistemological work. In this work, he aims at discovering what kind of thing God has fitted us to know. It also concerns how we should direct and use our intellect and understandings. His epistemological concerns were to find out the origin, certainty and extent of knowledge. Locke also restricted knowledge to ideas. But his concept of ideas involves the ideas generated by objects we experience, i.e. sensations.. He regarded the human mind as ‗tabula rasa‘ (white or blank paper). It implies that he was strictly against innate knowledge. According to him, origin of ideas is experience. There are two forms of experience—sensation and reflection. The ideas are formed through senses (experience of the external world) and reflection upon these ideas (an internal experience). But experience of reflection is not possible until the experience of sensation. Reflection means simply the mind‘s taking notice of

its own operations. But its operations begin when the mind is provided with ideas, and these ideas come from the external world through the senses.

Locke distinguished between simple and complex ideas. According to him, simple ideas are un-analyzable and indefinable and the complex ideas are mentally constructible out of simples. Simple ideas are received passively by the mind through the senses. They also originate in reflection. In relation to the ideas received through senses, the mind can develop other simple ideas by reasoning and judging. On the other hand, complex ideas are not received passively but are rather put together by the mind as compound of simple ideas. In complex ideas, the emphasis is upon the activity of the mind, which takes three forms as the mind joins ideas, brings ideas together but holds them separate, and abstracts.

Locke also makes distinction between primary qualities and secondary qualities in order to answer the question of how ideas are related to objects. Primary qualities are those that actually exist in concrete form. Secondary qualities produce ideas in our mind that have no exact counterpart in the object.

According to Locke, the extension and validity of knowledge depends upon the relations among the ideas. The ideas that enter the mind may be related to each other in many ways. The validity of knowledge depends upon the perception of the relationships of the ideas to each other. There are three modes of perception—intuitive, demonstrative and sensitive. Each one of these modes leads to a different degree of knowledge regarding reality. Sensitive knowledge can be said as the lowest knowledge. In strict sense, it cannot be considered as knowledge. It gives some degree of knowledge, but it does not give certainty, nor does it extend very far. It gives awareness of the qualities but not of the connections between qualities. Demonstrative knowledge occurs when our minds engage in trying to discover the agreement or disagreement of ideas by calling attention to other ideas. Intuitive knowledge is the highest and certain knowledge that is possible for humans.

Epistemological Views of Leibniz (1646-1716)

Gottfried Wilhelm Leibniz‘s works does not contain any theory of knowledge. He did not consider the epistemological issues in detail. However, he made important contributions to epistemology. He can be listed under both rationalist as well as empiricist. In 1684, Leibniz published a short treatise called ‒Meditations on Knowledge, Truth, and Ideas‖. There he mentioned a series of characteristic features for human knowledge or cognition—

- Knowledge is either obscure or clear,
- Clear knowledge is either confused or distinct,
- Distinct knowledge is either inadequate or adequate,
- Adequate knowledge is either symbolic or intuitive.

According to Leibniz, clear knowledge means the ability to recognize a thing, that is, the ability to account the characteristic features of that thing. This enables one to give a nominal definition of the thing. If all the features that form part of a distinct notion are themselves known, then the cognition is adequate. The knowledge is intuitive, if all the component notions of a complex notion can be considered simultaneously.

Leibniz‘s account of a priori knowledge infers his rationalistic approach to epistemology. He distinguished between *truths of reason* and *truths of fact* (Stumpf, 1988). A *truth of reason* is a necessary truth in that to deny it is to be involved in a contradiction. On the other hand, *truths of fact* are contingent, and their opposite is possible. Truths of reason are known purely by logic whereas truths of fact are known by experience. The test of a *truth of reason* is the law of contradiction, and the test for a *truth of fact* is the law of sufficient reason.

Leibniz‘s account of truth leads to the conclusion that all knowledge is ultimately a priori knowledge. But he himself avoids this conclusion. He claimed that the knowledge of particular contingent truths has its basis in the sense perception. He argued that the knowledge of universal contingent truths cannot be based entirely on simple enumerative inductions but must be supplemented by a priori knowledge. Although the senses are necessary for all

our actual knowledge, they are not sufficient to give us the whole of it. For this, he gave the reason that the senses give only instances, i.e. particular or individual truths.

Epistemological views of David Hume (1711-1776)

David Hume was an empiricist. Sometimes his philosophy is seen as skeptical. It was thought to consist in a string of arguments designed to show the impossibility of knowledge (indeed, even of reasonable belief) about many of the things that our common sense view of the world takes for granted. The common sense belief is that there is a world of bodies outside and independent of our minds. These bodies stand in causal relations to one another, which can be discovered through reason or experience. Thus, their behaviour can be predicted, at least to some extent.

He divided perceptions into two types—impressions and ideas. Impressions are more vivid perceptions while ideas are faint images of impressions. He maintains that all our concepts (ideas) are derived, directly or indirectly, from sensations (impressions). It implies his conclusion that impressions cause ideas. There are two kinds of impressions—sensation and reflection. After sensation, ideas are formed. From the ideas, the second kind of impressions is formed, which are the result of reflecting on ideas caused by sensation. Our beliefs are formed as a function of the strength of our impressions. Thinking refers to transition from one idea to another. This transition is a matter of natural propensities, not of reflective, rational calculation. It is governed by three ‗principles of association': resemblance, contiguity and cause and effect.

Epistemological Views of Kant (1724-1804)

Immanuel Kant's epistemology is a mixture of empiricism and rationalism. He was trained in rationalist tradition and influenced by empiricist. As such, he 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 believed that all knowledge cannot be derived from experience, but all knowledge is based on experience. He originates knowledge in intuitions but due to possibility of judgment about

things, intuition alone is also not sufficient. According to him, we have some objective knowledge of the world. But this knowledge relies on synthetic, a priori laws of nature. 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 considers them under categories. These categories uplift the intuition and produces universally necessary knowledge. This knowledge is gained through sensible intuition. A sensible intuition consists of a sensation and the form (i.e. its relation to other sensations). 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 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. It is found that almost all the philosophers i.e. Socrates' (469-399 BC), Plato's (427-347 BC), Descartes' (1596-1650), Spinoza (1632-1677) and Leibniz (1646-1716) believe that mind is the source of knowledge either in the form of universal ideas or imagination except Aristotle (384-322 BC) and David Hume (1711-1776). Though Locke (1632-1704) is an empiricist, he advocates that reflection is necessary for knowing the internal world. Kant (1724-1804), a reconciliator, believes that sensibility supplies the mind with intuition. Thus the rationalist approach towards epistemology laid the foundations of cognitive science.

History of Cognitive Science

The roots of cognitive science may be found in the ancient philosophical thoughts and discussions, particularly epistemological discussions. However, it was formalized into a discipline much later. While studying the historical development of cognitive science, the researcher divided it into two stages for the convenience of understanding—early history of cognitive science (historical developments in its contributing disciplines which may have effected in the emergence of cognitive science) and the formal conception of cognitive science.

Early History of Cognitive Science:

The inception of cognitive science took place in the early thoughts of the philosophers and other debates related with mind or knowledge in the branch disciplines of cognitive science, though in subtle form. Though the epistemological discussions in philosophy laid the foundation of cognitive science, the staircases are made by the queries related to cognition in other branch disciplines of cognitive science—psychology, linguistics, anthropology, neuroscience and artificial intelligence.

Philosophy: The roots of cognitive science go back to the thoughts of the early Greek philosophers like Socrates, Plato, Aristotle, etc. and some other great philosophers and scholars like Descartes, Spinoza, Locke, Leibniz, Berkeley, Hume, etc. Their debates on epistemological issues ultimately led 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), the mind is said to experience the ideas or forms through a process called ‗Intuition‘. Knowledge was having justified true belief. He described how the human mind achieves knowledge by means of his allegory of the Cave, the metaphor of the Divided Line and the doctrine of the Forms. According to him, learning or knowledge acquisition in the ordinary sense is impossible. Even if knowledge is attainable, it must of the real.

Aristotle‘s (384-322 BC) describes the mind in functional terms by regarding it as the part of the soul. The mind enables the soul to know and understand. Therefore, the mind is by nature desirable of knowledge. Aristotle says our mind has a better knowledge of the things close to our senses than of things farther from our senses. So, our mind moves from knowledge of particular things gained through sensation to universal or class ideas, which cannot be gained through sensation. Thus according to him, our mind provides the

universal characteristics of things, provided the premises based on our sense perception. Aristotle‘s idea may be schematically described as—

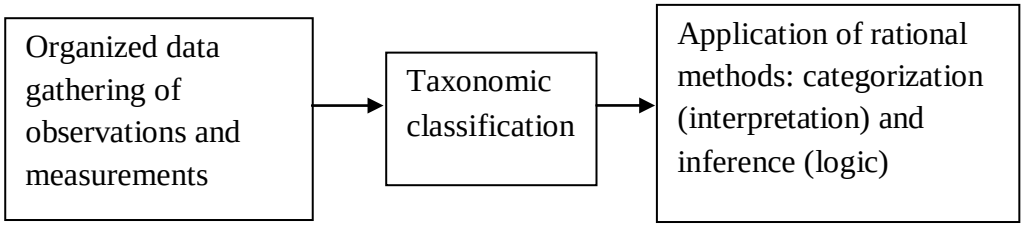

Fig. 2.1. Schematic representation of Aristotle’s Epistemological view

Descartes‘ (1596-1650) regarded the mind to be pure and infallible, if left to itself. The mind is distinct from the body. Its essence is thought. It naturally possesses two powers—intuitions and deduction. Descartes devised the Cartesian method which 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) believes that the human mind contains ideas. Some of these ideas—sensory images, qualitative feels, perceptual data—are imprecise qualitative phenomena. Because they are expression in thought of states of the body as it is affected by the bodies surrounding it. The knowledge perceived by the mind from the external world is vague and inadequate. Adequate ideas are formed in a rational and orderly manner. They are true and reveal the essences of things. The mind can deal with abstract ideas. Thus, the mind serves as the guarantee of true knowledge through reasoning and intuition. Spinoza's conception of adequate knowledge reveals an unrivaled optimism in the cognitive powers of the human being (Nadler, 2013).

According to Locke (1632-1704), at birth, the mind is like a blank slate (Tabula Rasa). Human beings experience the external world through the senses and the internal world through reflection. But, experience of reflection is not possible until the experience of sensation, i.e.

Sensation ⟶ Ideas ⟶ Reflection

The foundation of Locke's cognitive model is his division of human thinking into a series of interrelated but distinct processes—each with its own

parameters and functions. According to him, all thinking falls into one of the two general categories of sensation or reflection. Sensation describes the way in which our senses convey into the mind several distinct perceptions of things. Reflection is the perception of the operations of our own mind within us. Believing that the mind is tabula rasa, he claims that these two modes of thinking, i.e. sensations and reflection, are the only origins of our ideas. The ideas provided by the senses form the fundamental building blocks of all human thought. According to Locke, all Reflective thought falls into one of the following sub-categories: Memory, Retention, Discerning, Comparing, Composition and Abstraction. The ideas passively received by the mind are simple ideas and ideas produced by compounding of simple ideas by the mind are complex ideas.

Leibniz (1646-1716) is both an empiricist as well as a rationalist. He argued against both materialist and dualist view of the mind. According to him, the world consists solely of one *type* of substance, though there are infinitely many substances of that type. His system sometimes contains ideas of relevance even to contemporary discussions in the cognitive sciences (Kulstad & Carlin, 2013). He believes that everything in this world has a mind or something analogous to a mind. Leibniz calls these mind-like substances _monads.' While all monads have perceptions, only some of them are aware of what they perceive (he called them souls), and even fewer monads are capable of self-consciousness and rational perceptions (he called them minds). He argued that the mind is immaterial in nature. Therefore, it is impossible to construct a computer that can truly think or perceive like the human mind. These are significant positions of Leibniz in regard to cognitive science.

To explain the workings of our minds, David Hume (1711-1776) introduces the minimal amount of machinery he thinks is necessary to account for the mind's operations. He believes that everything (or every idea) we believe, is ultimately traceable to experience. He uses *perception* to designate any mental content. Perception is divided into two categories, *impressions* and *ideas*. In the *Treatise*, Hume proves his claim that our ideas are copies of our impressions. He gives an account of definition as a series of tests to determine

cognitive content. It involves asking about the idea annexed to a particular term. If there is an idea annexed to the term, and it is complex, it has to be broken down into the simple ideas that compose it, and trace them back to their original impressions. If the process fails at any point, the idea in question lacks cognitive content. The mind has the natural ability to associate certain ideas based on three principles: resemblance, contiguity in time and place, and causation.

Kant's model of the mind was the dominant model in the empirical psychology that flowed from his work and toward the end of the 20th century, especially in cognitive science. Three ideas define the basic shape (‗cognitive architecture‘) of Kant's model and one its dominant method. They have become part of the foundation of cognitive science.

1. The mind is complex set of abilities (functions).
2. The functions crucial for mental, knowledge-generating activity are spatio-temporal processing of and application of concepts to, sensory inputs. Cognition requires concepts as well as percepts.
3. These functions are forms of what Kant called synthesis. Synthesis is central to cognition.

Kant's transcendental method is regarded high in the contemporary cognitive science. According to it, to study the mind, the conditions necessary for experience are to be inferred. The core of this method is inference—the method of postulating unobservable mental mechanisms in order to explain observed behaviour. He held that some features of the mind and its knowledge had *a priori* origins. Kant believed that mind can be studied through transcendental method using transcendental arguments.

The 17th to 20th 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.

Psychology

In the field of psychology, the nature of the subject matter itself was a concern of controversy. It saw great changes during the late 18th century and throughout the 19th century.

Wilhelm Wundt (1832-1920) focused on understanding the nature of consciousness. He urged psychology to be a ‗true quantitative, experimental natural science'. The early psychologists of Wundt's school showed that mental activity can be broken down into more basic operations. Moreover, they developed objective methods for assessing mental activities. However, they also relied heavily on introspection.

But in 1885, Ebbinghaus proved Wundt's concept of psychology as wrong by inventing methods for the quantitative, experimental study of memory. William James (1842-1910) strongly argued that the subject matter of psychology should focus on understanding the functions of consciousness.

In 1896, Mary Whiton Calkins developed paired associate learning. She was first to discover the paired associates technique involved in memory. Through experimental investigation, she paired colors and numerals together and found that people could remember numerals better when a vivid color was consistently paired with the same numeral. Overall, she found the amount of exposure affected memory the most. Frequency of exposure (above vividness and how recent one was exposed to stimuli), was found to be the strongest factor for correct recall.

In 1913, behaviourism emerged, advocated by John B. Watson, who argued that psychology should focus on observable and measurable behaviour. Thorndike, Pavlov and Skinner were some psychologists who argued for the behaviouristic nature of psychology. They developed similar methods for studying learning in animals.

In 1920, Clark Hull adopted Ebbinghaus' methods to study concept formation. He wanted to exclude all cognitive notions from the description and explanation of behaviour. He felt that the ultimate explanations in psychology should come in neuro-physiological terms. Hull's theory of learning is

centered on the necessity of reinforcement, defined in terms of "drive reduction." The behaving organism is viewed in the context of homeostatic model seeking equilibrium from "drive forces."

Edward Tolman (1932) developed molar approach to behaviour, i.e. the behaviour is guided by the goal determined by the cognitive structure of the organism.

In the early part of the 20th century, the Gestalt psychology (1912) emerged against the behaviourist psychology. They considered mind to play a major role in learning (behaviour modification). They emphasized the role of configuration or organization in the perceptual field and highlighted the role of insight and understanding in learning or problem solving. A Gestalt psychologist, Kurt Lewin (1917), advocated that locomotion from one region of life space to another leads to change in the cognitive structure.

Jean Piaget (1920s) developed developmental psychology. He believed that real insight to human knowledge can be gained only through the study of its formation and evolution in childhood. He designed a proper framework to understand the structure, functioning and development of the cognitive network of the human mind. According to him, there are two aspects of human mind—cognitive structure and cognitive functioning.

J. S. Bruner (1915-) was largely influenced by Piaget. The outcome of cognitive development is thinking. The intelligent mind creates from experience generic coding systems that permit one to go beyond the data to new and possibly fruitful predictions. Cognitive growth involves an interaction between basic human capabilities and culturally invented technologies that serve as amplifiers of these capabilities. Knowledge and understanding can take 3 different forms which are known as the modes of representation. These are—enactive, iconic and symbolic.

D. Ausubel (1918-2008) views knowledge as representing an integrated system. Ideas are linked together in an orderly fashion. The human mind follows logical rules for organizing information into respective categories. Cognitive structure is hierarchically organized in terms of highly inclusive

concepts under which are subsumed less inclusive subconcepts and informational data (Ausubel, 1960). Subsumption allows us to absorb new information into our cognitive structures.

In the late 1950s and early 1960s, cognitive revolution took place. However, its root is in Jean Piaget‘s (1920s) interest in studying cognition and cognitive development in children. Then L. Vygotsky contributed to psychology in Piaget‘s line incorporating the social element in it. Cognitive revolution mostly developed when the researchers developed new methods to test predictions from computational models, which often specified the order in which specific mental activities take place. It led to the development of information processing approach to mental functioning. It along with the scientific approach to studying mind and belief in internal mental states later gave rise to cognitivism as the dominant model of the mind. At present, the field of psychology is dominated by the cognitivism and information processing models of mind.

Anthropology

Anthropology can be traced back to the earliest antiquity, when human beings first began to speculate about their own nature, origins and diversity. But as an explicitly defined field of inquiry, it is a product of the last two centuries of thought in the West. The development of anthropology consists of a complex interweaving of often opposing currents.

Mostly anthropologists have looked primarily at non-Western peoples. Anthropology began as a kind of natural history, a study of the peoples encountered along the frontiers of European expansion, and anthropologists have continued to use this approach. However, since 1930s, anthropology has been directly related to the social sciences. It analyzes and compares societies and their ways of life in search of theoretical generalizations, regularities of process and patterns. Thus, anthropology aimed at studying the human differences, which threw light on human nature and universals underlying diversity.

The history of anthropology goes back to the ancient civilizations of Egypt, Mesopotamia, China, India and Central America. It goes back more directly to the European thought of the Enlightment and to philosopher-scholars, notably J.J. Rousseau, who used fragmentary reports of exotic peoples to reflect on human nature, civilization and society.

In the second half of the 19th century, the information on primitive people increased and was incorporated into comparative theoretical schemes. The major theme was evolution: reconstructing the development of human cultures from the earliest ‗savage' stage of primitive promiscuity, through the progressive evolution of ‗barbarism', and finally to ‗civilization' (Shashi, 1992).

The scope of anthropology is very broad and varied. It incorporates the archeological surveys, collection of folklore and mapping the gene sequences of organisms. It is also concerned with the psychic unity of humankind. It assumes that races and peoples all over the world are same, both in terms of evolutionary biology and manipulation of culture.

In 1735, the Swedish naturalist Carl Linnaeus Systema Naturae (first edition), attempted to differentiate various types of people scientifically. He identified humans as a single species. He did not explicitly rank types of people within a hierarchy. Johann Blumenbach divided the human race into separate and unequal varieties (Ingold, 1994) published ‗On the Natural Varieties of Mankind'. Later the discussion of human difference was shifted from the religious to the natural world. During the early and middle part of 19th century, the American school of anthropology thrived as the champion of polygenism (the doctrine of multiple origins). It sparked a debate between those who believed in the unity of humanity and those who argued for the plurality of origins and the antiquity of distinct types.

In the last part of 19th century and the early part of 20th century, Franz Boas, the father of American anthropology, argued that the distinct cultures of the people around the world should not be viewed within a hierarchy, but holistically and as relative to other cultures. He was a critic of the comparative

method, which compared different groups and races within the rubrics of savage, barbarian, and civilized (Baker, 2008).

The second facet to the diversity of anthropological approaches lies in the fact that anthropology is not a single field, but is rather a contingent and unstable blend of subfields, each laden with its own history, theoretical agenda, and methodological preoccupations. In the American tradition, anthropology is distinguished into four subfields—physical, archaeological, cultural and linguistic. In the British tradition, however, there are only three subfields—physical, archaeological and social anthropology.

Linguistics

The earliest known linguistic tradition arose in antiquity, in societies with established traditions of writing. The historical development of linguistics include the Babylonian tradition, the Hindu tradition, Greek linguistics, Roman tradition, Arabic and Hebrew traditions, developments in Europe (from 500 AD to early 19th century) and modern era (from late 19th century). In the Babylonian tradition, word lists are found in Sumerian and Akkadian language. The focus of the Hindu tradition was on grammar covering phonetics and morphology.

The Greek tradition emphasized on the origin of language, parts of speech systems, the relation between language and thought, and the relation between the two aspects of word signs—whether form and meaning are connected by nature or purely by convention. Another important contribution was the syntax. Their philosophical studies incorporated speculation on the nature of their language. The embryonic science of Greeks was passed on to the Romans, whose linguistics studies on Latin were in general the application of Greek thought, controversies and grammatical categories. Like the Greeks, the Romans were aware of word changes in both form and meaning from earlier texts but no significant headway was made in the study of etymology. Their primary interest was in morphology, particularly parts of speech and the forms of nouns and verbs. The Arabic tradition (7th-8th centuries) also focused on morphology and phonetic descriptions. In the Hebrew (9th century) tradition, grammatical tradition flourished.

In Europe, the 12th century, the notion of the universal nature of grammar emerged. With the advent of Renaissance (14th-17th century), language studies underwent a change as both local and non-Indo-European languages came under linguistic scrutiny. Once vernacular languages were deemed worthy of study and the world‘s diversity in linguistics structures was recognized, language studies turned to universal linguistic concepts and to the idea of universal grammar.

An important trend in the 17th century was the effort to compare and classify languages in accordance with their resemblances. The study of etymology also gained momentum. In the early 18th century, comparative and historical linguistics gained more consistency. In the late 19th and early 20th century, modern linguistics emerged. The focus was shifted from historical concerns of changes in language to the idea that a language can be viewed as a self-contained and structured system situated at a particular point in time. Phonetics and phonology were dominant in early modern linguistics.

Thus, in the early part of the history of linguistics, the concern was more about phonetics, morphology and syntax. The schools of linguistics that emerged may be divided under two types—formal and functional—according to whether they adopt an overall focus on form or on function.

Neuroscience

Modern neuroscience has deep roots in the history of Western biology, medicine and philosophy. The history of Neuroscience has been shaped by three major debates: mind vs. brain debate (monism/dualism); localism vs. holism; and the nature of neural communication. The brain has been regarded as the location of intelligence since pre-Socratic times, except Aristotle, who regarded heart to be the seat of intelligence. Then the debate turned to localism vs. holism. In medieval Europe, mental faculties were localized in the ventricles of the brain. Rene Descartes, Thomas Willis, Franz Joseph Gall, J. H. Jackson, P. P. Broca, Gustav Fritsch, Korbinian Brodman and Wilder Penfield were the advocates of localism.

Rene Descartes (1596-1650) provided the first idea of reflex action. He thought within a nerve, there are thin threads attached at one end to the sense organs. External stimuli pull on threads to open little gates to the ventricles (reflected) through the same hollow nerves, causing movement by inflating the muscles.

Thomas Willis (1621-1675) took this idea further and related it to actual brain structures. He believed the cortex to initiate voluntary movement whereas the cerebellum is involved only in involuntary movement. He coined the term _neurology‘ in 1681.

Emanuel Swedenborg (1688-1772) gave the idea on importance of the cerebral cortex in sensation, cognition and movement. He argued that the cortex was the highest sensory and motor structure of the brain. He also had the idea of somatotopic organization of motor function in the cerebral cortex. It implies that he localized control of the foot in the dorsal cortex, the trunk in an intermediate site, and the face and hand in the ventral cortex.

Franz Joseph Gall (1758-1828) was a German anatomist and anthropologist who took a naturalistic approach, and saw that objective observation was very important in recognizing the different natures and functions of the brain. He concluded that all moral and intellectual faculties were innate; organization played a major role in the way that these faculties were used; the brain was the driving force of peoples‘ different propensities and talents; and that the brain was composed of as many organs, as there were faculties. He believed that each region of the brain had a particular function and the size of the region affected the shaping of the skull. The larger regions depicts that these faculties were more developed.

P. P. Broca (1824-1880) was a pioneering neurosurgeon. His work concluded that language was localized to the frontal lobes of the brain. This finding eventually led to Broca putting his full support behind the localization of function argument.

J. H. Jackson (1835-1911) reasoned that the cerebrum should have basic sensory-motor functions. He also inferred that different parts of the brain must be involved in the control of different muscle groups.

Gustav Fritsch (1838-1907) and Hitzig in 1870 reported in a paper that stimulation of portions of the cerebral cortex elicited movements and that the stimulation sites were somatotopically arranged.

Korbinian Brodman (1868-1918) categorized the brain into 52 distinct areas based on the cellular organization of the cortex in the respective regions, and therefore helped to support the localist view.

Pierre Flourens (1794-1867) held holistic view of the brain. According to him, other parts of the brain could take over the function of damaged ones.

The electrical nature of the nervous system was discovered in the early 18th century. In the modern period i.e. 21st century, the communication of discrete neurons using electrical and chemical signals is well established and accepted. Today localizationism dominates neuroscience. However, extreme localism and holism is being replaced by _connectionism', which believes that lower level or motor functions are strongly localized but higher level functions are the results of interconnections between brain areas. Cognitive science encompasses both localism and holism (Abraham & Betchel, 2012). It recognizes that as the behavioural techniques measure mental states, the neural techniques measure brain states. Neither replaces the other. Neuroscience provides converging evidence for the theories of cognitive psychology. A cognitive theory is best supported if both behavioural data and neurobiological data lead to exactly same conclusion.

Artificial Intelligence: The theoretical foundations of AI are philosophy, mathematics, economics, neuroscience, psychology, computer engineering, control theory and linguistics. Philosophers have floated the possibility of intelligent machines as a literary device to help us define what it means to be human. While Descartes saw ‒mechanical man‖ as a metaphor, Leibniz seemed to see the possibility of mechanical reasoning devices using rules of logic to settle disputes.

Leibniz and Blaise Pascal designed calculating machines that mechanized arithmetic. With early 20th century inventions in electronics and the post–World War II rise of modern computers, possibilities have given over to demonstrations.

Around the middle of the 20th century, cybernetics emerged, the concept of self-correcting and self-regulating systems (Weiner, 1948). This new science claimed that complex machines have to have control systems (that is, subcomponents of their architecture in charge of governing their inner functioning and their interactions with the external world), and that all such systems are to be considered instances of the same natural kind. Then robotics emerged and robots became powerful vehicles for testing our ideas about intelligent behaviour.

By 1944, Herbert Simon had laid the basis for the information-processing, symbol-manipulation theory of psychology. In the last half of 20th century we had computational devices and programming languages powerful enough to build experimental tests of ideas about what intelligence is.

Alan Turing‘s 1950 seminal paper crystallized ideas about the possibility of programming an electronic computer to behave intelligently. There were numerous programs actually solving problems that only intelligent people had previously been able to solve. Knowledge representation—both the formal and informal aspects—had become a cornerstone of every AI program. Marvin Minsky‘s work on network representations of knowledge in frames directed much research. In 1956, John McCarthy, the father of artificial intelligence has been an advocate for using formal representations, in particular extensions to predicate logic.

2.2.2. Formal conception of Cognitive Science:

Cognitive science got its formal conception in the 1950s in a conference of scholars of various disciplines. It developed with the contributions of various thinkers in different disciplines in the symposium held on information science at the MIT, Boston on 11th September, 1956. A number of diverse disciplines like philosophy, psychology, computer science, neuroscience, linguistics and anthropology met at the symposium.

Alan Newell and Herbert Simon emphasized on demonstrating the machine intelligence and 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 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 1960, the Centre for Cognitive Science was established at Harvard. In 1969, Ulreic Neisser published his book ‗Cognitive Psychology‘. The Sloan Foundation established a program in cognitive science in 1976. The publication of the journal ―Cognitive Science‖ and the first conference of the Cognitive Science Society at the University of California, San Diego in 1977 are regarded as the formalization of the enterprise as a properly recognized scientific discipline. 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.

Brief History of Pedagogy

‗Pedagogy‘ has generally remained the interest of the philosophers, psychologists and sociologists. Though, every few have dealt with it directly. Philosophers can help in learning research and innovation by providing explanations and clarifications of some confusing or ubiquitous concepts. Since philosophy is the foundation of education in general and particularly pedagogy, an analysis of the viewpoints of various philosophers regarding pedagogy will lay down its evolution.

Socrates and Plato

Socrates and Plato were two of the founders of Western philosophy. Socrates‘ most important contribution to Western thought is his dialectic method of inquiry, known as the Socratic Method. It is a commonly used tool in a wide range of discussions, and is also considered as a type of pedagogy. It was first described by Plato in the Socratic Dialogues. Plato was a speculative

philosopher who sought behind the changing phenomena of nature, the absolute and eternal. He talked of education for the body and education for the soul.

Most of Plato‘s ‒Dialogues‖ use the Socratic Method or the method of Dialectic. In this method, a question is put. The answer offered by the respondent is generally an attempted definition which is then refuted. He conceived a hierarchy of thinking and the level of understanding each sort of thinking could achieve. Opinion could only assist in understanding of the visible world. True knowledge of the universal forms could only be achieved through the higher reasoning process of the dialectic.

The process of dialectic is an interpersonal activity between a leader and a participant. In this process, both the leader and the participants enter a higher state of consciousness, allowing psychic material to flow through them. The process of dialectic is cannot be written but only experienced. At the beginning of a dialectic process, none of the participants knows consciously the answer or the answers. The answer or the solution or hypothesis is a joint creation or discovery or invention of new understanding produced in the process. Thus, dialectic is a process of bringing forth realities, ideas and images which are within us and are manifested in the process.

The dialogues are often misinterpreted as mere ordinary conversations, arguments or debates. But actually every element of the dialogue has a specific meaning, purpose and importance. The dialogues must be approached as situational learning phenomena. The dialogues should have a sense of respect and anticipation. They should be carefully designed to encourage specific transformative responses in the reader or the listener.

The Socratic Method is creative in so far as it produces cognitive gain or a changed perspective. It guides us anew each time to just and right human responses. Plato‘s _dialectical process of coming-to-know‘ seeks afresh what actions might be right for each inquiry occasion.

Aristotle

Aristotle is another important founding figure in Western philosophy. He advocated the method of observation, that is, knowledge received through observation of things and events of nature. He found the universal in particular things. For him, philosophic method implies the knowledge of essences from the study of particular phenomena to. He recognized the inductive method, in which the universal is arrived at from the particular, though he did not regard it as a perfect method. He thought that the deductive method, in which the particulars are deduced from the universal, provides perfect knowledge.

According to him, knowledge is about an object. It is conceptual in nature. Concepts are generalized classes of objects. True knowledge should be obtained through logical proof. Therefore, education and teaching are always about an object and should have content. The teacher instructs a learner about some knowledge, or some discipline. Teaching and learning never represent merely an interpersonal relationship or the expression of feelings. They are always about disciplined inquiry into some aspect of reality. The school should cultivate and develop each person‘s rationality.

Francis Bacon

Bacon (1561-1626) was an empiricist. His most influential work in the field of education was ―The Advancement of Learning‖. He attempted to provide a plan for better education system in it. He believed in a research based learning system and created methods like the scientific method. The students need to learn dynamically rather than scholastically. He wholly believed that scholasticism is not good for the educational process. He emphasized on experiment, experience, logic and reasoning for learning. It implies self-explored knowledge is more effective for the learners. He regards sense-experience as hindrance to reliable knowledge. His method is not just experiencing, but planned experiencing. Planning the experiences helps in applying logic and induction for learning. Thus knowledge is created by its own. He wants men to learn with instructors, not teachers. He urges students to question, to experience and experiment. Thus his pedagogy mostly constitute of instructions, experience and experiment.

Locke

Locke‘s empiricism states that all our ideas come from sense perception or reflection (introspection). Of course, it does not mean that ideas come ready made into the mind; but it is to say that every idea is ultimately reducible to elements which have been the data of sensible or introspective experience. He believed that human beings are born in total ignorance, and that even our theoretical ideas of identity, quantity and substance are derived from experience (Cranston, 1957). Sensation is the basis of Locke‘s argument for knowledge not being innate, but another main point in his essay is ideas and perception. This theory had profound influence on his pedagogy. Thus, the pedagogy implied in Locke‘s philosophy is that the learners should be given enough opportunities for perception and sensation.

According to Locke, learning is the last and least part of education. He had a great aversion of the ordinary method of teaching. He believed, the best way to get man do what he is wanted is not to terrify or force them but to motivate them, to arouse and then rely on desires, while letting them think, not without justice, that they are acting for their own sakes and of their own free will (Tarcov, 1984). For the poor learners, he suggested the method of practice. This will lead to natural habit functioning beyond conscious memory. According to Locke, children are curious, therefore, a good teacher should be able to seize this natural curiosity and channel it into knowledge. Moreover, he insists that teachers must instill discipline when a child‘s mind is elastic.

Locke advocated for self-discipline, which he meant denying oneself one‘s desires, crossing one‘s inclinations and purely follow what reason directs. But giving opportunity for self-discipline meant maintaining a perfect balance between freedom and strictness (responsibility). Education is the art of maintaining this balance—to keep up the child‘s spirit, easy, active and free; and yet, at the same time, to restrain him from certain things and to draw him to certain other things. Instead of reward or punishment, the incentives of esteem and disgrace should be used for this purpose. Because using reward and punishment make the child learn the content for the sake of the reward or to avoid punishment and not for the sake of the content itself.

For the development of character and reason, the teacher should not lay down many rules. Locke thinks that the teacher should make sure the child understands and can carry out the task set for him and make them repeat the task over and over.

Rousseau

Rousseau‘s approach to pedagogy is based on the philosophy that the natural world can teach us all we need to know. He stated the importance of the natural environment and that learning will take place if the provision for a learning experience is planned and acted upon, not merely left to chance. It is necessary to plan and observe so that the child has every opportunity to play its way into learning and understanding.

He argued that we are inherently good, but we become corrupted by the evils of the society. We are born capable of sensation and from birth are affected in diverse ways by the object around us. Consequently, bringing up children in harmony with nature and its laws so as to preserve the good was central for Rousseau‘s pedagogic theory. His *Emile* stressed wholeness and harmony, and a concern for the person in the learner. Central to this was the idea that it was possible to preserve the original perfect nature of the child, by means of the control of his education and environment, based on an analysis of the different physical and psychological stages through which he passed from birth to maturity. He appreciated the idea of individualized education.

He argued that the momentum for learning was provided by the growth of the person (nature). The responsibility of the teacher was to facilitate opportunities for learning. He also emphasized the power of the environment for education. It was essential that teachers attend to the environment to which the learner will be exposed. More control will result in more effectiveness. According to him, the child should remain in complete ignorance of those ideas that are beyond his/her grasping.

For him, it was important to develop ideas of the world in our own ways. The teacher should encourage the learners to reason their way through to their own conclusions, and not rely on the teachers or books. The sensations make an

impression on him, and he remembers them. From this, without thinking about it, he continually enriches his memory while waiting until his judgment is able to profit by it. It is in the choice of these objects, the presenting of those that he can know and, of hiding from him those that he ought to ignore that constitutes the true art of cultivating in him this first faculty. It forms a store of knowledge that serves his education throughout his life.

Since it is not possible to prevent the child from learning what he sees outside himself, those examples should be presented on his mind in the best suited form for him. He considers teaching as an art of controlling without percepts and to do everything without doing anything at all. A good education aims to make a man reasonable.

He argued for experience against verbal lessons. To exercise their attention, only those things should be told to them in which they interested at present. The teacher should remain brief but without being obscure or vague.

Descartes (1596-1650)

While modifying the false direction of the mind in the search for scientific truth, Descartes stated some of the great principles of modern pedagogy. The first is the equal aptitude of minds to know and comprehend. But equal capability of mind does not mean equal use of it. According to him, nature is not sufficient in herself; she needs to be guided and directed. Success will depend less on natural qualities, such as imagination, memory, quickness of thought, than upon the rules of intellectual direction imposed on the mind (Compayre, 1889). It means that formation and development of the individual depends mostly on the education rather than the nature. Another Cartesian principle is the substitution of free inquiry and reflective conviction for blind beliefs founded upon authority. He opposed the mechanical processes and exercises of pure memory in the education process, and emphasized the use of rational methods that stimulate the intelligence, clear and distinct ideas, judgment and reflection. The rule of evidence, applied with moderation and discretion, is an excellent pedagogical concept to save the child from being a mere machine. He also distinguished between subjective and objective pedagogy. Subjective pedagogy refers to instructions that led to the

development of the internal qualities of precision and measure. Objective pedagogy is instruction that takes place through what is without, through an extended erudition, through an accumulation of knowledge.

Malebranche (1638-1715)

Malebranche was a staunch idealist philosopher. He totally condemned sense instruction. According to him, sensations hinder the metaphysical pursuit of the individual. Therefore, the child should be nourished on abstract truths, as souls have no age and the infant is always capable of ideal contemplation. It is only bad habits which makes the child or the individual incapable of meditation on abstract truths. For this, he also suggested remedy for this that the child should be kept away from fear, desires, hope, pain, pleasures, etc. Therefore, all kinds of sensible rewards should be avoided. But he upholds material punishments in the education of children, which is in contradiction to theory against sense. He believes in the influence of physical environment on the development of the soul. The soul is not an independent and isolate force which develops through an internal activity. So, his pedagogy considers an appropriate environment important for learning and development of the individual.

Relationship between Epistemology and Pedagogy

Epistemology is a branch of philosophy. It is the study of knowledge and what it means to know something (Shaffer, 2007). It studies the nature, methods, limitations, and validity of knowledge and belief and addresses questions such as: What is knowledge? How is knowledge acquired? What do people know? Pedagogy, on the other hand, is the art or science of being a teacher, generally referring to strategies or styles of instruction. It is not simply the act or method of teaching, rather it involves creating a proper social, educational and developmental environment which is aimed at facilitating learning based on specific norms and values. It is characterized by the personality, authority and professionalism of the teacher as he/she enters into interpersonal relationships with the learners for helping them to develop.

As a discipline pedagogy is closely related to philosophy. Epistemology is the theory of knowledge and pedagogy is the theory of teaching, the art of taking the

comprehension of the knowledge by the teacher to its comprehension by the students. The theories of pedagogy are based on the theories of epistemology. Epistemologies are fruits on the imaginary tree of knowledge while pedagogy is the seed of its replication and transmission. Pedagogy is the way through which the epistemologies are shared and transmitted to the future generations. Personal epistemological beliefs reflect an individual‘s views about what knowledge is, how knowledge is gained, and the degree of certainty with which knowledge can be held. Pedagogical beliefs refer to preferred ways of teaching by teachers (Chai, 2010). The personal epistemological beliefs of the teacher influence his pedagogy. Hofer and Pintrich (1997) argued that ―beliefs about learning and teaching are related to how knowledge is acquired, and in terms of the psychological reality of the network of individuals‘ beliefs, beliefs about learning, teaching, and knowledge are probably intertwined‖. Some other researches have also supported this view. Thus, it can be said that epistemology and pedagogy are closely related to each other. Epistemology is related to pedagogy in three ways—teacher‘s knowledge about the content, teacher‘s knowledge about the skills and strategies and teacher‘s knowledge about his own learning.