

# CONCEPTUAL MODEL FOR EPISTEMOLOGY OF KNOWLEDGE IN TECHNICAL AND ENGINEERING EDUCATION

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## **Abstract**

There are three important components in engineering education which are knowledge, skills and attitudes. The knowledge is defined as the facts and the concepts of engineering education. The skills are used by engineers in managing and applying their knowledge in computation, experimentation, analysis, designation or synthesis and evaluation. Meanwhile, the attitudes are about how people use their skills and knowledge through personal values, concerns, preferences and biases toward their professional goal (Rugarcia, Felder and Woods, 2000). The challenge of the coming century is to prepare young generation to gain knowledge, the relevant skills and possess attitudes beyond the range of traditional engineering curriculum or to prepare a knowledgeable generation. Therefore, there is a need to shift away focus in engineering education from the simple presentation of knowledge to the integration of knowledge. In order to have better understanding about the integration of knowledge process, academics have to understand the meaning of education. Hence, the goal of this article is to develop the meaning of education, the concept of knowledge from philosophical perspective and its relationship with human nature or *fitrah*. The last part of this article is to suggest a conceptual model for epistemology of knowledge in engineering education.

## **1.0 INTRODUCTION**

Technical and engineering education is one of disciplines focusing on acquiring and application of technical, scientific and mathematical knowledge to design and solve problems. According to Rugarcia, Felder and Woods (2000), the primary values of engineering education at the very beginning of education practice were for functionality and profit. Most of engineering education curriculums reinforced these values. However, the rapid changes in knowledge, skill and values make the engineering education will never be possible to teach everything that engineering students should know before going to work. Therefore, the challenges of engineering education today is not only to produce expert in engineering

disciplines, but also to produce knowledgeable students who are able to integrate scientific knowledge in problem solving process.

There is also miss assumption among those who designed the technical and engineering curricula for the past half-century. The technical and engineering curriculum designers think that by including several humanities courses in engineering curriculum is sufficient enough to produce responsible and ethical engineers. The failure of the engineering curricula to address attitudes and values systematically has had unfortunate consequences. Engineers often make decisions without feeling a need to take into account any of the social, ethical, and moral consequences of those decisions. They believed that those attitudes and values are in someone else's responsibility (Rugarcia, Felder and Woods, 2000).

A critical problem in technical and engineering education nowadays is to produce independent learners. Most of students engineering students tend to be dependent learners. They tend to be in the dualist picture of the world. Every point of view is either right or wrong, all knowledge is known and obtainable from teachers and texts, and students' tasks are to absorb what they are told and then demonstrate having done so by repeating what they have learned from their teachers or lecturers (Rugarcia, Felder and Woods (2000). In other words, they have been exposed to well planned problems solving process for the specific career that they are trained for rarely expose to problems solving process that involve the integration of various branches of knowledge. This situation has shaped the students to become dualist thinkers who are not able to integrate various branches of knowledge in problem solving process. The situation is different when the students enter the real world of work. They need to learn and relearn and understand other area of knowledge from what they have been trained for in order to solve the problem.

Dualist thinker resulted from the dual education systems: the traditional Islamic education system and the modern secular education system (Isharaf Hossain, 2009). Since most Muslim countries have been colonized by western countries, the secular education system has been adopted and implemented in those Muslim countries. Unfortunately, the adoption has developed confusion about the original vision of education and knowledge development process. As a result, the sublime and spiritual aspect of education has been ignored (Wahid Bakhsh Shaikh, 1999) but attention was given on the development of knowledge from western philosophy that emphasize on scientific evidence. Therefore, the adoption impact has created dualism phenomenon in epistemology of knowledge among scholars, thinkers and every aspect of human life (Syed Mohammad Dawilah al-Edrus, 2007).

Dualism in knowledge development process also produced well inform students in a specific area of study but do not be able to make associations and integration between knowledge and is also very weak in

decision making (Rohana Hamzah, 2009). The long term impact of dualism in knowledge is the development of conflict and crisis in thinking process as well as in moral judgment when human being not be able to differentiate between the truth and the false or between good and bad (Anuar Ahmad, 2009). The following subtopics of this paper will discuss further about the concept of knowledge, unity through the diversity of knowledge and the concept of unity through epistemology of knowledge development in engineering education.

## **2.0 THE CONCEPT OF KNOWLEDGE**

According to an Islamic scholar, Al-Farabi, knowledge is defined as the cause of things especially when it deals with scientific knowledge. Meanwhile, the word science itself comes from the Latin “scientia” meaning knowledge (Anuar Ahmad, 2009). Omar Jah in Wan Mohd. Nor Wan Daud and Muhammad Zainiy Uthman (2010) views knowledge as a certainty that contrary to doubt.

Al-Ghazali defines knowledge as intellectual realities. The knowledge seeing things as it is. The thing is occasionally denoted as the known or object of knowledge or as an existent. The thing as ‘it really is’ is the reality of the thing, its essence, its universal meaning or its spirit. Knowledge also can be defined as a sense of permanence felt by anybody who is searching for the truth. Therefore, at least two elements play as a fundamental role in shaping knowledge. They are the factor of “permanence” which refer to the spiritual and universal meaning of the object of knowledge and the “principle of clarity”, which concerns with the observation and perception of the observer (Mohd Zaidi, 2002).

According to Mohd Zaidi (2002), when something is considered in it, it is named existent. The truth (knowledge) only occurs when the “permanence” or the universal meaning be compatible to the existence. Therefore, the more permanence element inherent in an object, the more real it is and the truer the perception is. The perception becomes more real when the observer develops their certainty about the permanence element in the object. The significant impact of this process brings the observer closer to the Creator (God).

Al-Ghazali identified two purposes of acquiring knowledge which is as a means to an end and as the end itself. In his further explanation, “it is in itself delightful and therefore sought for its own intrinsic value”. The second objective of acquiring knowledge is as a way which leads to happiness, the only means whereby all creations come close to God (Mohd Zaidi, 2002).

There are three levels of knowledge; knowledge acquired through reasoning, knowledge arrived by means of observation and true knowledge which corresponds to direct experience that is the intuitive knowledge or inspiration (Omar Jah in Wan Mohd. Nor Wan Daud and Muhammad Zainiy Uthman, 2010). Reason and experience alone as identified by modern scientists as the only sources of knowledge, cannot lead to true certainty or absolute reality. The true certainty in knowledge will lead to the recognition and acknowledgement of the proper place of God in the order of existence and the proper place of mankind in the order of all God creations.

Since technical and engineering education put a significant emphasis on the application of knowledge, it seems very important to discuss the meaning of application of knowledge. The application of knowledge means putting things in their proper place in the order of creation (Omar Jah in Wan Mohd. Nor Wan Daud and Muhammad Zainiy Uthman, 2010). This represents justice and wisdom in human activities or as a natural outcome of freedom in choice.

The development of knowledge has direct impact on the way in which human beings relate themselves to Allah as the absolute reality, to other human beings and to the physical environment and nature (Fazlur Rahman 1999). The development of scientific knowledge or intellectual knowledge which is based on observation by the ‘eyes and the ears’ is more significant if the knowledge finally able to ‘strike the heart’, understand its relationship and responsibilities toward society and physical world and to kindle a perception in the human beings which later transform its scientific and technological skills in accordance to God will.

### **3.0 EPISTEMOLOGY OF KNOWLEDGE: UNITY THROUGH THE DIVERSITY**

Al-Ghazali defines the epistemology as a nature and way of acquiring knowledge. In an epistemological process, it is a spirit of a thing, but not the thing itself, that is apprehended (Mohd Zaidi, 2002). In order for knowledge to materialize, the meaning of knowledge holds its similarity in the cognitive form and the existential form. Al-Ghazali identified the soul (the permanence entity in God creation) as the actual set of knowledge.

The source of knowledge in Islam is revelation while the nature is universe. The method to obtain the knowledge must involve the integration of reasoning faculty and the *fitrah* or the internal senses to be

pure submission to God. Meanwhile, the result should be consistent with the human nature, the laws of the universe, Islamic teaching and values.

According to Syed Naquib al-Attas, mankind is consisting of a dual nature, therefore knowledge that purports to serve them best would be of dual aspect; the prior is that which serves his more permanent, spiritual dimension or the core knowledge; and other; his secondary, material and emotional mode of existence. Therefore, Syed Naquib al-Attas and al-Ghazali classified knowledge into two categories. The first category is *fard ayn* or religious science and the second is the *fard kifayah* or intellectual science which included the physical and technical sciences.

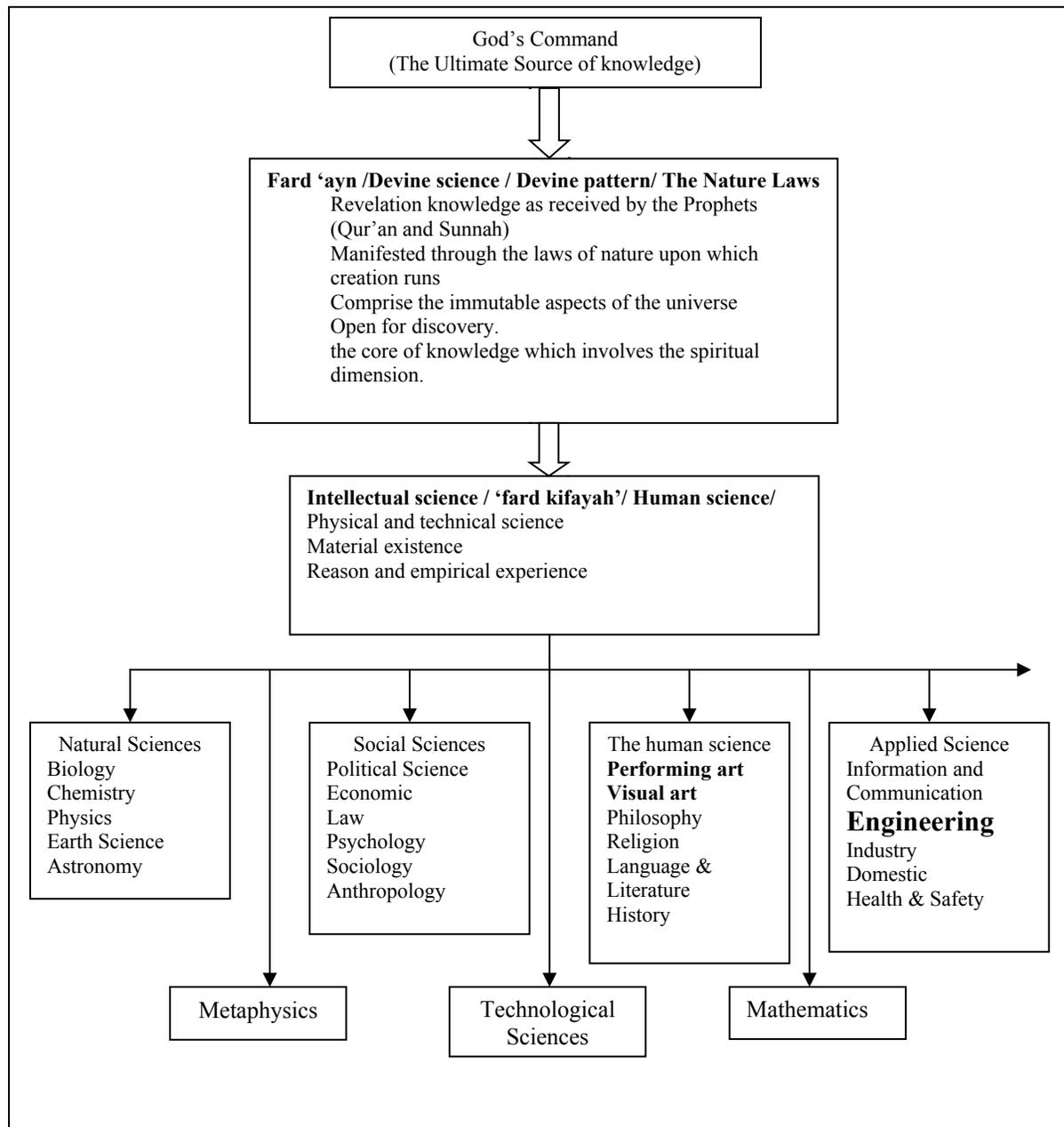
The religious knowledge is the highest and it is related to mankind's *fitrah* that Allah has given in every soul the knowledge that God as the only creator. The *fitrah* is the 'pure state' containing God's consciousness so that every mankind can experience God's perception of the world (Muhammad al-Mahdi, 2005). This knowledge must be pursued from the age of responsibility until the death-bed and cannot be limited primarily to schooling. Therefore religious knowledge is dynamic and expands according to an individual's intellectual and spiritual growing processes (Wan Mohd. Nor, 2005).

Those two categories of knowledge give great prominence on religious science because the former is said to be based on revealed teaching while the later (intellectual science) is based on reason (Wan Mohd. Nor, 2005; Osman, 2006). Qutb al-Din defines religious knowledge as the philosophical sciences that are same for all times. The religious knowledge is about the natures of things that comprises the immutable aspects of the universe (Osman, 2006). The immutable aspect of the universe is well known as a law of nature. The law of nature is the Divine patterns which every creation runs just like specific program created for every specific creation. They are immutable and their fulfilment is cosmic and may be known by reason.

Al-Ghazali divides knowledge that based on reason and empirical experience to mathematics, natural sciences, metaphysics and political science. Meanwhile, al-Attas classifies this knowledge into eight broad disciplines which are the human sciences, natural sciences, applied sciences, technological sciences, comparative religion, western culture and civilization, linguistic sciences and Islamic history. However al-Attas does not confine the intellectual science to only eight broad disciplines above because knowledge, being an attribute of God is infinite. The intellectual science would also expand according to the needs and plans of a particular society. This category of knowledge should reflect the changing needs of the contemporary and the expected demands of the future (Wan Mohd. Nor, 2005).

However, Muslim scholars such as al-Farabi, al-Ghazali and Qutb al-Din do not regard the distinction between sciences based on revelation and sciences based on reason and empirical as dualistic because even though divine knowledge is more superior to the intellectual knowledge, the former cannot be truly explained and elaborated without the latter. The latter without the former will be misguided. So they are complementary, though not equal to one and another. Although the later categories are posterior, yet they are important when located in their proper places. Therefore, education process should never neglect the scientific or experimental knowledge (Osman, 2006).

Muslim scholars agreed that the highest knowledge hierarchy is the knowledge of God. It is for the sake of knowledge of God that all other forms of knowledge are sought. Knowledge of all things other than God must be conceptually or organically related to the knowledge of God. This idea together with the view that all knowledge come ultimately from the same source constitutes, it the idea of the unity of the Oneness of God (Osman, 2006). Figure 3.1 illustrates the concept of unity through the diversity of knowledge.



**Figure 1: The unity concept through diversity of knowledge**

#### **4.0 THE CONCEPT OF UNITY THROUGH EPISTEMOLOGY OF KNOWLEDGE IN ENGINEERING EDUCATION**

The epistemology of knowledge should be built based on universal ethical values and educators should play a leadership role in the creation of a knowledge-based society. According to Anis Ahmad (2009), this universal value should be placed at the top of the hierarchy of values which goes beyond religious, ethnic, linguistic and colour barriers. They are universal in their genesis and global and relevant to the whole of human. If we lose these values, we will lose humanity, culture and civility.

The following unity concepts are suggested as the principles of knowledge development process in engineering education:

##### **i. The Unity in Life**

If the purpose of education process is to systematically expose students to empirical data and train them in its classification and re-arrangement in order to meet the material needs of society, it can not bring peace, harmony and fairness in human society. The education process only can produce functional, robotic human beings, create the students with excellent skills yet no unified vision, fragmented personality, conflict interests, and contradiction in behaviour but deprived of love, justice, sacrifice honesty and truth.

In contrast, value based education concentrate on the development of holistic personality with no compartmentalize between faith, culture and technology. The value based education tends to integrate whatever values that consider beneficial for goodness and it moves around the central value of unity in life. The unity in life means elimination of contradiction, conflicts and dual standards of ethics and morality.

In Islamic life, the value of unity is the first principle of Islam and it refers to the unity of Allah as the one and only. Everything else is separate and different from Him as a creator. He is the first and ultimate cause and end of everything. His will is a law of nature as well as a law of morality. According to Anis Ahmad (2009), the message of unity in Islam is very simple; the compartmentalization in life or dualism thinker in order to serve diverse gods can never bring harmony, unity and cohesiveness in life. Therefore, the integration of this primary values will produce united and integrated thinkers who live and think in consciousness of divine unity which is Oneness of God as the ultimate and united vision.

The concept of unity also can be realizing as a divine pattern or the laws of nature upon which all creation runs. This divine pattern is immutable and their fulfillment is cosmic. Mankind is the only creature that carries the divine trust of freedom to exercise his/her pure submission to God or not and carry the moral freedom of law, which constitutes of *khalifah* (a leader to all God's creation) to God.

The main corpus of moral laws consists of actual practices of living, of being, and of doing. When what we do fulfills the moral requirement, it is good; when it does not, it is evil. Therefore, the deeds of a mankind alone could be good or evil, depending upon whether they bring about justice, righteousness, beauty, happiness or otherwise. In other word, the fulfillment of *khalifah's* responsibilities leads to the development and the establishment of culture and civilization. Therefore, mankind is a God's servant and God's *khalifah* which is responsible to seek goodness, justice and the truth as a reference standard of morality in his action.

## **ii. The Unity of Creation**

The unity of God's creation has proven by the unity and the consistency of cosmic order. Every creation in the cosmos takes place do so by God command. Therefore, the cosmic order consists of the law of nature or Divine pattern. The unity and the consistency of cosmic order enable mankind to recognize the permanence substances of things and the repetition of events that produce cause and effect relations. Everything has a purpose, never final, and always subject to other purpose where God is the ultimate cause and the ultimate end.

## **iii. Unity of Humanity**

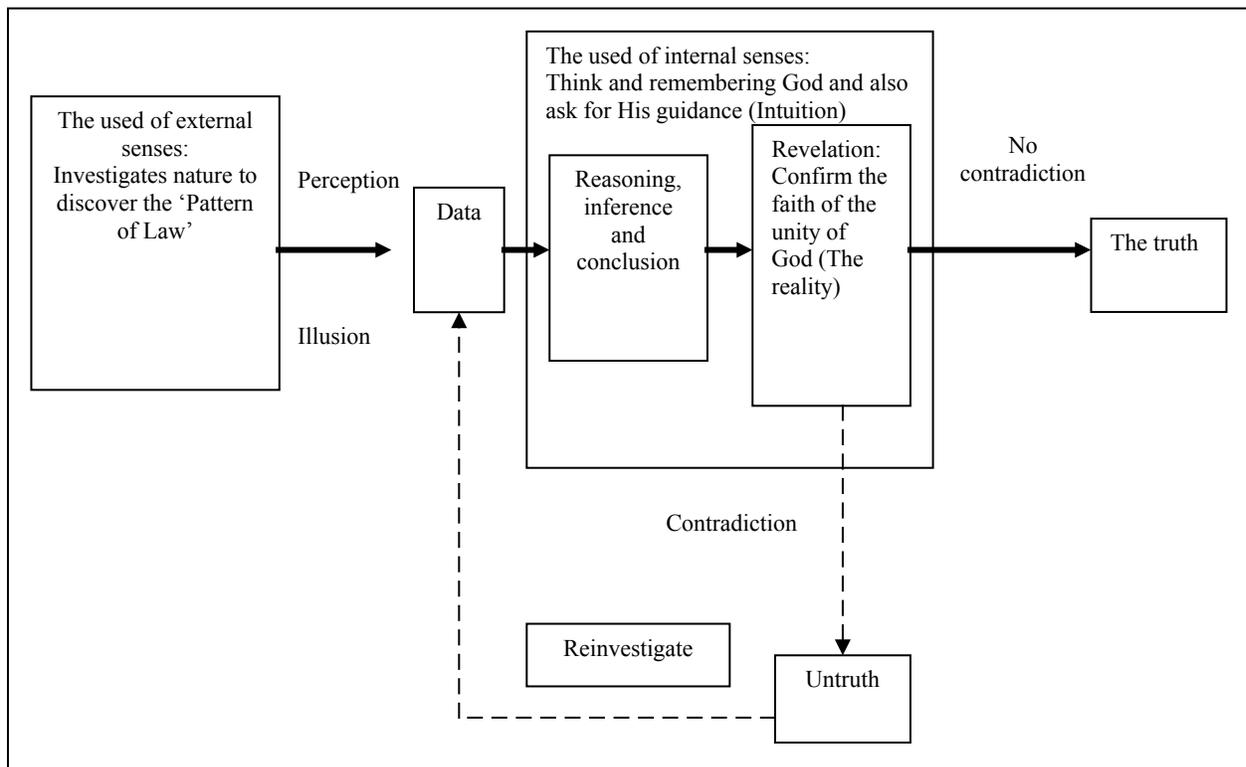
All mankind are one and the same; this is the basis that forms the groundwork of universal values in Islam. The mankind is one in the eye of Allah except as their deeds that distinguish them in moral value and civilization achievement.

## **iv. Unity of The Truth and Unity of Knowledge**

Allah has provided mankind with ability of reasoning (*'aql*), as a tool to get to know and to think the world around him/her. The divine revelation is meant to guide the mankind to get knowledge. The revelation and reason are both complementary and essential for righteous life, to help the mankind to understand their aims and fulfill their responsibilities. Therefore, there is no contradiction between revelation and reasoning.

The light of faith is definitely epistemological and is a consequence of reasonableness. Since Allah is the one and only Lord, truth cannot be equivocal. He knows the truth and in His revelation. What He conveys in the revelation cannot be different from reality, since He is the creator of all realities as well as of all truths. The truth, which is the object of reason, is embodied in the laws of nature. These are the patterns of Allah’s creation, which are constant and unchangeable, possible to discover to establish and use for the benefit of humanity.

The logical equivalence of reason, truth, and reality is the fact that revelation. It is the most critical principle epistemology in Islam. The unity of truth prescribes that there is no contradiction or variation between reason and revelation. When a researcher investigates nature in an attempt to discover the patterns of law of the creator in the universe, it is certainly possible to make mistakes. In other words, what the researcher perceived through his sense and the data that he have collected does not necessarily represent the ultimate reality (S. Imtiaz Ahmad, 1986). This would create discrepancy between revelation and reason. However, according to the concept of the unity of truth, it rejects such discrepancy and demands that the researcher reinvestigate for the data. The re-examination in the light of the principle of unity of truth will clear up the truth and rectify perception, thereby removing the contradiction between revelation, reality and its conception. The epistemology of knowledge in engineering education can be illustrated in the following figure:



**Figure 2: The Conceptual Model of Epistemology of Knowledge in Engineering Education**

## 5.0 CONCLUSION

The challenges of engineering education today is not only to produce experts in engineering disciplines, but also to produce knowledgeable engineering education students who are able to integrate scientific knowledge in problem solving process. The available teaching and learning strategies and curricula in the engineering education have shaped the engineering education students become dualist thinkers. In order to shift away focus in engineering education from simple presentation of knowledge to the integration of knowledge in an attempt to prepare young generation with knowledge, skills and attitudes beyond the range of traditional engineering curriculum, they need to understand the meaning of education and the concept of unity in knowledge development process.

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