THE EFFECT OF INTEGRATED AFFECTIVE-COGNITIVE TEACHING AND LEARNING APPROACH ON STUDENT'S LEARNING IN ENGINEERING EDUCATION

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ABSTRACT

Prevalent practices in engineering education do not often consider the affective learning needs due the difficulty in integrating affects into teaching that focuses more on the cognitive learning needs. However, affective learning could be used to support the internalization of cognitive learning needs. Therefore, to strike a balance between pursuit of cognitive and affective goals an integrated affective-cognitive teaching and learning approach framework is proposed. The affective variables of interest are self-efficacy, locus of control, attitude towards engineering, and behavioural engagement. To determine the effectiveness of the integration of affective-cognitive teaching and learning approach the quasi experimental research design was conducted on 70 engineering students (36 in experimental group and 34 in control group) who were enrolled in a Diploma of engineering programme in the Universiti Tun Hussein Onn Malaysia. Existing self-report instruments were adopted and used to measure locus of control, self-efficacy and attitude towards engineering; behavioural observation checklist was used to assess behavioural engagement and scores obtained on selected course was used to measure academic achievement. The data analysis using MANCOVA indicates that the experimental group was better on the achievement test (cognitive learning) and attitude measures (affective learning) compared to the control group. Observational data indicate that the proposed approach promotes certain types of positive behavioural engagement while suppressing certain types of negative engagements. Thus, it is concluded that the proposed framework can be used as a guideline in designing effective instructional materials for developing holistic student's attitude.

ABSTRAK

Amalan pendidikan kejuruteraan rata-rata tidak mengambilkira keperluan afektif disebabkan kesukaran untuk menyepadukan atribut afektif dalam pengajaran yang lebih menumpukan kepada keperluan pembelajaran kognitif. Walau bagaimanapun, pembelajaran afektif boleh digunakan untuk menyokong keperluan pembelajaran kognitif. Oleh itu, untuk mencapai keseimbangan antara mengejar kognitif dan matlamat afektif, satu kerangka bersepadu pendekatan afektif-kognitif dicadangkan.. Pemboleh ubah afektif yang dikaji ialah efikasi kendiri, lokus kawalan, sikap terhadap kejuruteraan dan penglibatan tingkah laku. Untuk menentukan keberkesanan pendekatan yang dicadangkan, eksperimen kuasi telah dijalankan ke atas 70 orang pelajar kejuruteraan (36 bagi kumpulan eksperimen dan 34 bagi kumpulan kawalan) yang telah mendaftar dalam program Diploma kejuruteraan di Universiti Tun Hussein Onn Malaysia. Instrumen laporan kendiri sedia ada telah diadaptasi dan digunakan untuk mengukur lokus kawalan, efikasi kendiri dan sikap terhadap kejuruteraan; senarai semak telah digunakan untuk mencerap penglibatan tingkah laku dan skor yang diperolehi oleh pelajar dalam kursus terpilih telah digunakan untuk mengukur pencapaian akademik mereka. Analisis data menggunakan MANCOVA menunjukkan bahawa kumpulan eksperimen adalah lebih baik pada ujian pencapaian dan sikap berbanding dengan kumpulan kawalan. Data pemerhatian menunjukkan bahawa pendekatan yang telah dicadangkan menggalakkan beberapa jenis penglibatan tingkah laku positif di samping mengurangi beberapa jenis tingkah laku negatif. Kesimpulannya, pendekatan yang dicadanglan boleh digunakan sebagai panduan oleh pendidik dalam mereka bentuk bahan pengajaran yang keberkesanan dan mampan yang akan menghasilkan jurutera-jurutera yang efektif untuk pembangunan pada masa hadapan.

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LIST OF SYMBOLS AND ABBREVIATIONS

RLOC	-	Rotter's locus of control
SESS	-	Self-efficacy and study skills questionnaire
PFEAS	-	Pittsburg freshman engineering attitudes scale
SE	-	Self-efficacy
LOC	-	Locus of control
R	-	Response
S	-	Stimulus
S-O-R	-	Stimulus-organism-response
IQ	-	Intelligence quotient
SCL	-	Social-cognitive learning
I-E	-	Internal-external
TRA	-	Theory of reasoned action
ZPD	-	Zone of proximal development
RO	-	Reflective observation
AC	-	Abstract conceptualisation
AE	-	Active experimentation
CE	-	Concrete experience
UTHM	-	Universiti Tun Hussein Onn Malaysia
CGPA	-	Cumulative Grade Point Average
GIE	-	General impressions of engineering
FI	-	Financial influences for studying engineering
PECS	-	Perception of how engineering contribute to society
PEP	-	Perception of the work engineers do and engineering Profession
MSC	-	Enjoyment of math and science courses
ES	-	Engineering perceived as being and "Exact" science
FISE	-	Family influences to studying engineering

CBEKS	-	Confidence in communication and computer skills
CCCS	-	Confidence in basic engineering knowledge and skills
ASH	-	Adequate study habits
WIG	-	Working in groups
PSA	-	Problem solving abilities
EC	-	Engineering capability
SPSS	-	Statistical package of social sciences
AA	-	Academic achievement
SHM	-	Simple Harmonic Motion
Exp	-	Experimental group
Con	-	Control group
MANCOVA	-	Multivariate analysis of covariance
W	-	Shapiro-Wilks
ANCOVA	-	Analysis of covariance
IV	-	Independent variable
DV	-	Dependent variable

LIST OF APPENDICES

LIST OF PUBLICATIONS

Journals:

(i) Tahira Anwar Lashari, Maizam Alias, Mohd Jahaya kesot & Zainal Abdin Akasah, (2014). The effect of an integrated affective-cognitive teaching and learning approach on academic achievement, self-efficacy, locus of control and attitude towards engineering. *Journal of technical Education and Training*, 6(1), 13-31, ISSN 2229-8932.

(ii) Maizam Alias, Tahira Anwar Lashari, Zainal Abdin Akasah & Mohd Jahaya kesot (2013). Translating theory into practice: integrating the affective and cognitive learning dimensions for effective instruction in engineering education. *European Journal of Engineering Education*, 1(1), 1-21, DOI:10.1080/03043797.2013.838543.

(iii) Tahira Anwar Lashari, Maizam Alias, Mohd Jahaya kesot & Zainal Abdin Akasah, (2013). An affective-cognitive teaching and learning approach for enhanced behavioural engagements among engineering students, *Engineering Education,* 8(2), 65-78. DOI: 10.11120/ened.2013.00011

(iv) Tahira Anwar Lashari, Maizam Alias, Zainal Abdin Akasah, & Mohd Jahaya kesot (2012). An affective cognitive teaching and learning framework in engineering education. *ASEAN Journal of Engineering Education,* 1(1), 11-24, ISSN 22319433.

Proceedings:

(i) Tahira Anwar Lashari, Maizam Alias, Mohd Jahaya Kesot & Zainal Abdin Akasah (September, 2012). The effect of integrated affective-cognitive learning approach on classroom Behavioural engagement of engineering students. *International Conference on Active Learning (ICAL 2012),* 18-20 September 2012, UTeM, Melaka, pp-19-25, ISBN N0: 978-967-0257-15-0.

(ii) Tahira Anwar Lashari, Maizam Alias & Zainal Abdin Akasah (2012). The relationship between socio-psychological variables and academic achievement among engineering students. *Prosiding Seminar Pendidikan Pasca Ijazah Dalam PTV Kali Ke*-2, 2012, pp. 246-260.

(iii) Tahira Anwar Lashari, Maizam Alias & Zainal Abdin Akasah (November, 2011). A framework for investigating the role of affect in cognitive development in engineering education. *Proceeding in Malaysian Technical Universities International Conference on Engineering & Technology (MUiCET).* Batu Pahat, Malaysia, pp. 1032-1039.

Award:

(i) **Bronze Medal in Research & Innovation Festival 2013:**
Maizam Alias and Tahira Anwar Lashari. "The effect of an integrated affective-cognitive teaching approach on affective and cognitive learning goals".

CHAPTER 1

INTRODUCTION

1.1 An overview

Engineers play a vital role in ensuring the prosperity of a nation (Megat Johari *et al*., 2002). They are involved in nation building that can be observed in many areas such as in the development of innovative products; creation and management of energy, transportation and communications systems; prevention of new and addressing existing environmental problems; creation of health care devices and above all, making the technology work (Mustafa *et al*., 2008). Therefore, engineers' role in the development of industries, infrastructures, global market place, sustainable wealth creation, international competitiveness and general well-being cannot be underestimated.

To be successful in the above mentioned endeavors, engineers need to have multiple competencies that include affective skills in addition to the necessary technical know-how such in team-working (Akasah & Alias, 2010; Hadjiachilleos, Valanides & Angeli, 2013), communication (Kort & Reilly, 2002), professional development, ethical attitude etc. In this regard, engineering students must be educated to have similar attributes that is, they must be educated so that they can work as a part of a team, communicate well, and understand the economic, social, environmental context of their professional activities which encompass intellectual, technical and affective competencies. These competencies are embodied in the three broad competency domains that are widely known as knowledge, skills and attitude in the working world (Anderson & Krathwohl, 2001). Although some of these skills could be considered to be related to a student's personality, it becomes explicit when nourish personality attributes and efficacy of an engineering student. For example, an engineering student who have a good leadership qualities can also have an effective

communication skills and these attributes can be seen when examining the stated outcomes of several engineering degrees therefore, assumed to be fundamental aspects in the adequately developing the student's non-technical skills in the workplace (Martin *et al.,* 2005). Ensuring that graduate engineers possess these attributes is vital to the nation's industrial strength and to the ability of engineers to serve as technology and policy decision makers. Thus, effective engineering education is important in developing engineers whose decision makings can contribute greatly towards the socio-economic well-being of a nation.

Malaysia aspires to be a developed nation by 2020. To achieve this, it requires 200,000 engineers to serve this developing nation (Malaysia: The Millennium Development Goals at 2010, 2011; Alias & Abu Bakar, 2010). Malaysia adapted the Australian model of a four year engineering programme in 2000 and adopted it to meet the local needs i.e., cultural, social, economic, and environmental needs. Five criteria were acknowledged as fundamental in the Malaysian Engineering Education Model namely, scientific strength, professional competencies, multi-skilled, well-respected and potential industry leader, and morally and ethically sound (Megat Johari *et al*., 2002). Amongst the five criteria, scientific strength and professional competencies have direct connection with the cognitive dimension of learning outcome while, multi-skilled; well-respected and potential industry leaders; and morally and ethically sound are associated with the affective dimensions of learning. Thus, there is an increasing demand for engineering education providers to produce graduates who are more holistic in their attributes as making it the goal of engineering education in Malaysia (Malaysia: The Millennium Development Goals at 2010, 2011). Consequently, providing effective engineering education that produces graduates with the appropriate cognitive and affective attributes is crucial in ensuring that the expected educational goals of engineering education are fulfilled (Malan, 2000).

Looking at the engineering content of teaching and learning in particular, one of the goals of engineering education is to produce students that have the appropriate level of engineering content knowledge and skills for the cognitive domain (Redish & Smith, 2008; Gondim & Mutti, 2011); which is one of the learning domains identified by Bloom (Bloom, 1956). Bloom's taxonomy of the cognitive domain is commonly used in engineering education (Besterfield-Sacre *et al*., 2000; Vanasupa, Stolk & Herter, 2009). In addition to the cognitive domain goals, engineering

education is also aimed at producing engineers who are competent in the other two domains namely the psychomotor domain and the affective domain (Anderson & Krathwohl, 2001). In contrast to learning in the cognitive domain, learning in the psychomotor domain would results in a more observable change that is, a change in the level of students' practical skills (Hassan, 2011). Examples of psychomotor skills that could be acquired through a learning process includes the ability to do welding in electrical and mechanical engineering work and to level a theodolite for a civil engineering field work. Affective domain is associated with the emotional attachment of students with learning. Thus, current expectations of engineering students are not only that they have the ability to learn, to achieve and to create but also to have the ability to be empathetic, self-starters, critical and creative thinkers (Lewis, 2009) which reflects an individual values, motives and interests (Atsumne & Saba, 2008) which are attributes that falls under the affective learning domain.

Although the affective dimension of learning also plays a vital role in achieving a certain level of affective skills, it is also influential towards acquiring the desired cognitive learning outcomes of education, engineering education included (Picard *et al*., 2004; Strobel *et al.,* 2011; Hassan, 2011). The affective domain is predominately associated with the emotional components of learning such as feeling, attitudinal change and the degree of acceptance or rejection (Akasah & Alias, 2010; Martin, 2010). Past studies indicate that the affective and cognitive dimensions of learning acts in "reciprocity" which means that they are mutual interacting determinants of each other (Denton & McKinney, 2004).

Much research has been conducted in other disciplines to support this claim, such as in the neurosciences (Lu & Zhang, 2009), behavioural psychology (Pervin, 2007) and medicine (Davison, Neale & Kring, 2008) that substantiated the role of affects in generating physiological changes that are influential to learning (Lu & Zhang, 2009). The affective and cognitive therapies are used to determine the etiologies and prognosis of psychopathologies such as eating disorder, somatization disorder, depression, anxiety disorder, and stress appraisal. In medicine for example, the affective and cognitive connection is greatly emphasized in educating professionals resulting in professionals who can appreciate (affective) and understand (cognitive) patients' problems displaying caring attitude towards patients motivating them to seek early diagnosis and treatments (Shephard, 2008). Thus, the

affective learning dimension could be used to support the internalization of cognitive contents.

The affective dimension is also closely related to personality which relates to feeling and self-worth (Caine & Caine, 1991; Swanson 1995; Alias, Akasah & Kesot, 2012). Thus, personality cannot be ignored as it can sometimes cast a big influence on academic achievement (Poropat, 2009). Personality is a multidimensional psychological construct that is composed of relatively stable attributes. According to Bandura (2005), personality refers to an individual's unique, relatively consistent pattern of thoughts, beliefs, feeling and affect, and behavioral intentions in the form of cognition and affects. However; situational factors such as such as hope, opportunities, expectations, changing roles, performance outcomes, social influences and responses might influence its level. For example, a classroom is a place where engineering students are engaged in learning as well as socialization process (Fredricks, Blumenfeld & Paris, 2004). As a result, a classroom is often charged with socialization "affects" such as positive and negative emotions or feeling of acceptance or rejection that could support or hinder learning. Other desirable affective outcomes may also be experienced during classroom interactions such as positive teacher's attitude, respect, valuing other's point of view in the form of appreciation which can promote enthusiasm for learning. Thus, the classroom also offers the opportunity for students to demonstrate and strengthen their personality traits.

1.2 Problem Statement

Integration of affective learning needs into the teaching and learning for cognitive goals has been found to motivate students to learn (Cruickshank & Fenner, 2007). Theory also supports the notion that the affective learning attributes when taken into consideration using appropriate and effective teaching and learning strategies can enhance the achievement of cognitive goals in engineering education (Aziz *et al*., 2005; Shephard, 2008). In general, however, there has been relatively little research on the role of affects in achieving cognitive learning goals particularly in engineering education (Simpson *et al*., 1994; Griffith, 2006; Boyle, 2007; Owen-Smith, 2008; Lu & Zhang, 2009; Casale, Kuri & Silva; 2010; Strobel *et al*., 2011); although much

emphasis has been placed on the cognitive learning (Hung, 2003; Apple *et al*., 2004; Miller & Mohler, 2009; Alias & Hafir, 2009; Cyung *et al*., 2010; Mohammad & Rajuddin, 2010).

Ignoring the role of affect (such as attitudes, and feelings) has resulted in failure in providing an adequate model for effective and sustainable engineering education (Aziz *et al.,* 2005; Jonassen, Strobel & Lee, 2006; Mokhtar & Mamat, 2009; Yoon, Diefes-Dux & Strobel, 2013). Furthermore ignorance leads to undervaluing the students' potential and raises the level of frustration among the engineering lectures (Alias, Akasah & Kesot, 2012). Most importantly, the lower emphasis on affects encourages the perception of students that the engineering discipline is an object-oriented discipline rather than a people-oriented discipline (Strobel *et al*., 2011). This is unhealthy as it will hinder the development of the appropriate attributes in future engineers who have to deal with social and people issues in order to support sustainable development.

Even where affects are accepted as important, there is little consensus on how to integrate affect into the cognitive teaching and learning especially in engineering education (Greenberg & Baron, 2003). This study attempts to investigate the effect of an integrated affective-cognitive teaching and learning approach incorporating psychological attributes that strikes a balance between the pursuit of cognitive and affective goals where each goal is pursued as both; a means and an end of education in such a way that neither should be seen as subservient to the other rather that they should be blended naturally into a lesson plan.

The psychological attributes which are embedded into the integrated affective-cognitive teaching and learning framework were locus of control, self-efficacy, attitude towards engineering, behavioural engagement and academic achievement. Locus of control is thinking pattern of individuals' consideration of controlling events - either internal or external - that could affect them. Self-efficacy is belief in the ability to perform well in a particular task. Attitude is tendency to respond either positive or negative towards a certain object, event and person. Behavioral engagement is active participation of students in a learning process. Academic achievement is performance of a student in the cognitive task (Mayer, 2008).

1.3 Aim of the study

The aim of this study is to determine the effect of integrated affective-cognitive teaching and learning approach that incorporate the affective learning needs on learning in the cognitive and affective domain.

1.4 Research objectives

Based on the research background and the related issues, three objectives of this research have been formulated as follows:

(i) To identify the relationship between psychological variables namely locus of control, self-efficacy, attitude towards engineering and academic achievement.

(ii) To establish a causal relationship between the teaching approach and learning achievement that emphasizes the affective dimension of learning.

(iii) To identify the dominant types of behavioural engagement (positive/negative) in the experimental and control groups.

1.5 Research questions

Study seeks to address the following questions:

Q 1: What is the relationship between locus of control, self-efficacy, attitude towards engineering and academic achievement?

Q 2: Is there any difference between group of students exposed to the affective-cognitive teaching and learning approach and group of students exposed to the traditional method in their locus of control, self-efficacy, attitude towards engineering and academic achievement?

Q 3: What are the dominant types of behavioural engagement (positive/negative) in the experimental and control groups?

1.6 Research hypotheses

Based on the considerations, study was guided by three research hypotheses that are written below:

(i) There is no significant relationship between locus of control, self-efficacy, attitude towards engineering, and academic achievement.

(ii) There is no statistically significant difference between group of students exposed to the affective-cognitive teaching and learning approach and group of students exposed to the traditional method in their locus of control, self-efficacy, attitude towards engineering, and academic achievement.

(iii) There are no dominant types of behavioural engagement (positive/negative) in the experimental and control groups.

1.7 Theoretical framework of the study

The theoretical framework of the study is based on the underpinning concept of social-cognitive learning theory by Albert Bandura which comes under social culturalism. The social cognitive theory explains how people acquire and maintain certain behavioural patterns in a social context. Behavioural patterns depends on three simultaneously influencing components namely the environmental factor, the personal factor, and the behavioural factor itself (Bandura, 2005). The environmental factors refer to the physical surrounding around the individual that contain potentially reinforcing stimuli. For instance, in a classroom learning is shaped by academic environmental stimuli that trigger a response such as reinforcements by a lecturer. The personal factors refer to the characteristics that have been rewarded in the past. Most prominently personality and cognitive aspects play a vital part in how a person behaves. Consequently, behaviour is modified by personal and environmental factor.

Learning involves interaction of student's own thoughts, self-beliefs systems and their interpretation of a classroom context. These interactive effects are considered "mutually influencing" – usually referred to as reciprocal determinism (See Section 2.2.3 (i)). Modifying the variables of study in the reciprocal

determinism of social-cognitive learning; it can be elaborated as the integrated-affective-cognitive teaching and learning approach (environmental factor) which influences personal belief system and cognition (personal factor) which in-turn brings out consequences as learning outcome (behavioual factor); (See Figure 1.1).

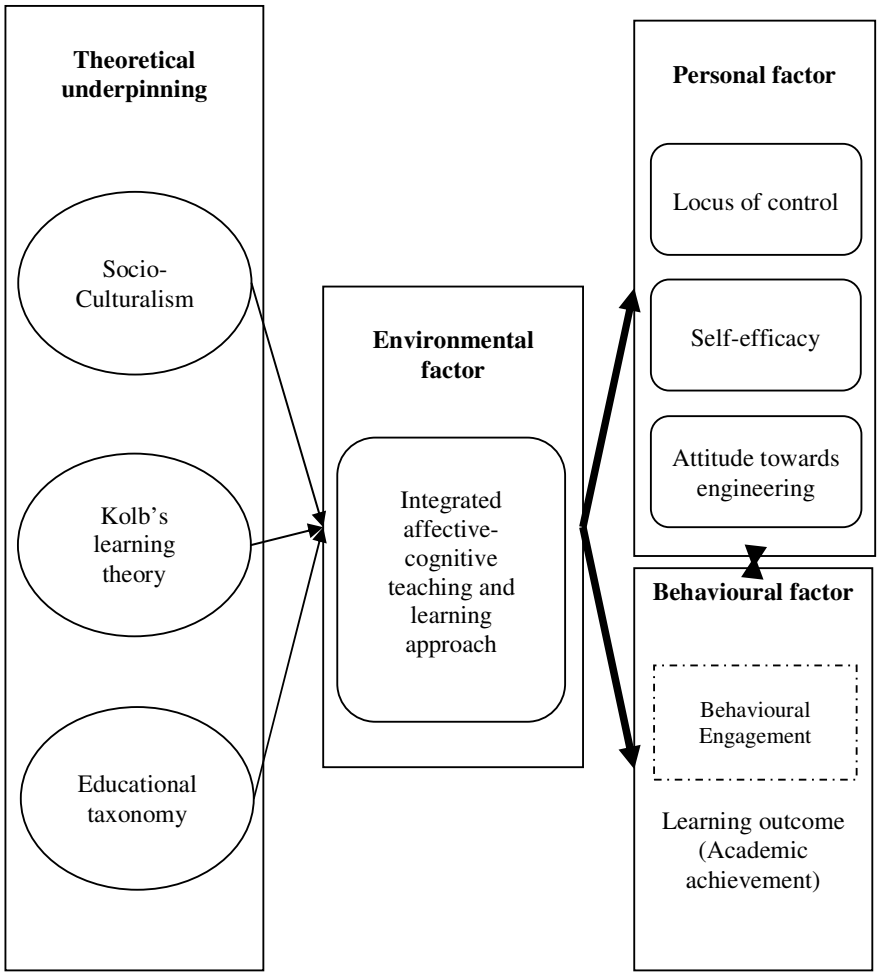


Figure 1.1: Conceptual framework based on reciprocal determinism (Bandura, 2005)

Legend:

Factors

Theories

Variables

1.8 Scope of the study

This research focused on testing the effectiveness of a new approach, the integrated affective-cognitive teaching and learning approach in engineering education, specifically its effect on cognitive learning and affective learning. Of interest was the effect of the approach on five affective attributes that are psychological in nature namely locus of control, self-efficacy, attitude towards engineering, behavioural engagement and academic achievement. These psychological attributes were identified through the literature to be important input elements in designing the learning activities that can foster student's affective-cognitive abilities. To measure the selected psychological variables four existing paper-pencil based instruments that are self-report inventories were used.

1.9 Definitions of the variables

The variables and important concepts used in the study are defined below:

(i) The integrated affective-cognitive approach

The integrated affective-cognitive approach is an instructional approach that has taken affective and cognitive learning needs simultaneously into consideration for achieving learning in the cognitive domain with the support of the affective domain as well as to enhance the effectiveness of teaching for affective domain in an engineering course.

(ii) Locus of control

Locus of control refers to an individual's belief on the controlling factors that could affect their academic performance either internal or external (Rotter, 1966). The operational definition of locus of control is scores obtained by the participants on the Rotter's locus of control scale (RLOC). A high score indicates that a person tends to have an external locus of control while a low score indicates that a person tends to have an internal locus of control.

(iii) Self-efficacy

Self-efficacy refers to one's belief/expectation of performing well in a particular situation, and the ability to accomplish a particular task (Bandura, 2001). The operational definition of self-efficacy is the scores obtained by the participants on the self-efficacy and study skills questionnaire (SESS) scale. A high score on the scale indicates a high self-efficacy whereas a low score means low self-efficacy.

(iv) Attitude towards engineering

Attitude towards engineering defined as an opinion that can influence individual's behaviour towards engineering that can modify one's behaviour accordingly in a certain situation (Festinger, 1957). The operational definition of an attitude towards engineering is the scores obtained by the participants on the Pittsburg freshman engineering attitudes scale (PFEAS) scale. A high score reveals high positive attitude towards engineering while a low score reveals less positive attitude towards engineering respectively.

(v) Behavioural engagement

Behavioural engagement is related to active participant of a student in learning that underpins the particular set of behaviour such as devotion and determination (Griffin, Parker & Neal, 2008), learning behaviour, sense of belongingness (Fredricks, Blumenfeld & Paris; 2004), and students self-regulatory strategies to monitor the learning processes (Chapman, 2003). The operational definition of behavioural engagement is the frequencies observed as on behavioural observation checklist. More frequencies on behavioural indicators indicate more behavioural engagement either positive or negative.

(vi) Academic achievement

Academic achievement is related to the performance of the student in any of his/her cognitive task which is generally referred to the ability of the student. Academic achievement can be measured via making a comparison on students' marks with the standard criteria called pass marks. The term as well means the attainment of success of a student in his school work among his classmates (Avoseh, 1985). The operational definition of the academic achievement is the scores obtained on selected engineering course.

1.10 Thesis outline

This thesis consists of five chapters, which are briefly described as follows:

An overview of the research is explained in chapter 1 that encompasses the background of the study, problem statement, aim of the study, research objectives, research questions, research hypothesis, the scope of the study, definitions of the variables, conceptual framework of the study and thesis outline respective.

Chapter 2 provides a discussion on learning theories specifically which identify the role of affects in learning of cognitive domain. The discussion then continues complementary approaches for studying affective and cognitive learning and their relevance to the engineering education. Afterwards, an overview to the emergence of the integration of affective-cognitive teaching and learning approach underpinning theoretical foundation incorporating personality attributes was given.

Chapter 3 describes the research design used to carry out the integration of affective-cognitive teaching and learning approach. The chapter continues with the explanation on the synthesis of the integration of affective-cognitive teaching and learning approach. Afterwards, a step forward to brief explanation to each step involved in the formation of the integration of affective-cognitive teaching and learning approach and procedures involved are also discussed.

Chapter 4 reveals the results acquired on the tested hypotheses, a thorough analysis related to adaptive parameters towards the integration of affective-cognitive teaching and learning approach is presented in tables and a few graphs are plotted.

Finally, discussion on the obtained results is made in Chapter 5; which discusses the finding of the study and then it goes on to describe some directions for future works, recommendations and implications based on the empirical findings that followed by the contribution of the study and conclusion of the chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter begins by laying out the theoretical background of the research; it looks at how selected learning theories are relevant that leads to the development of the proposed approach (i.e. integrated affective-cognitive teaching and learning approach). An overview to major contributing learning theories namely behaviourism, cognitivism, socio-culturalism, constructivism along with sub-learning theories and their relevance to engineering education is discussed. The purpose of reviewing the relevant learning theories were to identify variables which are most relevant to study and to establish conceptual framework which later followed by the chapter summary. However, the progressive development of the conceptual framework will be explained in the next chapter.

2.2 An overview to major learning theories

Learning theories are propositions on how learning is acquired by a learner including what affects learning gains which can be a source of knowledge and guidance for researchers and practitioners in engineering education sectors (Tomei, 2001). Each theory has its strengths and weaknesses and thus may not be suitable for all occasion of learning. The abundance of learning theories that are not always in agreements with one another may not be helping engineering teachers. For example, in the behaviourist paradigm learning is perceived as a relatively permanent change in behaviour as the result of practice or experience with a demonstrable outcome and external indicators can be used to measure learning gains (Morris *et al.,* 1995; Davison, Neale, & Kring; 2008).

Thus, behaviourism is based on the stimulus-response model (classical conditioning) and reinforcement (operant conditioning) that attempt to study behaviour in observable and measurable way (Ormond, 2000). Hence, behaviourism does not appreciate mental processes of a learner that may influence observable behaviour and tried to project human beings as complex machines. Behaviourism is thus often guides training for skills development.

Cognitivism on the other hand which is an extension of behaviourism acknowledges the cognitive involvement in learning. Cognitive involvement was acknowledged by Tolman in his work on latent learning and became a first step in the emergence of cognitive theory (See Section 2.2.1). Cognitive theory attempts to explain mind as a reference tool and a linear functioning organism. Though, cognitive school rejected behaviourism but they make use of some of behaviourist techniques such as progressive relaxation, assertiveness skill, and journal assignment (Krista, 2008), consequently the emergence of the cognitive-behavioural theory.

However (in the social-cognitivist paradigm) learning is not always demonstrable. Learning sometimes can be implicit in nature where a learner might not be aware that they have actually learned - as in latent learning (Mayer, 2008). For instance - taking an example from everyday life - student A; who comes to school every day with student B who drives the car, may learn the route to school equally well as student B demonstrating latent learning by student A.

Later on, emerges the social-cognitive theory which proposed that both behaviour and environment equally contribute to learning (Mayer, 2008). For example, behaviour can influence environment as well as environment can influence behaviour. Mind is not just a reactant to neural events but rather an active component that can conceive an idea, rethink over the same idea, can function as the evaluator and executor of ideas depending on the person whose mind it belongs, situation and social setting (See Section 2.2.3 (i) Triadic-reciprocal determinant theory of learning; under social-cognitive learning theory).

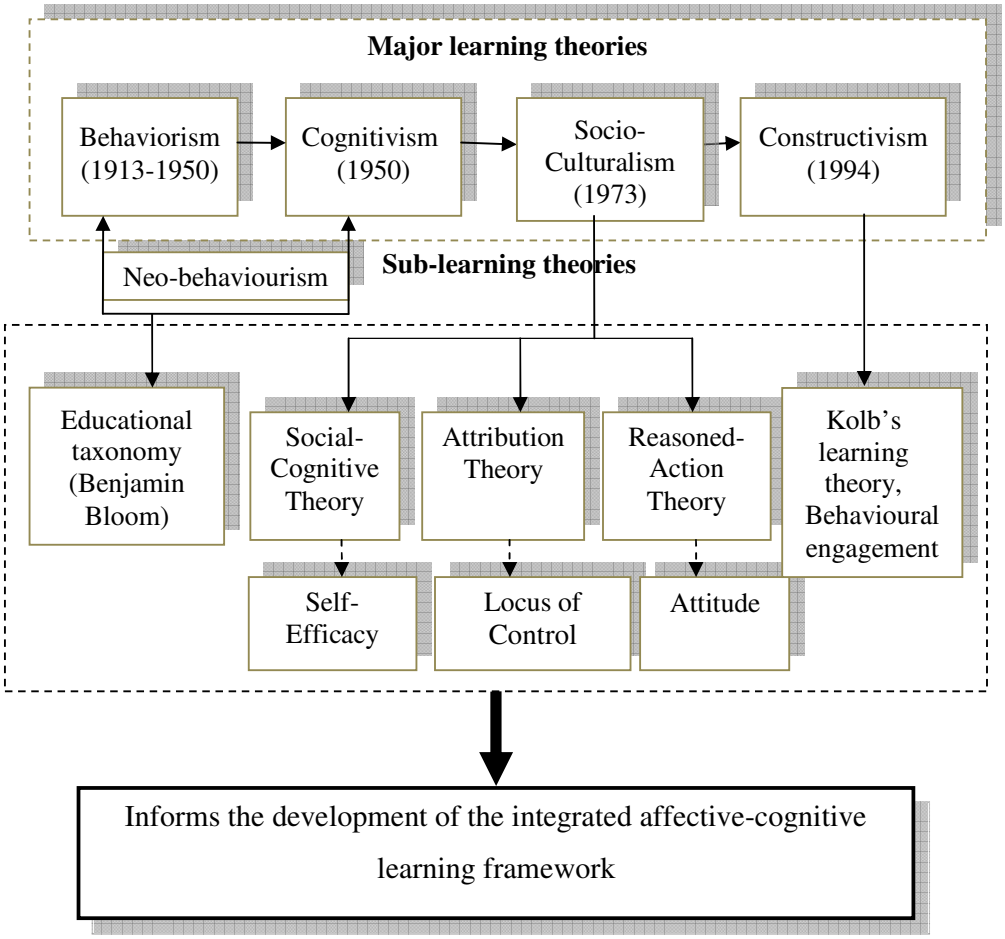
Therefore, an effective teacher does not make use of one learning theory only but might employ different theories at various times depending on the nature of the expected learning outcome and students attributes to make learning effective. Engineering instructors need to be aware of the various ways of how students learn and the various types of learning that may occur to design teaching strategies that will target their desired learning outcomes.

Besides, trying to make sense of the multitude of theories can be confusing to novice teachers, what is more to engineering teachers who have not had any exposure to teacher training as it is not part of their engineering training (Hassan, 2011).

In attempt to provide a comprehensive review of the literature, it is important to establish a solid foundation of knowledge regarding variables namely locus of control, self-efficacy, attitude, and behavioural engagement. Since the current study is concerned with teacher-student relationship and the desired attributes that have been selected. Therefore, the main source of guidance for this study is obtained from four sub-theories; three of them fall under same major theory while fourth comes under constructivism; i.e. the social-cognitive learning theory (SE), attribution theory (LOC) and action-reasoned theory (attitude) that fall under the social-culturalism school of thoughts and behavioural engagement which is a part of constructivism.

Thus, this study engaged four inter-related schools of thought namely behaviourism, cognitivism, socio-culturalism, and constructivism. The contributions of the four schools of thoughts on engineering learning have been duly acknowledged by other as they can be widely utilized and integrated in the different educational systems within engineering education (Miller, 2005).

The interrelationship between the major schools of thought and theories based on their successive development is exemplified in Figure 2.1. Each school of thoughts and the relevant learning theories that support this study is discussed.



Source: (Saettler, 1990; Lowenthal & Muth, 2008; Ormrod, 2000).

Figure 2.1: Block diagram illustrating the successive development of school of thoughts and learning theories supporting the proposed framework of study

The experiential learning theory by Kolb (1984) also provides guidance especially in developing the integration of affective-cognitive teaching and learning approach. Kolb learning theory is selected for two reasons; the proposed study is on higher education (engineering education) and it concerns with an integrated affective-cognitive learning approach. Although Kolb learning theory does not directly deal with the affective domain but the role of affects is implicitly acknowledged in the theory (Akasah & Alias, 2010) through the origin of the theory.

For instance, the derivation of Kolb's theory is based on the philosophical background of Dewey (personality psychology and affective dimensions), Piaget (knowledge of cognition) and Lewin (social influence and affective involvement on learning) (Schellhase, 2006). The choice of the Kolb learning theory is also appropriate as it provides a holistic and multilinear learning model for adult development as the emphasis is on experience hence called experiential learning theory. Kolb defines learning as "the process whereby knowledge is created through the transformation of experience" (Kolb & Kolb, 1999). Further explanation on the Kolb learning theory is given in Section 2.2.4 (i).

As the focused research variables are self-efficacy, locus of control, attitude towards engineering and behavioural engagement therefore; the respective underpinning learning theories for each of the research variables is taken. Moreover, the explanation on the selected theories is given in the particular Sections. Social-cognitive learning theory is a learning theory that has emerged from the integration of the social learning theory (from social-culturalism) and the cognitive learning theory (from cognitivism). The cognitive learning theory on the other hand is the advancement of the behaviourist learning theory. The social learning theory is later expanded into constructivism.

2.2.1 Behaviourism

Behaviourism is a first major learning theory that reviewed the overt measurable characteristics of behaviour (Mayer, 2008). Behaviorism proposes two major principles of learning namely, law of association, under the classical conditioning, pioneered by Pavlov and law of reinforcement under the operant conditioning, pioneered by skinner. Law of association explains the phenomenon that learning as a passive response (R) to stimulus (S) i.e. the behavioural response to any event determines S-R connection. Behavioural response is a reaction (R); whereas, the event is the stimulus (S) and both brings the consequences explicit. Law of reinforcement gives emphasis to the consequences of any event and outcome played a critical role in shaping the behavior of a learner (Adam, 2007).

Behavioural reinforcement determines the probability of a specific type of behaviour occurring. If the behaviour is positively reinforced then learning is strengthened in the form of the desired behaviour. On the other hand, the negative demonstrated behaviour is followed with the punishment or aversive response then the behaviour will be weakened. However, punishment also gives rise to other negative responses such as depression, aggression or withdrawal from learning. Therefore, a minimum level of punishment that leads to success is preferable (Davison, Neale, & Kring, 2008).

Skinner believes that a teacher can promote confidence and positive attitude in students through positive reinforcement during instructions. Therefore, in attempting to provide a suitable learning environment, a teacher needs to bear in mind certain considerations based on the philosophical foundation of teaching and learning theories. Naturally, capabilities of students must be evaluated to make instructions appropriate. Moreover, skinner also believes that teacher is the source that can make instructions that creates condition for positive reinforcement, creates a confident and daring attitude in students to speak (Deubel, 2003).

Although, behaviourism had directly ignored the affective dimension but the contribution to learning cannot be disregarded. Rather, it implicitly acknowledged the affective role in learning via skinner's work such as appreciation, reinforcement, immediate positive feedback and motivation which are connected attributes to affective dimension of learning (Epstein, 1997). Thus, the affective domain leads to desirable consequences in academic performance. For example in engineering education; reinforcement especially has been associated with appropriate behaviour such as pay attention, decreasing misbehaviours and bring out the desirable consequences (Felder *et al*., 2000). Besides, Hassan (2011) also states that rewards as positive reinforcement in the form of teacher's approval and appreciation can leads students towards goal accomplishment and continue efforts.

Tolman who was dissatisfied with behaviourism extended the behaviourist learning theory and proposed his expectancy theory. He included internal mental phenomenon to the exiting theory in the enlightenment of how learning occurs. According to him, learning is acquired as a result of stimulus-organism-response (S-O-R) which was an extension of the S-R connection. For example, a teacher's delivering of a lecture is a stimulus; a student's learning process or organizing the information is organism and the learning outcome is the response. The study on

latent behaviour focused the attention towards the role cognition in learning later called cognitivism (Ormrod, 2000).

(i) Educational taxonomy

Understanding of learning is not complete without a discussion on educational taxonomy. Lynch *et al*., (2009) depicts that there are many educational taxonomies that describes the same object—the human person—and the same process of human development. Taxonomy is a simple tool for classification and a productive step from simple to complex. It is to break the overall development process into smaller parts within which it is easier to discuss educational goals; to construct metrics of achievement and to evaluate individual achievement.

Thus, educational taxonomies were developed that describe learning outcomes to enable educators to deal with learning difficulties. If taxonomy is used in education setting than it means successive development of thinking pattern and learning. Taxonomy of particular domain provides best ways to deal with learning difficulties. Dealing with the learning difficulties and progressive advances in intellectual abilities there are certain criteria to handle. Furthermore, it helps in differentiating the curriculum according to student's IQ (intelligence quotient) at all levels. Teacher can use taxonomy to plan specific quality of thinking they wish to create learning environment in their students. Nevertheless the age level should be appropriate accordingly to the taxonomy (Tomei, 2001).

A group of educational psychologists headed by Benjamin Bloom in 1948 developed a classification of learning that eventually became a taxonomy which classified the level of intellectual behaviour of learning into three overlapping categories (Anderson & Krathwohl, 2001; Jones, 2007; Atherton, 2011) which could be utilised via appropriate medium namely the cognitive, affective, and psychomotor domain (as illustrated in Figure 2.2). They were created to give teachers an opportunity to sort out the data in hierarchical levels of quality (Hassan, 2011).

Bloom's taxonomy stood the test of time, the popularity and long history reinterpreted taxonomy into diverse ways. In 1990's one of the former student of Bloom raised the issue of updating the taxonomy according to the advanced era of 21st century's students and teachers. Thus, in 2002 the revised version was published with the approval of cognitive psychologists, curriculum theorist, instructional

researchers, and testing and assessment specialists. The following changes are made to the original taxonomy. Firstly, the naming of the Bloom's six categories was changed from noun to verb form. Secondly, in the lower hierarchy, knowledge was renamed as remembering whereas comprehension and synthesis in higher levels were labeled as understanding and creating. Thirdly, while the old version is one dimensional, the revised version is two-dimensional namely, with the knowledge dimension (factual, conceptual, procedural, and meta-cognitive) and cognitive process dimension (six levels of thinking) (Anderson & Krathwohl, 2001). Thus, there is no doubt about that it is unified model developed by Bloom and his colleagues.

In general, teaching and learning follows a well-structured pattern to account students affective and cognitive needs of learning. Therefore, Bloom's revised taxonomy for the cognitive domain of learning and Anderson and Kraftwohl taxonomy for the affective domain of learning are selected. Separate dimension for each of the learning domain is considered to get a fully understanding of the learning needs.

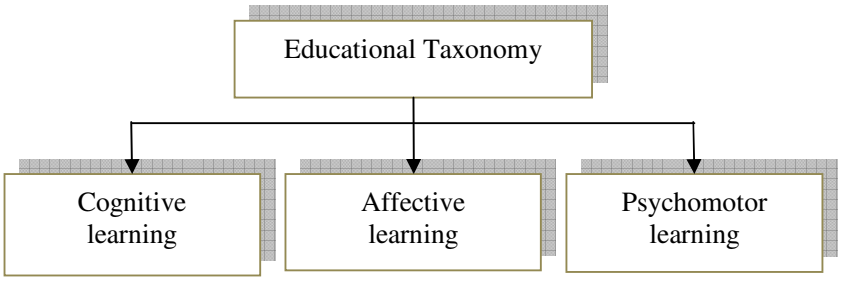


Figure 2.2: Educational taxonomy

The cognitive domain mainly deals with intellectual abilities, mental skills or knowledge acquisition. The affective domain provides insights into the emotional attachment of a learner; thus affective domain is related to growth in the feelings or otherwise attitude. The psychomotor domain is concerned with manual or physical skills (Tomei, 2001; Sadula, 2010; Chowdhury, 2004; Atherton 2011). The work on the cognitive domain was completed in 1956 and a taxonomy commonly known as "Bloom's taxonomy" was established that classifies thinking into six cognitive levels (Bloom, & Krathwohl, 1956).

a) Cognitive learning

Cognitive domain has long been recognized by educators as an important area of study on learning (Lynch *et al*., 2009). Research measures cognitive outcomes ranges from analysis of basic knowledge acquisition to evaluation, which is successive development from lower order thinking to higher order thinking (Huitt, 2009; Casale, Kuri, & Silva; 2010; Chyung *et al.,* 2010).

The hierarchy of the revised taxonomy on the cognitive domain includes remembering, understanding, applying, analyzing, evaluating, and creating respectively. Remembering, understanding, and applying are related to lower level of thinking, while the other three aspects such as analyzing, evaluating, and creating associated to higher order thinking (Huitt, 2009). Figure 2.3 shows the hierarchy of cognitive learning which includes six categories (Atherton, 2011).

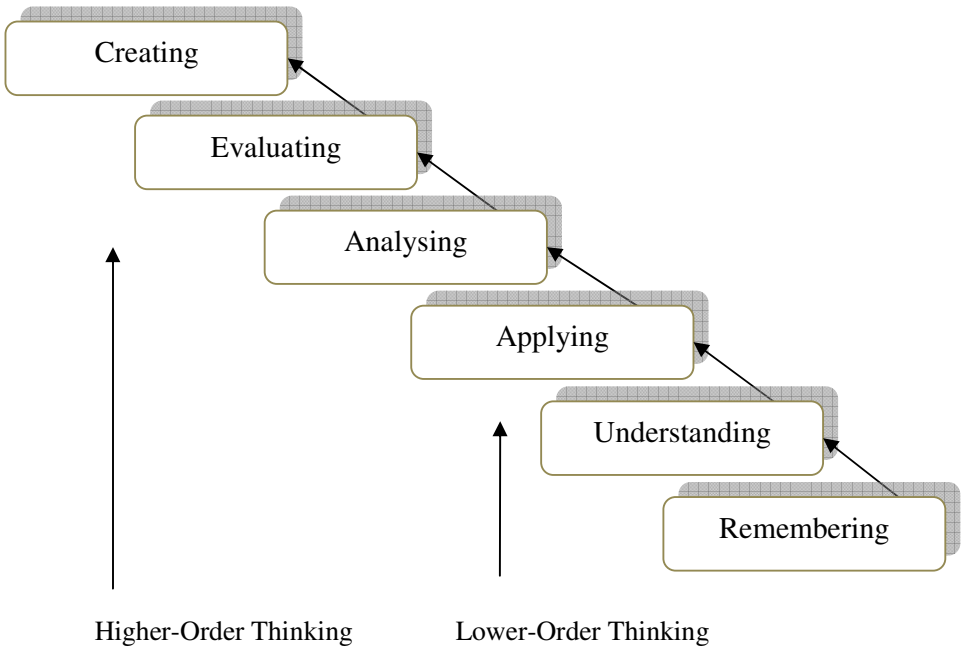


Figure 2.3: The hierarchy of revised cognitive domain (Krathwohl, 2002)

In hierarchy of cognitive learning remembering refers to the ability to remember or recall the particular information and description of basic factual knowledge. The keywords are defining, duplicating, recognizing, listing, arranging, memorizing and repeating. Understanding refers to the ability to grasp new information, manipulate a prior knowledge, and ability to explain the ideas in one's own words. The keywords are discussing, describing, paraphrasing, exemplifying, classifying, and summarizing. The last stage in lower-order thinking is applying which is related to the application of knowledge to produce results. The keywords are executing and interpretation. The application to oneself is related to lower level but when the same application is applied to community then it refers to analyzing. In a simple layman term, analysis relates to relation built-up with the society where student make comparison between different ideas. The keywords are demonstrating, differentiating, organizing, calculating, and illustrating. Evaluating is ability to organize or assemble the ideas in one. It is related to abstract hypothetical construct or deductive reasoning where student justify or made a decision. The keywords are arguing, evaluating, judging, supporting, and predicting. Creativity is the last stage which refers to student's ability to produce unique, different and master piece. Student can produce a new idea or create a product. The keywords are formulating, developing, designing, constructing, generating and creating (Apple *et al*., 2004; Casale, Kuri & Silva; 2010; Chyung *et al.,* 2010; Crippen & Ebert, 2010; Rodrigo & Mercedes, 2010; Sadula; 2010).

b) Affective learning

Affective learning is acquisition of behaviours that reflects feelings, attitudes, appreciations, values (what is being learnt) and ultimately incorporating the values of a discipline into a way of life (Boyle, 2007: Hewitt, Leise & Hall, 2011). Thus, affective domain explores the student's emotional reactions to a given subject. Affective domain is grounded in every form either through the verbal or written expression. This dimension includes emotions, values, beliefs, spirituality, and self-understanding (Paimin, Hadgraft, & Prpic, 2009). Thus, consideration of such affective aspects is important in creating an effective learning environment.

Affective domain can be explained in a layman definition as when teacher present any idea or any material to students which is usually in a polished structure. Instantly polished structure of learning may cause confusion among students in understanding the concept (the psychological state such as anxiety, and confusion are the emotional state), and after getting more knowledge on the concept helps students in gaining a deeper understanding and acquisition of knowledge will bring optimism and confidence among students so learning naturally involves success and failing phenomenon as a way of trial and error and consequences of learning often associated with affective responses (Kort & Reilly, 2002; Koballa, 2010).

Hargreaves (1998) revealed that students in higher education are treated as "emotionally anorexic" with regards to feelings (Anorexia is Latin word which means lack of desire). Emotion is usually ignored in adult learning because it is assumed that adult learning is the stage in which students are well aware of their emotional needs towards education. Moreover, learning is not just a matter of knowing a subject rather it's more on valuing the acquired knowledge. Because in high it is usually expected that students are mature enough to put their emotional attachment to learning by themselves (Omen-Smith 2008; Annesley & Putt, 2009).

"Feeling and emotional attachment" in affective domain of learning is a silent feature to study because it can create emotional scaffolding that boosts student's coping strategies in academic outcome and cognitive scaffolding is often bound to the affects (Wilson & Compbell, 2009). Affective dimension of learning covers all aspects of personality. The ways students interact in the classroom and deals with the elements of attention, emotion and valuing are reflective of the affective dimension of learning and it reveals an individual's preference in social setting. Student's way of both knowledge acquisition and knowledge integration reflect their influence of heredity as well as environment (Brown, 1998).

Anderson and Kraftwohl (2001) identify five hierarchical stages of affective domain namely receiving; responding, valuing, organisation, and characterization by value (Figure 2.4)**.**

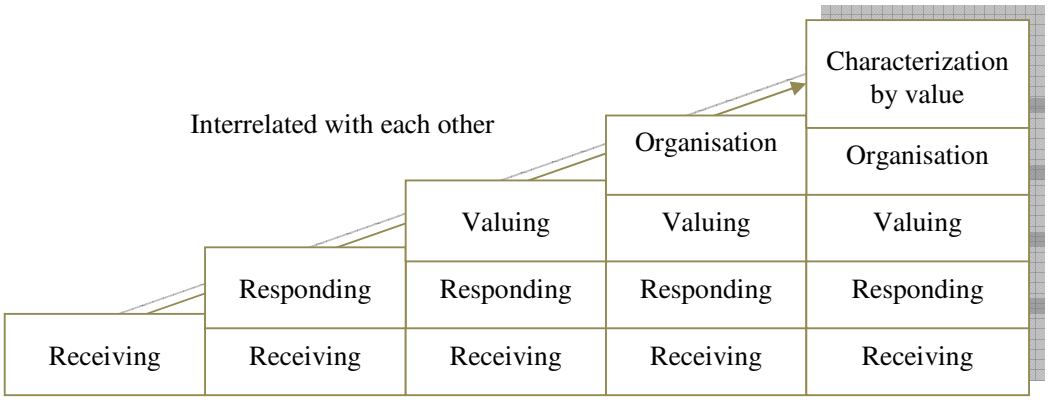


Figure 2.4: The hierarchy of affective domain by Anderson and Kraftwohl (2001)

The hierarchy of affective domain objectives by Anderson and Kraftwohl (2001) explains that each object is interrelated with each other. Receiving refers to conscious state of mind in which the learner is eager to learn, willing to hear, and receive information. After receiving the second stage is responding; responding is active participation of students and their contribution in responses and this observable behaviour indicates student's motivation in learning. Third aspect is valuing. Valuing is the ability of a learner to see worth or value in a particular object/ideas according to their way of perception. This phenomenon is ranging from simpler accepting form to complex state of commitment. Thus, valuing is the value of a person attaches to something (Jones, 2007). Organisation is the fourth stage in hierarchy. Organization refers to the ability of a learner to see contrast in different values, to resolve conflicts and discrepancies among different values or to be innovative in creating a new and unique organisation of value system. In a simple way organization is organising or values into order of priority (Krathwohl., Bloom & Masia, 1964; Aronbolin, 2006). Last element in the affective domain is characterization by value which is a coherent value system that determines the persistent, consistent, and predictable characteristics of a learner (Griffith, 2006; Annesley & Putt, 2009; Campbell, Ryan & Wilson, 2009; Huitt, 2009; Chyung *et al.,* 2010; Gordon, 2011). It determines a behaviour which is controlled by a value system (Boyle, 2007).

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