An Affective-Cognitive Teaching and Learning Framework in Engineering Education

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Abstract

The affective aspect of learning (feeling, emotion, and attitude) tends to be relatively less appreciated in engineering education compared to the cognitive aspect of learning, although numerous studies support the importance of the affective dimension in facilitating the effective cognitive processes and the internalization of cognitive knowledge. Lack of appreciation of the affective dimension often results in undervaluing the students' potential which leads to poorer realization of students' achievement. One of the factors that may contribute to this phenomenon is the lack of a teaching and learning model for supporting the utilization of the affective dimension in the teaching for cognitive learning. Therefore, this paper proposes an affective-cognitive framework based on the proposed study for teaching and learning in engineering education that integrates the affective aspects of learning into teaching and learning activities. The affective aspects namely, self-efficacy, locus of control and attitude has been identified from existing knowledge on personality traits as being important in promoting learning. It is expected that the integrated approach can be used as a guideline by engineering educators in designing effective and sustainable instructional materials that would result in effective engineers for future development.

Introduction

Engineers play a vital role in the prosperity of a nation. Therefore, providing effective engineering education is of utmost importance where the task of the engineering educators is to ensure that the expected educational goals are achieved (Malan, 2000). In other words there is an increasing concern in trying to make learning more effective for engineering students (Carberry, Lee, & Ohland, 2010). One of the important goals of engineering education is to produce graduates that have the appropriate level of engineering content knowledge and skills such as the ability to manipulate processes, solve problems and produce new knowledge (Gondim & Mutti, 2011) which are primarily the learning outcomes for the cognitive domain; one of the learning domains identified by Bloom (Anderson & Krathwohl, 2001).

In addition to the cognitive domain, engineering education is also aimed at producing engineers who are competent in the other two domains, the psychomotor domain and the affective domain (Anderson & Krathwohl, 2001). In contrast to learning in the cognitive domain, learning in the psychomotor domain would result 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 civil engineering field work.

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) that reflects an individual values, motives and interests (Atsumne & Saba, 2008) which are attributes that falls under the affective learning domain. In other words, when teaching is aimed at learning for the affective domain, a teacher would expect a change in students' emotional aspects such as empathy, care, enthusiasm and motivation (Chowdhury, 2004; Strobel *et al.,* 2011). However, in a psychological context, engineering students are often perceived as being more object-oriented than people-oriented. Thus, the affective dimensions of learning tend to be more widely incorporated in social science research than in engineering education research (Strobel *et al.,* 2011).

The affective dimension of learning is important not only because achieving a certain level of affective skills is important by itself but is sometimes critical towards acquiring the desired cognitive learning outcomes of education, engineering education included (Picard *et al*., 2004; Strobel *et al.,* 2011; Hassan, 2011). A classroom is a place where engineering students are engaged in learning as well as socialization process (Fredricks, Blumenfeld, & Paris, 2004). Thus, an engineering 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 (Ormond, 2000). 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 (Cruickshank & Fenner, 2007). Work by Schunk (1991) and Denton & McKinney (2004) propose that the affective and cognitive dimension of learning are two elements that act in "reciprocity" that is, mutually interacting determinants of the success of the each other. So important is the affective dimension of learning that an affective attribute that motivates a student to learn in the first place is also the attribute that sustain their learning efforts in the long run (Cruickshank & Fenner, 2007). Thus the affective dimension of learning could be used to support the internalization of cognitive knowledge (Akasah & Alias, 2010).

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The limited work on the contribution of the affective dimension towards cognitive learning and the lack of guidelines on its integration into classroom teaching and learning not only resulted in undervaluing students' potential but also raised the level of frustration among engineering lecturers who often find it difficult to achieve the desired cognitive learning outcomes. Thus, this paper proposes an affective-cognitive instructional framework that supports the integration of the affective aspects of learning towards greater achievement of cognitive goals in engineering education. The development of this framework is part of a larger study that looks into the effect of an integrated affective-cognitive approach on academic achievement in engineering education.

This paper is divided into four sections: Section 2 provides the theoretical perspective of the overall study as well as guidance for the development of the integrated teaching and learning framework; section 3 describes the development process of the framework and section 4 describes the conceptual framework to be followed by the conclusion.

Theoretical Perspectives

Learning theories such as behaviorism, cognitivism, and social-constructivism are propositions or explanations on how learning is acquired by a learner (Hassan, 2011). Therefore, in creating a lesson plan and 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 (Hassan, 2011). Each theory has its strengths and weaknesses and thus may not be suitable for all occasion of learning. For example, behaviorism is based on the stimulus-response model (classical conditioning) and reinforcement (operant conditioning) that attempt to study behavior in observable and measurable way (Ormond, 2000). Hence, behaviourism does not appreciate mental processes of a learner that may influence observable behavior and tried to project human beings as complex machines. Behaviorism is thus often guides training for skills development. Cognitivism on the other hand which is an extension of behaviorism acknowledges cognitive involvement in learning. Cognitive involvement was first acknowledged by Tolman in his work on latent learning and became a first step in the emergence of cognitive theory (Pervin, 2007). Cognitive theory attempts to explain mind as a reference tool and a linear functioning organism. Though, cognitive school rejected behaviorism but they make use of some of behaviorist techniques such as progressive relaxation, assertiveness skill, and journal assignment (Krista, 2008), thus the emergence of the cognitive-behavioral theory. Later on, emerges the social-cognitive theory which proposed that both behavior and environment equally contribute to learning. For example, behavior can influence environment as well as environment can influence behavior. 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 (Mayer, 2008). Thus, an effective teacher does not make use of one learning theory only but may employ different theories at various times depending on the nature of the expected learning outcome and students' attributes to make learning effective (Ormond, 2000).

As the current study is concerned with teacher-student relationship and the desired attributes that have been selected, the social-cognitive learning theory is deemed to be the most appropriate framework. In addition to this theory, the experiential learning theory by Kolb also provides guidance especially in developing the affective-cognitive teaching and learning framework.

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 deals with the affective domain but the role of affects is implicitly acknowledged in this 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 multi-linear 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 4.

Social Cognitive Learning Theory

Social-cognitive learning (SCL) theory intertwines a person's emotional capacities with cognitive capabilities in the social context (Bandura, 2005). It provides an understanding of the contribution of social and mental processes in the achievement of a learning outcome. The SCL theory explains how the social sources of information is weighed and evaluated by a person and how much these sources influence the analysis of a given task and competence in a particular scenario (Bandura, 2005).

The fundamental aspect in social circumstances which is critical in bringing the behavior explicit is known as reciprocal determinism. Reciprocal determinism was set-forth by Bandura explains the inter-relationship between personal (biological, cognitive, and affective characteristics i.e. competency, relatedness, and autonomy),

environmental (everything external to the individual i.e. event, life experiences) and behavioral factors (behavioral intensions) (Ponton *et al*., 2001) as illustrated in figure 1. Thus, based on reciprocal determinism, all three factors must be considered in order to elicit a student's learning outcomes. A change in either one of these factors will affect the other factor. For example, the personal factor such as "a person's expectation, beliefs, self-perceptions, goals and intensions give shapes and direction to behavior (Mayer, 2008). A change in a student's behavior could then affect the environment. Prolong exposure to a certain environmental factor could also affect the personal factor. For example, a student who is taking several subjects might face difficulty in one of the subjects, making him/her dislike the subject which afterwards leads to poor performance in this particular subject. In another example, unfavorable learning environment can lead to maladjustment among students which can hinder learning and can raise frustration among teachers (Ormond, 2000).

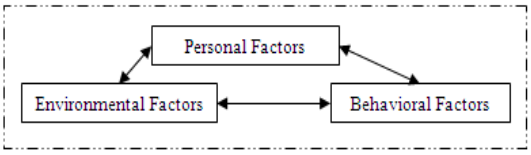

Figure 1: Triadic-Reciprocal Determinant Theory of Learning

There are a number of environmental factors within the educational context such as parents, teachers and faculty that can influence the learning outcome (Mayer, 2008). Nevertheless, the research is only focusing on the teacher-student interaction and their effect on the learning outcome and thus the teaching approach is the most important environmental factor in this particular context. A chosen teaching approach could be well received/or not by a student depending on his/her preferences (personal factor) leading to a certain type of behavioral engagement (behavioral factor) which ultimately results in achievement or under achievement of the learning objectives.

From an educational perspective, a student's engagement is composed of three components i.e. emotional, psychological or affective engagement, cognitive engagement and behavioral engagement. A student needs to be engaged in all three aspects of engagement to be fully engaged (Lee, 2008). Emotional engagement relates to emotional reactions and sense of belongingness towards the task, peer, people, and feelings of liking, disliking, interest, happiness, sadness, anxiousness and aggression. However, the measuring of emotional engagement often does not specify the source of the feelings (Fredricks, Blumenfeld, & Paris, 2004). For example, a student who is happy to attend school may be because he likes to learn or he likes to take part in extra-curricular activities. Cognitive engagement is related to thinking process which involves seeking, interpreting, analyzing, reasoning with data and making decisions (Zhu, 2006). A student's self-regulatory strategy to monitor their learning process while a lesson is progressing is an example of cognitive engagement (Chapman, 2003). Behavioral engagement refers to the active participations of student in the learning processes and can be objectively measured. Although the term behavioral engagement refers to physical engagement, it is often used by educators to refer to the affective responses of students (Wang, 2010). The affective responses could be the result of affective cues from teachers (environmental factor) and affective cues have been shown to be an influential factor towards efficient cognitive processes (Mayer, 2008). Thus, although the three educational engagements appear to be three separate components, they are actually inter-related and have been implicated in the successful outcome of a learning process.

Among the three types of educational engagements, behavioral engagement is the more easily measured and at the same time can function as indicator of the affective dimensions of learning. Thus behavioral engagement is included in this study. Two types of behavioral engagement can be observed in the classroom; positive and negative behavioral engagement (Wang, 2010). Positive behavioral engagement refers to the willingness of students to participate in class activities, such as listening and responding to a teacher's instructions, attending classes regularly, making optimum efforts in group assignments and projects, avoiding disruptive behavior and submitting required work on time. On the other hand, negative indicators of behavioral engagement are cheating on tests, frequent absence from classes, damaging school properties or having delinquent behaviors. Educators often made use of "time-base indices" which measure the time engaged in assignment completion as the operationalisation of behavioral engagement (Chapman, 2003).

Personal factor includes personality traits that are the characteristics of a person that are the result of either environmental or genetic factors. Personality traits are relatively stable attributes despite age and circumstances (Mayer, 2008). However, situational factors such as expectations, changing roles, performance outcomes, and responses from others may influence its level (Bandura, 2005). A classroom environment is such a place that offers the opportunity for students to demonstrate and strengthen their personality traits such as self-worth, skills and confidence (Brown, 1998). Personality traits have received substantial amount of attention in psychological functioning and thus worthy of inclusion in educational setting (Pervin, 2008), hence the inclusion of these traits in the current study. Three personality traits are being investigated in this study namely, locus of control, self-efficacy and attitude.

Bandura defined personality as an individual's unique, relatively consistent pattern of thoughts, feeling and affect, and behavior intentions in form of cognition and affect (Bandura, 2005). In this study, the selected psychological variables are self-efficacy, locus of control, and attitude that fits according to the given definition of personality by Bandura. For example, self-efficacy is self-belief, locus of control is thinking pattern of individuals' consideration of controlling events - either internal or external - that could affect them (Woolfolk, 2010), and attitude is affect that can be observed and measured via behavioral intension (Pervin, 2007). Hence, these selected psychological variables played a contributing role in composing a person's personality (Bandura, 2005) and are defined as personality traits in accordance with his theoretical foundation. The next section elaborates further on the three personality traits.

Self-Efficacy

Self-Efficacy refers to a person's belief that he/she is competent to handle a specific task. It is an expectation of a person that he/she can perform well in a particular situation (Alias, and Hafir, 2009). The belief that "I can do it" or "I am improving" are the motivating and triggering factors that boost the self-efficacy level and these are the factors that promotes internal motivation for students to learn (Krista, 2008).

According to the Bandura's SCL theory; four elements are important in enhancing the level of self-efficacy, namely vicarious experience, verbal persuasion, psychological state and mastery experiences. Vicarious experience is observing successful performance by others on a particular task can boost a person's self-efficacy in the same task (Modeling and observational learning). A person self-efficacy can also be influenced if they are given verbal reinforcements or verbal persuasion (Alias and Hafir, 2009). Verbal persuasions are statements that make a person realize his/her abilities and strengths. According to Ponton *et al.,* (2001), teachers can enhance students' self-efficacy by telling them that they have the potential to achieve the desirable skills and learning outcomes. Besides verbal persuasions, the psychological state of a person, (such as being emotional, sad) may also influence the self-efficacy judgment of a person and last but not least experiencing success in the past on a task can definitely increase a person's belief that he can master the same task given the opportunity, which is mastery expectation (Alias and Hafir, 2009).

To achieve optimum learning, teachers can integrate into their instructional strategies activities that improve self-efficacy by enhancing performance attainment (master experience), increasing peer interactions (vicarious experience), making students aware of their requisite capabilities (verbal persuasion), and by imparting coping strategies (teaching students that reduction in stress increases their ability). Hence in this way teachers can achieve their learning goals and make learning effective for students (Ponton *et al*., 2001; Mayer, 2008; Alias, and Hafir, 2009).

Locus of Control

Locus of control is a trait that is based on cognition, a term coined by Julian Rotter (Woolfolk, 2010). It is an individual's perceptions of the factor that control or affect their efforts which could be either internal or external factor (Hildenbrand, 2009). A person is said to possess an internal locus of control when he/she perceives that events results primarily from his/her own behavior, action, and that he/she believes that his/her efforts is the determinant of t his /her success (Krista, 2008). On the other hand, a person is said to have an external locus of control, if he/she tends to believe that behavior or action is beyond his/her control and assumes most of the time that efforts will result in failure because of the belief that event is the consequence of luck or fate (Anderson, Hattie, & Hamilton, 2005). The success of the engineering profession depends on the ability of this sector to attract and retain the young people as engineers. Understanding their personality traits is the first step towards attracting and retaining engineering students. Enhancing their personality traits by through greater awareness of their responsibilities, the worth of their profession and their potential to contribute to nation building is a way forward in producing the desired engineering attributes (Chowdhury, 2004)

Attitude

Attitudes are composed of beliefs, opinions and thoughts linked up with behavior and it influences the level of consistency (Felder, Felder, & Dietz, 2002). The benchmark concept of attitude was given by Leon Festinger in the cognitive-dissonance theory on attitude formation (Woolfolk, 2010). Attitudes can influence an individual's behavior and can modify it accordingly and an attitude can be either positive or negative (Pervin, 2007). For example, a person who is subjected to a group of people talking negatively about his/her appearance will tend to develop a negative attitude towards that group. In summary, attitude is set of beliefs, emotions and intentions towards an object, a person or an event.

Social psychologists study attitudes to measure the tendency of attitude and the strength of attitude in predicting behavior (Mayer, 2008). They believe that attitude have three components, affective, behavioral intention and cognitive component**.** Referring to the previously given example, the phenomenon covers all the components of attitude: as negative feeling reflects affects, negative thinking patterns reflect cognition and behavior symptoms like widening of eye-balls reflects behavior intention. Attitudes are systems or constructs that are composed of three interrelated qualities: affective responses, cognitions,

behavioral intentions. They vary in direction (positive or negative), degree (amount of positive or negative feeling), and intensity (the level of commitment the individual has to the position). Attitudes are not directly observable, but the actions and behaviors to which they contribute may be observed. Formation and change of attitude are separate entities. People are always in a state of modifying, manipulating, and adjusting to fit their ever-changing interests and needs (Halonen & Santrock, 1999) and an attitude toward learning is created when a student possesses curiosity, and the motivation to learn (Chowdhury, 2004).

Development of an Integrated Affective-Cognitive Teaching and Learning Framework

The affective-cognitive teaching and learning framework is developed based on considerations for the needs of the two learning domains; the cognitive domain and the affective domain. In this framework, the existing affective skills are invoked and used to support learning of the cognitive domain. Thus, the teaching goals in this case focus on cognitive learning while the teaching and learning activities emphasize equally on the needs of the affective as well as the cognitive domain. Understanding of the cognitive domain and affective domain is obtained from Bloom (Anderson & Krathwohl, 2001) respectively. Understanding of students' learning preferences and learning stages is important in order to develop appropriate teaching and learning approaches and strategies. Thus, Kolb's learning model is used to support these needs as the technical discipline involves much "experiential" learning (Kolb & Kolb, 1999). The source of knowledge that contributes to the framework is illustrated in figure 2.

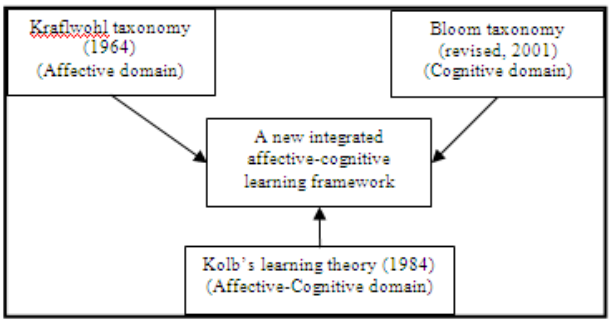

Figure 2: Components of the affective-cognitive approach

Each component that contributes to the affective-cognitive framework will be explained in the following sections beginning with Kolb's learning theory, to be followed by Krathwohl affective learning domain and finally by the Bloom's taxonomy for the cognitive domain.

Kolb' learning theory

Kolb formulated an experiential learning theory on the belief that learning results from interaction between an individual's internal characteristics and their external environments (Schellhase, 2006). For example, a learner often self-selects an educational program in which he/she is comfortable with. However, the learning environment in which the learner is associated with can reinforce, modify or alter the learner's characteristics. Therefore, the person's identity develops via the experience that they are exposed in the process of learning (Kolb & Kolb, 1999).

To fully understand the Kolb's model, we need to understand what contribute towards it. Kolb's learning model is a hybrid between the empirical work of John Dewey, Kurt Lewin, and Jean Piaget (Alseddiqi & Mishra, 2010). Dewey's scientific and practical system of education gives a useful contribution in functionalism while Lewin was the pioneer of field theory. Piaget on the other hand was the one who coined the now well-known terms, "assimilation and accommodation" which lay down the foundation of cognitive psychology.

Dewey's work emphasizes on projection which is the affective and subjective evaluation of a person to a stimulus. His cyclic arrangement of observation and knowledge served as a framework for the Kolb's learning cycle. Dewey believed that experiential learning could be used as a bridge between theoretical ideas and practical attempts. This affective and cognitive approach of experiential learning becomes the basic tenets of the Kolb's experiential learning model (Alseddiqi & Mishra, 2010).

Lewin's work focuses on group dynamics and leadership styles. His initial work was based on the principles of totality which falls under Gestalt psychology while his later work was on action research which was more associated with social psychology. Lewin's model on action research comprised four learning stages namely concrete experience, observation and reflection, abstract formation, and generation and testing the implication of new concepts. He proposes that learning occurs best when a learner resolves the conflict between his/her inner thoughts and his/her concrete experience. The explanation of learning styles put the theoretical foundation of Kolb's learning theory on learning styles (Schellhase, 2006).

Piaget who was a rationalist developed a cognitive model that explains cognitive development and sequence of relative discrete stages (Ormond, 2000). His theory on the four developmental stages includes sensori-motor, pre-operational, concrete operational and formal operational, concept of formation, schema development which put a novel contribution to Kolb learning theory (Alseddiqi & Mishra, 2010).

As a result of the integration of the various psychological perspectives, Kolb model proposes that knowledge results from a combination of grasping and transforming experience. His learning approach depicts two dialectically interrelated modes of learning based on how one acquires knowledge, and

how knowledge is transferred (Schellhase, 2006) as illustrated below in figure 3. One dimension represents the transformation of knowledge from concrete experience (feeling) to abstract conceptualization (thinking) along with vertical axis. Reflective observation (watching) and active experimentation (doing) are on the other dimension along with horizontal axis. This process of learning explains the acquisition of knowledge (Alseddiqi & Mishra, 2010).

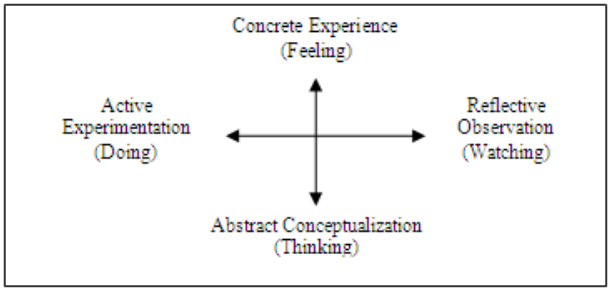

Figure 3: Kolb's modes of learning (adapted from Akasah & Alias, 2010)

The Kolb's learning cycle also defines the learning styles which are preferred by the students. It highlights the condition under which learners learn better. It is two by two matrixes of four stages learning theory as illustrated in figure 4. This learning approach includes the pedagogical activities that incorporates and allows the students to conduct both academic and practical activities (Alseddiqi & Mishra, 2010).

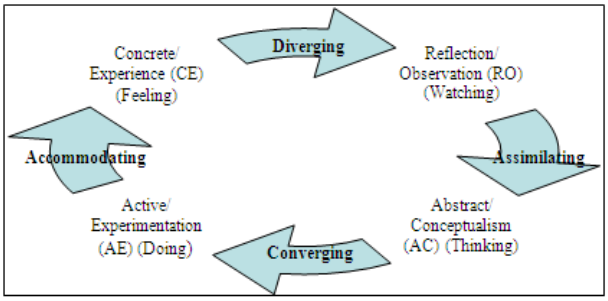

Figure 4: Kolb's learning cycle (adapted from Schellhase, 2006).

Learning style is defined by the quadrants of learning modes. Learners who adopt concrete experience plus reflective observation learning strategy are categorized as having a diverging learning style. Diverging learning style is an extensive learning style in which students learn better when the concept given to them is from diverse perspectives. Those who posses this learning style tend to have strong imaginative ability; tend to take more interest in humanities, counseling and the social sciences. They prefer to work in group, listen to others carefully, and well at idea generation and receiving personal feedback (Kolb & Kolb, 1999).

Learners who adopt reflective observation plus abstract conceptualization learning strategy are categorized as having an assimilating learning style. Assimilating is a style of learning where students learn better when materials are presented to them with sound logical theories. These students like to organize and structure the understanding of their knowledge and they tend to focus more on their skill development. Therefore, they took keen interest in research and planning. Whatever they learn; they learn it in a sequential manner to get a clear explanation.

Learners who adopt abstract conceptualization plus active experimentation learning strategy are categorized as converging. Converging is style of learning where students learn better when the data are provided in practical applicable way. They focus on the hypo-deductive reasoning on specific problem and believe in idea based on solid facts and figures. They are practical dominant people, a bit unemotional and interested in science and engineering field (Schellhase, 2006).

Learners who adopt active experimentation plus concrete experience learning strategy are categorized as accommodating. Accommodation is style of learning where students learn well when methods adopted by the mentors through "hands-on" experiences. They prefer to explore complexity by direct interaction, risk orientated, flexible, and creative. Therefore, they are interested in experimentation and practical work (Kolb & Kolb, 1999).

Understanding of learning is not complete without a discussion on educational taxonomy. Taxonomy is a classification of things into sub-groups that are different in characteristics or into sub-groups that reflects simple to complex relationships. Thus, educational taxonomies were developed that describe learning outcomes to enable educators to deal with learning difficulties (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 learning outcomes into three categories (Anderson & Krathwohl, 2001) namely the cognitive, affective, and psychomotor domain. The cognitive domain mainly deals with intellectual abilities, the affective domain provides insights into the emotional attachment of learner and the psychomotor domain is concerned with learners' physical skills (Chowdhury, 2004).

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 i.e. knowledge, comprehension, application, analysis, synthesis and evaluation (Bloom, & Krathwohl, 1956). 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 2001 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). There is no doubt that Bloom's taxonomy is a unified model developed by Bloom and his colleagues. "Bloom's taxonomy measures the cognitive levels of learner (Hassan, 2001). However, much of the existing work shows that there is no consensus on how to integrate affect into cognitive teaching and learning. Therefore, a new integrated affective-cognitive learning approach in engineering education is the step towards interrelationship to see the viability of these identified factors.

Anderson & Krathwohl's Taxonomy on Affective Learning

Affective learning is acquisition of behaviors that reflects feelings, attitudes, appreciations, and values (Paimin, Hadgraft, & Prpic, 2009). Affective domain can be expressed either through the verbal or written expression. However, Hargreaves (1998) revealed that individuals 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. "Feeling of relatedness" in the affective domain is a silent feature to study because it can create emotional scaffolding that boosts student's coping strategies for achieving the academic outcome (Wilson & Campbell, 2009). Affective dimension of learning covers all aspects of personality, with personality traits and the evolutionary process of learning. 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. They reveal 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 & Kraftwohl have identified five hierarchical stages of learning in the affective domain namely receiving, responding, valuing, organization, and characterization by value (Chowdhury, 2004; Anderson & Kraftwohl, 2001) as illustrated in figure 5. Receiving is the conscious state of mind in which the learner is eager to learn, and receive the information. Responding is active participation of students and their contribution in responses. 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 ranges from a simple accepting form to a complex state of commitment. 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 organization of value system. Characterization by value is a coherent value system that determines the persistent, consistent, and predictable characteristics of a learner.

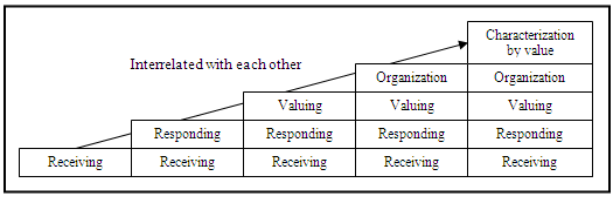

Figure 5: The hierarchy of Affective domain (Source: Anderson & Kraftwohl, 2001)

Bloom's Taxonomy on Cognitive Learning

Cognitive domain has long been recognized by educators as an important area of study on learning. Research projects that measures cognitive outcome ranges from analysis of basic knowledge acquisition which is lower order to evaluation, higher order thinking skills. 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 intellectual skills such as analyzing, evaluating, and creating are related to higher order thinking. In this hierarchy remembering refers to the ability to remember or recall the particular information while understanding refers to the ability to grasp new information, manipulate prior knowledge and making a conclusion. The last stage in lower-order thinking is applying which is related to the application of knowledge to produce results. Analyzing is the skills related to the ability to identify the separate parts of a whole while evaluating refers to the ability make judgment based on criteria whereas the last stage, creating refers to the ability to produce unique, different product or master piece (Lynch et al., 2009). The different level of Bloom's taxonomy is illustrated in figure 6.

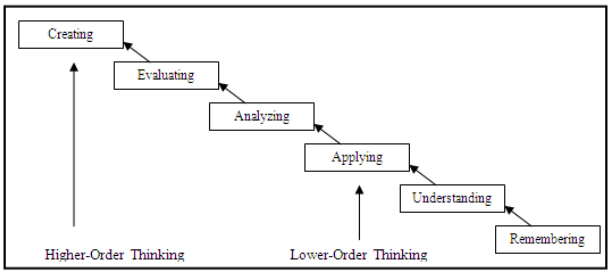

Figure 6: The hierarchy of cognitive domain by Bloom (Source: Anderson & Kraftwohl, 2001)

Proposed Affective-Cognitive Framework for Teaching and Learning

This section explains the development of the proposed framework for teaching and learning. It will focus on the student's cognitive learning with the support of affective learning. The teaching sequence in the proposed framework is based on knowledge gained from the Kolb's learning model, teaching and learning for the cognitive domain (Bloom's taxonomy) and teaching and learning for the affective domain (Krathwohl's taxonomy). Considerations of the personality traits namely, self-efficacy, locus of control, and attitude will be embedded with the teaching and learning activities. The hypothesis that these personality traits will influence learning outcome is gained from the literature (Huang, 2003; Krista, 2008; Hildenbrand, 2009). The proposed teaching and learning framework is designed to achieve the following objectives:

(i) To enhance the level of self-efficacy
(ii) To evoke positive attitude towards the subjects,
(iii) To enhance cognitive development through considerations of self-efficacy, locus of control attitude and behavioral engagement.

Taking the above-mentioned objectives into consideration, the teaching and learning framework is proposed as illustrated in figure 7. This framework consists of two parallel components, one component displaying the teaching phase and strategies while the other component displaying the learning phase and strategies. The teaching component proposes strategies to be undertaken by a teacher where teaching activities will be designed in such a way that the expected learning goals can be achieved through the integration of affective and cognitive learning needs. On the other hand the learning component refers to the stages that a student goes through in their learning process. The learning phases takes into considerations the needs for progressive development in intellectual skills as well as their related challenges.

The needs of the three personality traits (self-efficacy, attitude, locus of control) are considered in developing the proposed framework. The teaching and learning activities are designed to develop these traits sequentially in three stages based on knowledge gained from the literature on teaching and learning. The first stage of teaching focuses on the development of self-efficacy by showing students a motivational video to provide vicarious experience as one of the factors that enhances self-efficacy is vicarious experience (Bandura, 2005). Vicarious experience can be provided via modeling and observation. Related suitable motivational videos can be used to boost the level of self-efficacy (Mayer, 2008). Watching the video can strengthen students' self-beliefs in their capabilities (Akasah & Alias, 2010) and by developing a non-threatening learning environment (eliminating the fear of failing, appreciating and reinforcing their achievements, greeting students with enthusiasm, developing rapport with each other, and helping students coping strategies to manage anxiety and improve their performance) (Pervin, 2007; Ormond, 2000).

The second stage of the teaching activity is designed to develop/invoke positive attitude towards the learning of the materials at hand among students. Positive attitude can be invoked by using activity that involves such as filling in missing information and monitoring one's thoughts as feeling are connected with thoughts (Ormond, 2000). The third stage of teaching

focused on dealing with locus of control. Activities will be designed to promote internal locus of control as having internal locus of control is related to better persistence in learning efforts.

Affects are being emphasized for the purpose of incorporating the needs for learning in the cognitive domain. Therefore, in the process the material for the cognitive domain will be explored so that the development of intellectual skills enhanced through appropriate consideration of the learning taxonomy (Akasah & Alias, 2010). Learning taxonomies are used to provide the guidance for classification of learning objectives (Hassan, 2011).

The affective-cognitive learning framework comprises several hierarchical levels of teaching and learning skills and activities ranging from simple to complex. The different affective skills and cognitive skills are illustrated as inter-related components of the teaching and learning process. When a student is exposed to a new knowledge, information is presented to student from lower level of remembering and understanding (such as knowing what it is) so that a student gets engaged or at least start to engage with the learning materials. This phase is supported by the receiving, responding and valuing (an indication that student pay attention to gain knowledge) which is the assimilating stage of Kolb's theory. This scenario helps in developing students' self-efficacy. Furthermore, student can be given an activity through which his/her self-efficacy can be improved. Motivational statement such as "I can do it, I am confident that I will be successful, and I will continue to learn it" will help in boosting the level of self-efficacy (Bandura, 2005). Moreover, free style learning such as any assigned activity by teacher can engage the student at initial stage on which student's performance can be evaluated. This is the way

through which students will be given the awareness of their potentials and abilities.

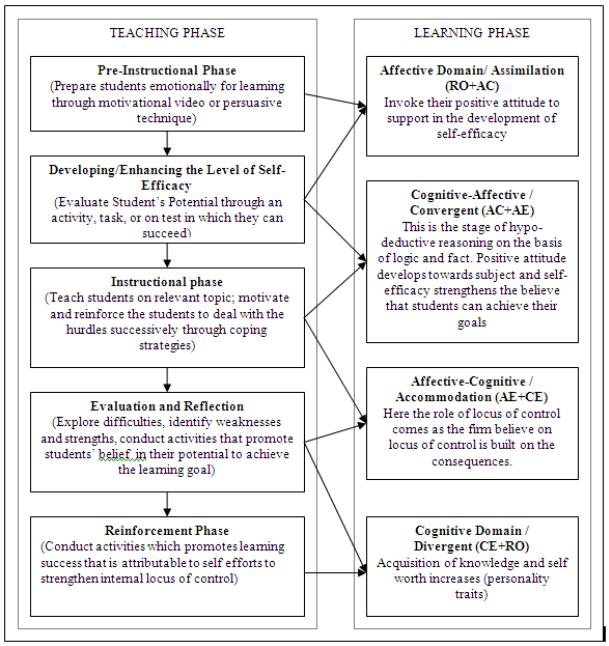

Figure 7: Progressive Method of Dealing with Learning Incorporating Affective Dimensions

Legend:
RO + AC: reflective observation plus abstract conceptualization.
AC+AE: abstract conceptualization plus active experimentation.
AE+CE: active experimentation plus concrete experience.
CE+RO: concrete experience plus reflective observation

At this stage, persuasive communicative skills can be utilized as a strategy to develop positive attitude towards the subject among novices. This persuasive technique raises the level of affective and cognitive learning. Valuing and organization that are acquired in the affective domain goes hand in hand with applying and analyzing of the cognitive domain (Chyung et al., 2010). The students' personal experience in learning helps them in developing positive attitude towards the subject. Consequently, both nourished factors (high self-efficacy and positive attitude) leads towards the identification of significant role of internal locus of control in academic success and personality development (Hildenbrand, 2009).

The framework proposed here provides an engineering lecturer with the guidance to develop unique instructional materials that can attract students' interest which should promote future learning. Chyung *et al.,* (2010) revealed that about forty-one percent of students indicated that motivation learning method is suitable for complex subjects. Thus, subsequent learning task is designed in such a way to develop progressively from less to more complex to ensure that the cognitive goals of learning are achieved as expected (see appendix a).

Conceptual Framework for the Study

Based on the discussions on the social cognitive learning theory and its related concepts, the conceptual framework for this study is developed which shows the relationship between the various psychological variables as illustrated in figure 8. The framework has considered the three potential variables namely independent, mediating and dependent variable that can be measured using the appropriate tools. Independent variables are personal factor (personality styles and personality traits), and environmental factor is teaching and learning method (affective-cognitive learning approach and Kolb learning theory), mediating variables (behavioral factor) and dependent variable is learning outcome (academic achievement) respectively.

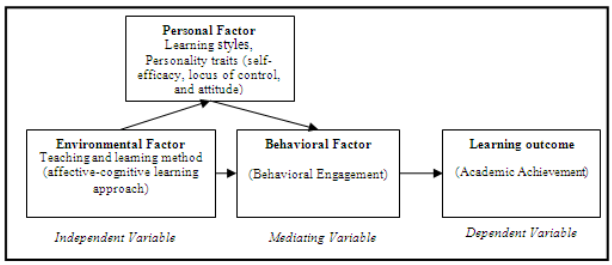

Figure 8: Conceptual framework for the study

The teaching method (environmental factor) is the independent variable, the personality traits (personal factor) is the moderating variable and the behavioral engagement (behavioral factor) is the mediating variable that leads to the explicit outcomes in the form of student's academic achievement (dependent variable).

Conclusion

Existing knowledge on learning indicates that effective teaching and learning for the cognitive domain can only be realized through the integration of the personal and affective needs of a learner. Prevalent practices in engineering education however do not often consider these needs. The lack of considerations is partly due to the difficulty in integrating affects into teaching and learning as well as the lack of pedagogical expertise among engineering educators who are in general not trained in pedagogy. An integrated affective-cognitive teaching framework is proposed in this paper (based on a proposed study) to provide guidance for engineering educators in designing effective teaching and learning environments. This framework takes into considerations the intellectual demand and psychological demands of learning based on knowledge gained from the social cognitive learning theory and Kolb's learning theory. Kolb learning theory highlights the conditions under which the students learn better. While the social-cognitive theory informs on how social sources of information

influences the analysis of task and personal competence. It is expected that the integrated approach can be used as a guideline by engineering educators in designing effective and sustainable instructional material that would result in the effective engineers for future development.

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Appendix
Lesson Plan

Time: 50 minutes
No. of students: 35
Programme Level: Diploma
Programme Year: Second Year
Course: DAC 20703 Mechanics of Materials
Topic: Chapter 3: Normal stress in beam due to bending moment.
General objective: To enable students to understand the general procedure of beam design subjected to bending load.

Specific objectives: By the end of the lesson, students will be able to:

1. Calculate the magnitude of normal stress developed along beam cross section using moment-stress equation
2. Compare the calculated versus allowable stress and ascertain the limit of safety.
3. Design a beam size and geometry for any combination of material and loading.
4. Demonstrate various generic skills particularly (but not limited to) critical thinking and problem solving skill.

Prior Skills involved:
1. Able to draw shear and moment diagram along any beam length. (Ch.2)
2. Understand design safety factor concept and materials failure characteristics. (Ch.1)
3. Able to calculate magnitude of stress for any given strain i.e., understand relationship between stress/strain relationship (Ch.1)

Teaching Aids:
1. Chalk and board.
2. PowerPoint slide and short video
3. Polystyrene bar to give visual illustration of shortening and elongation of different part of a beam length or cross section.

TEACHING PHASE	CONTENT	PROCEDURES AND RATIONALE	LEARNING PHASE (KOLB CYCLE)
PHASE 1 Pre-Instructional phase 5 minutes	**Teaching &Learning (T&L) method:** Whole-class discussion **Teaching Aids:** PowerPoint slides **Objectives:** To stimulate students' affective attributes toward subject matter	1. Display PowerPoint slides showing building/construction disaster caused specifically by beam failures. 2. Show statistics on death and injuries caused by such disasters 3. Explain the responsibilities of an engineer as a person who designs such structures, their legal liability and moral responsibility.	**Affective domain/ Assimilation (RO+AC)** Invoke their feelings on their profession and promote positive attitude towards the engineering profession that support community infrastructure needs, and promote belief that

TEACHING PHASE	CONTENT	PROCEDURES AND RATIONALE	LEARNING PHASE (KOLB CYCLE)
	which will trigger students' interest to learn.	*Rationale* - To induce the sense of "**fear"** of causing death, injury and material damage. - To induce the sense **shame** of being prosecuted. - Fear and shame are selected as negative reinforcement and preventative measure to stimulate students' sense of responsibility to learn and master the topic materials - Negative reinforcements are chosen over positive reinforcements because of local culture and in upbringing that often gives more emphasis on punishment rather than reward. Thus fear is more prevalence in promoting positive actions rather than reward. - Meanwhile, this exercise goes well toward achieving PLO 8 which is: *"Melaksanakan tanggungjawab secara beretika terhadap tugas, masyarakat dan negara demi kemakmuran sejagat. (A2, C3)"* **Note:** A2:Affective domain at the Responding level C3:Cognitive domain at the Application level	they can make a change to the world through their efforts - promotes the development of self-efficacy
PHASE 2 Developing/ Enhancing level of self efficacy 10 minutes	**T&L method:** - Whole-class discussion. - 3 students act as demonstrator. **Teaching Aids:** - PowerPoint slides - Polystyrene beam model - Markers and white board. **Knowledge content:** "Shape of bending beam, contraction, elongation and neutral axis" **Objectives:** - To introduce subject matter through	1. Demonstrate the effect of bending on a beam with rectangular cross section using a polystyrene beam model. Questions : - Which side will elongate? - Which side will contract? - Any part that does not change? - Any relationship with shape of moment diagram? **Note:** Simple and objective questions that students can answer based on prior knowledge, visual and tactile experiences, and logic or rational thinking. 2. Show PPT slide on the overview of lesson. 3. Show PPT slide on development of strains on beam extreme	**Cognitive-affective/ convergent (AC+AE)** This is the stage of hypo-deductive reasoning on the basis of logic and fact. Positive attitude develops towards subject and self-efficacy strengthens the believe that students can achieve their goals.

TEACHING PHASE	CONTENT	PROCEDURES AND RATIONALE	LEARNING PHASE (KOLB CYCLE)
	simple visual and tactile experience. - To develop students' confidence in mastering subject matter.	fiber *Simple Questions*: - Elongation and contraction is a sign of … (strain) - Presence of strain will always accompanied by … (stress) *Challenging questions*:- - Guess which part will develop the highest stress level? (edge) - What happen if stress exceeds the permitted limit? (beam fail, crack, crush) - What is the allowable maximum stress? - How can we measure the stress? *Rationale* - By introducing subject matter through simple and easy to understand method, student will not feel intimidated. - Furthermore, the presence of positive reinforcement (when they answer questions correctly from what they can easily visualize), sense of confidence and deeper interest will be developed further.	
PHASE 3 Instructional Phase (1) 10 minutes	**T&L method:** Whole-class discussion **Teaching Aids:** PowerPoint slide **Knowledge Content:** "Nomenclature Of Beam In Bending : Stress, strain, Hooke Law, neutral axis, moment of inertia, extreme fiber and y distance"	1. Introduce terms and symbols related to subject matter. 2. Ask the meaning of each symbol related to lesson in previous chapter. 3. Guide students to mentally visualize the mechanic of each symbol in the context of current lesson. *Rationale:* - By recalling their prior knowledge, students will be able to visualize the similarity of mechanical function of each terms or symbols in new contextual situation. - Students should feel comfortable dealing with subject that they already know.	**Cognitive-Affective / Convergent (AC+AE)** This is the stage of hypo-deductive reasoning on the basis of logic and fact. Positive attitude develops towards subject and self-efficacy strengthens the believe that students can achieve their goals

TEACHING PHASE	CONTENT	PROCEDURES AND RATIONALE	LEARNING PHASE (KOLB CYCLE)
Instructional Phase (2) 10 minutes	**T&L method:** Whole-class discussion **Teaching Aids:** Talk and chalk **Knowledge Content:** "Derivation of beam stress formula and application: How the formula come into being"	1. Simple derivation: just to let students know the relationship between each used term (symbols) 2. Show one simple example how to apply the derived formula	
PHASE 4 Evaluation and Reflection 10 minutes Explore difficulties, identify weaknesses and strengths, conduct activities that promote students' belief in their potential to achieve the learning goal	**T&L method:** Whole-class discussion **Teaching Aids:** Markers and white board	Questions: - What is the relationship between stress and moment? - What is the relationship between stress and moment of inertia? - What is the relationship between stress and distance from neutral axis? *Rationale* - By this stage, students should be in a ready state to accommodate cognitive input and therefore, will be able to master the detail of the lesson - Teacher should access students' response to the above questions and adjust accordingly the delivery of the following stage of materials (5)	**Affective-Cognitive / Accommodation (AE+CE)** Internal locus of control increases Acquisition of knowledge and self worth increases
PHASE 5 Reinforcement phase 5 minutes Conduct activities which promotes learning success that is attributable to self efforts to strengthen internal locus of control	**Closure**	1. Teacher goes through the day's lesson by asking students structured and leading questions leading to the application of beam stress equation.	**Cognitive Domain /Divergent (CE+RO)** Knowledge is acquired; belief that a learning target is achievable increases (self-efficacy); belief in self role in success and failure increases (internal locus of control) and perceive subject as useful, interesting and should be studied increases (positive attitude towards subject matter).