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The Paradigm of Constructivism

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Abstract: This concept study attempts to justify the theoretical framework and pedagogical issues addressed in most writings and discussion about learning and to some extent teaching theories. In so doing, the discussion and analysis of this study derives from secondary data gathered through extensive literature review. The first half of this study analyses the history and evolution of constructivism. The second half, then proceeds to examine one application of constructivism in the educational context, namely; student-centred learning. Various theories of learning have been considered but constructivism is argued to provide strong theoretical, as well as pedagogical links to learning through technology, such as e-Learning and simulation. At the same time, as the empirical part of future research of this study discusses tertiary military students and their learning and training needs, constructivism offers learning and training criteria that appear to be particularly relevant to a military setting. This is because all criteria critical for building the guardians of a nation, such as active learning, higher levels of discipline and responsibility, collaboration and critical thinking derive from constructivism.

Key words: Bloom's taxonomy, constructivism, e-Learning, Kolb's cognitive constructive learning, simulation, student-centred learning

INTRODUCTION

This study acts as a concept study to critically explore the needs to understand one key learning theory which is constructivism. The main argument of this study is that while educators try to incorporate constructivism in the classroom teaching and learning, many are still perplexed of how constructivism assists in student-centred learning. For one, Malaysian tertiary education is now adopting Bloom's Taxonomy using outcome-based education and student-centred learning as the instruments. New and perhaps senior educators may feel handicapped when they lack understanding of constructivism. Hence, this concept study relies on extensive literature analysis and it is divided into four sections including this introduction to facilitate discussion.

CONSTRUCTIVISM: A HISTORICAL CRITIQUE

The basic principle of constructivism was that students learnt by interacting with learning materials rather than just observing them. At the same time, students bring prior knowledge to a learning situation in which they must critically assess and re-evaluate their understanding of new information. The concept of constructivism had its roots in classical antiquity going back to Socrates dialogues with his followers in which he asked directed questions that led his students to realise for themselves the weaknesses in their thinking. The Socratic dialogues are still an important tool in the way constructivist educators assess their students' learning and plan new learning experiences.

The constructivist approach to teaching and learning was based on a combination of a subset of research within cognitive psychology and a subset of research within social psychology. The basic premise was that an individual student must actively build or construct knowledge and skills and that information existed within these built constructs rather than in the external environment. e-Learning and simulations have always been associated with constructivism. This relationship was perhaps due to the fact that technology provided students with almost unlimited access to information that they needed in order to do research and test their ideas (Becket, 2000). Technology also facilitated communication as it allowed students to present their views and products to broader audiences and also exposed them to the opinions of a more diverse group of people in the real world beyond the classroom, school and local community all these conditions were optimal for constructivist learning. A principle in constructivism was to provide a context for the student in order to teach him or her concepts of wholes. The context should place the student in a situation similar to the one in which he or she was going to apply the knowledge where understanding was much more important than memorising facts.

John Dewey was often cited as the philosophical founder of and the greatest influence on constructivism (Lefoe, 1998). It was Dewey who placed the elements of constructivism in their rightful place in education as he argued against the earlier educational framework of memorisation and recitation. Dewey (1933) saw the human mind as an active processor that could work hard to make sense of the world an idea that predated today's notions of constructivism and active learning. Dewey (1938) then developed theories of childhood development and education which were labelled progressive education. Progressive education led to the evolution of constructivism. Before further discussion on constructivism, it is crucial to focus on what Dewey proposed for a reformed educational system. According to Dewey, there were four key educational issues. These continue to provide the basis of critiques of and discussion about contemporary education.

The first key issue proposed by Dewey was the value of students' experiences. He called for education to be grounded in real experience when he stated:

> If one has doubts about how learning happens, engage in sustained inquiry: Study, ponder, consider alternative possibilities and arrive at one's belief grounded in evidence.

Inquiry became a key part of constructivist learning. Dewey believed that the way learning occurred inside the formal educational setting should not be isolated from learning achieved elsewhere. He advocated a continuity of the process of learning between settings and viewed each student's greatest asset as being his/her direct, personal experience that must not be ignored or thrown away in the process of learning. Dewey further proposed the principle of learning through personal experience that rested on two factors internal and external experiences. He made it very clear that while learning came about through experience not all experiences were genuinely or equally educative. Those he considered truly educative were experiences that promoted the continued growth and development of the individual and provided momentum for future learning opportunities. Thus, the instructor's roles were two fold: To evaluate whether the direction of a student's experience was conducive to continued growth (continuity) and to determine the kinds of situations which were suitable to promote continued growth (interaction). All in all for Dewey, education was a re-construction of experience that continuously unfolded students' potential.

Dewey's second key educational issue was that learning should be by doing. This meant giving more independence and active roles to students in their learning. Students were to describe the construction of their own learning by using their previous knowledge or experience. In other words, the role of active engagement was being advocated. Most scholars in the 1920-1960s thought that education had not changed, even though there was a need for it. There were calls for a connective curriculum by which was meant the engagement of the learning process with the students' past experience, present needs and future intentions; an education that required the commitment and involvement of students. This was because teacher-centred models still dominated learning, even a century after the first proposal (in the early 1910s) for student-centred education. Dewey further noted that traditional schools kept insisting on telling students what they needed to learn, despite research clearly demonstrating that learning by telling did not work and learning by doing did. Following Dewey, education should be democratic, a social function it should be experiential, in the sense of engaging the interests of the students and it should be reflective in encouraging students not just to gather facts but to make connections and to critique knowledge. Thus, Dewey believed in the engagement of students in the learning process through doing and not just listening.

The third key educational issue promoted by Dewey was purposeful learning. For what purpose was the content to be learnt? Dewey forcefully stressed the need for activities to be linked cumulatively, defining educative experiences as those that gave rise to the students' need to gather more facts, become more skilled and use lessons learnt in one experience as the basis for future experiences. He termed this a continuous spiral. Also, Dewey proposed that when students had a clear and strong purpose for learning, they became more committed and able to participate actively in the learning sessions. However, the purpose of learning did not lie only in the future; skills, knowledge and experience must have meaning in the present too. Dewey believed skills must be useful in the here and now and make an individual more capable of self-support and self-respecting independence. Therefore, learning must be meaningful for students in the sense that they understood why they were learning something.

The fourth key educational issue stressed by Dewey was the importance of critical thinking in the education system. Dewey proposed that in order for learning to be truly effective, it must inculcate reflective thought or what was referred to in contemporary education today as critical thinking. He defined reflective thought as an active and persistent process that was able to support individual's opinions. As this was an individual process, each student would construct his/her own opinions and

critically reflect on those opinions. Furthermore, Dewey elaborated that there were two important elements of reflective thinking. The first element was, a state of perplexity, hesitation and doubt and the second element was, an act of search or investigation directed towards bringing to light further facts which serve to corroborate or to nullify the suggested belief. By these two elements, Dewey suggested that in order to be a reflective or critical thinker, students should have doubts or question ideas that they just encountered. They must not believe or merely accept the ideas without trying to challenge their validity. The next step was to analyse the ideas and try to find support to accept or reject them. Thus for Dewey, critical thinking or reflective thought helped students to construct and build new knowledge, making them aware that they must be active in questioning and challenging new information.

Dewey and his philosophical and educational ideas have been criticised by many scholars. On the educational front, LaHaye (1980) and Robertson (1990) laid much of the blame for undisciplined, child-centred freedom and present social ills at the feet of Dewey. These critics made it clear that if Dewey had not introduced progressive education, students would not be tempted to think freely and so treat the opinions of their elders with disrespect. Other critics of Dewey could be grouped into three. Firstly, Dewey had not done empirical research to support his ideas and theories. He has been attacked for this. As a philosopher, many of his writings were based on personal encounters, observations and experiences (Garforth, 1966). This gave the appearance of exaggeration to his writings because the empirical foundations for his ideas were more limited than his passion. Secondly, the ambiguity of Dewey's writing style led scholars, such as LaHaye (1980), Robertson (1990) and Colson (1999) to criticise him. Dewey risked misinterpretation by leaving to others the task of explicating the practical consequences of his ideas. Finally, Dewey himself would be the first to admit that his views were tentative and subject to modification (Garforth, 1966). In addition, Dewey himself agreed that some educators were drawn to progressive education because they thought it would be easier and less disciplined than traditional methods (Mooney, 2000). Despite his critics, Dewey's interpretations of learning have proven to be useful in the modern world of education. It is in the 21st century that scholars, such as Hickman (1990) and Phillips (2002) have realised that what Dewey stated as the critical issues in education are indeed valid. This is because when Dewey began his philosophising on education many misunderstood his ideas of progressive and reflective education. Some even understood Dewey's ideas as only having relevance to children and their education. Nonetheless today, it has become increasingly obvious that Dewey's writings were not limited to children's education only.

Today's strongest supporters of Dewey come in the form of a research centre dedicated to Dewey's ideas and theories, namely; the centre for Dewey studies based in Southern Illinois University Carbondale. Led by an internationally-known expert on Dewey, Professor Larry Hickman, this institution organises debates, seminars and intellectual discourse to explore and debate Dewey's ideas. Prof. Hickman also shares Dewey's vision with passion. When Dewey began to write about education, no one realised that part of his argument raised the question of how technology and education could go hand in hand. In today's contemporary education, Hickman as one of the supporters of Dewey has highlighted this symbiotic relationship. In two of his books on Dewey and technology, Hickman has shown that Dewey had a well-developed philosophy not only of education but also technology. This aspect of Dewey had been overlooked in part because his writings on technology were scattered throughout his major and minor works. According to Hickman, Dewey was interested in technology as a tool that could help humans advance naturally. Dewey believed technology was necessary for the advancement of both education and democracy. Moreover, education itself had to be democratised and to make that possible, technology was needed. By the democratisation of education Dewey meant access to education for all. In this way, Dewey recognised that it was through technology that those who did not have the time for fixed classes and learning places could use technology to facilitate their learning processes.

Another supporter of Dewey was Phillips (2002). According to Phillips, Dewey himself condemned a misguided student-centred education that left teachers, discipline and subject matter out of the educational picture. Referring critics to the child and curriculum, Phillips stressed how Dewey cautioned against methods and practices that asserted childhood interests over and above adult life. In addition, Phillips also pointed out to critics how in democracy and education, Dewey had clearly stated that discipline and student interest in learning could be complementary:

> Discipline is positive. To cow the spirit, to subdue inclination, to compel obedience, to mortify the flesh, to make a subordinate perform an uncongenial task these things are or are not disciplinary, according as they do or do not tend to the development of power to recognise what one is about and to persistence in accomplishment looks odd.

As such, though Dewey promoted freedom in thinking and re-evaluating new knowledge, students'

interests and discipline were linked tightly as discipline could be used to help students avoid making false judgements and evaluations. Thus, the task of educators was to guide students in finding the right way in their life and not to let students fend for themselves.

In essence, Dewey's discussion about the nature of learning led to the theory of constructivism. Over time, constructivism has evolved into many branches, responding to diverse fields of studies. There developed at least two important variations of constructivism-cognitive constructivism and social constructivism. Piaget (1972a, b) and Bruner (1990) were considered the chief theorists among cognitive constructivists while Vygotsky (1978) was the major theorist of the social constructivists.

Piaget's interest in cognitive development came from his training in the natural sciences and his interest in epistemology. Piaget was very interested in knowledge and how children came to know their world. In short, Piaget concluded that intellectual development was the result of the interaction of hereditary and environmental factors. As the child developed and constantly interacted with the world around him/her knowledge was invented and re-invented. Piaget (1972a) was best known for developing the theory of the four stages of intellectual development. He discovered that children thought and reasoned differently at different periods in their lives. He believed that everyone passed through a fixed sequence of four qualitatively distinct stages. Although, every normal child passed through stages in exactly the same order, there was some variability in the ages at which children attained each stage. Generally, the evolution of intellectual development was divided into four phases including sensorimotor, preoperational, operational and formal operational. Piaget's ideas are complicated yet comprehensive, especially his first two phases which traced a child's development by months and years.

A central component of Piaget's developmental theory of learning and thinking was that it involved the participation of the student. Knowledge was not merely transmitted verbally but must be constructed and re-constructed by the student. In this way, Piaget elaborated on Dewey. Piaget asserted that for a child to know and construct knowledge of the world the child must act on objects and it was this action that provided knowledge of those objects; the mind organised reality and acted upon it. Piaget's approach to learning was a readiness approach. Readiness approaches in developmental psychology emphasised that children could not learn something until maturation gave them certain pre-requisites. The ability to learn any cognitive content was always related to their stage of intellectual development. Children who were at a given stage could not be taught the concepts of a higher stage. In addition, according to Piaget, intellectual growth involved three fundamental processes assimilation (applying old knowledge to new), accommodation (changing old knowledge to ensure it worked better) and equilibration (the balance between assimilation and accommodation). For Piaget, equilibration was the major factor in explaining why some students advanced more quickly in the development of logical intelligence than did others. The role of educators was that they must be able to assess students' present cognitive level their strengths and weaknesses. Instruction should be individualised as much as possible and students should have opportunities to communicate with one another, such as to argue and debate issues. Educators were the facilitators of knowledge they were to guide and stimulate students. In actual fact, learning was much more meaningful if students were allowed to experiment on their own rather than listening to the teacher. In one of his books, Piaget (1972b) stated the basic principle of active methods thus:

> To understand is to discover or re-construct by re-discovery and such conditions must be complied with if in the future individuals are to be formed who are capable of production and creativity and not simple repetition.

Therefore, Piaget's contribution to cognitive constructivism was in giving educators an understanding of how students developed their cognitive skills through his conceptualisation of the four stages of intellectual development and its fundamental processes. It was as if Dewey's individual learning process had now been de-constructed into four distinctive phases, all of them demonstrating the interaction between learning, thought and experience.

The second leader in cognitive constructivism was Bruner. Bruner was actually one of the early critics of some of the ideas proposed by Piaget in the english-speaking world (Sutherland, 1992). His criticisms were based on his claim that Piaget had failed to take into account students' previous learning experiences and the role of insightful teaching the intervention of teachers in the process of students' learning. Consequently, a major theme in the theoretical framework of Bruner was that learning was an active process by which students constructed new ideas or concepts based on their current and past experiences. Students selected and transformed information, constructed hypotheses and made decisions while relying on a cognitive structure to do so. Cognitive structure, such as schema and mental models, provided

meaning and organisation for experiences and allowed the individual to go beyond the information given. As far as intervention by teachers (through instruction) was concerned, the teacher should try and encourage an active dialogue, such as socratic learning. The main task of the teacher was to present information to be learnt to match the students' current state of understanding. The curriculum should be organised in a spiral manner so that the student continually built upon what they had already learnt. Bruner stated that a theory of instruction should address four major factors:

- Students' predisposition towards learning
- The ways in which a body of knowledge could be structured so that it could be most readily grasped by the students
- The most effective sequences in which to present materials
- The nature and pacing of rewards and punishments

These factors required that teachers be aware of students' levels of understanding and readiness in learning new knowledge. In this way, students would grasp the new experience more readily. Alongside these four major factors, there were three important principles stressed by Bruner on the subject of cognitive constructivism. The first principle was that instruction must be concerned with the experiences and contexts that made the students willing and able to learn (readiness). The second principle was that instruction must be structured so that it could be easily grasped by the students (spiral organisation). The last principle was that instruction should be designed to facilitate extrapolation and/or fill in the gaps (going beyond the information given). All in all, Bruner stressed that the active participation of students through their own experiences helped them to develop their own learning processes. Again, it can be seen how Bruner refined the interaction between learning and experience, first identified by Dewey as the critical foundation for new learning.

The leader of social constructivism, Vygotsky, became the first and main critic of Piaget and his followers. For him, cognitive constructivism lacked social, as well as cultural ambience in the learning process. Vygotsky's major theoretical framework was that firstly, social interaction played a fundamental role in the development of cognition. He stated that every function in a child's cultural development appeared twice first, on the social level and later, on the individual level. This meant that firstly, a child was exposed to his surrounding by his/her social contact with people (inter-psychological) and then secondly, a child would have inner interaction with him/herself (intra-psychological). Vygotsky's second theoretical framework was the idea that the potential of cognitive development was limited to a certain time span that he called the Zone of Proximal Development (ZPD). This meant that every child had the possibility of going beyond his/her present level of learning if prompted and guided appropriately by the teacher. Full development during ZPD depended upon full social interaction, the range of skills that could be developed with adult guidance or peer collaboration exceeded what could be attained alone.

Because Vygotsky's focus was on cognitive development, it is instructive to compare the differences and similarities between his views and those of Bruner and Piaget. Vygotsky's theory was an attempt to explain consciousness as the end product of socialisation. For example in language learning, a child's first utterances with peers or adults were for the purpose of communication but once mastered, the utterances became internalised and allowed inner speech. Following this, two important principles of Vygotsky's social constructivism were firstly, cognitive development was limited to a certain range at any given age and secondly, by taking Piaget and Bruner's idea further full cognitive development required social interaction. Vygotsky's theory and principles became the key component of situated learning theory and anchored instruction.

Vygotsky believed that students could achieve more in learning with the assistance of teachers or more able peers. He termed this assistance scaffolding. In order for teachers or more able peers to scaffold, they needed to be very keen observers of the students. Using the information from these observations, teachers and peers would be able to estimate the level of assistance needed by the students. This was similar to Dewey's belief that teachers should use their greater knowledge of the world to help students made sense of the learning process (Mooney, 2000). All in all, Vygotsky claimed that students needed their surroundings to enhance their learning process, especially their teachers and peers and social as well as cultural contexts. One can see in Vygotsky how he is an intellectual heir to Dewey at the same time, as the educational debate became more intense, Dewey's original ideas gave birth to a range of related but competing ideas in which the exponents themselves were then subjected to further critique and counter-critique.

Other critics of Piaget, especially of his four stages of intellectual development included Bower (1977) and Butterworth (1981) on the sensorimotor period and Donaldson and McGarrigle (1974) on the concrete

operations. Specifically for educators, Piaget's theory had two serious weaknesses. These were firstly, the failure to take individual differences into account (Sutherland, 1992) including; personality, gender, intelligence and experiences (as criticised by Bruner) and other factors that affected the ability to progress cognitively. Secondly, as Vygotskay noted, Piaget had ignored the social and cultural aspects of intellectual development. Global cultural differences were also ignored by Piaget Sutherland (1992), for example argues that Piaget's paradigms are not relevant to some non-Western cultures that either lack formal organisations or do not value abstract thinking.

Nonetheless, Piaget remained an important figure in learning theory (Smith, 1996). It was Piaget who introduced developmental psychology without his contributions it is reasonable to say that the discipline would not have existed. In fact, Piaget's quest for knowledge was a considerable intellectual resource which had raised and which might continue to raise, good questions regarding the linkages between psychology and education (Smith, 1996). Piaget himself claimed that he had provided an important and necessary link that connected a priori questions in philosophy with empirical issues across the spiral of sciences.

Table 1 synthesises the main points of cognitive and social constructivist thought, including the key

Table 1: Comparison chart of perspectives Dewey, Piaget, Bruner and Vygotsky

Construct	Reformed education Dewey*	Cognitive constructivist Piaget/Bruner	Social constructivist Vygotsky
Approach	Pragmatist	Piaget-realist; Bruner-interventionist	Developmental interactionist
Main key word (s)/Phrase (s)	Progressive education, learning by doing, reflective activity/learning	Piaget schemata, intellectual development, ego-centricism Bruner meaning making, spiral curriculum	Zone of proximal development, scaffolding
Knowledge	For students to re-describe, re-construct and re-evaluate	Changing body of knowledge, individually constructed in social world	Changing body of knowledge, mutually constructed with others
Learning what	Things that were relevant to students' development	Active construction, reconstructing prior knowledge	Collaborative construction of socially/ culturally defined knowledge and values
How	Through past and relevant experiences, by doing and purposeful learning, reflective activities	Through multiple opportunities and diverse processes to connect to what was already known	Through socially and culturally constructed opportunities, tying to students' experience
Where	Interaction with others and self	In interaction with others and environment	In collaboration with others through the social/cultural setting
Teaching	Provided students a platform to explore, relate to other students' experience	Challenge thinking towards more complete understanding (guide on the side)	Co-constructed knowledge with students by sharing expertise and understanding (actuator of learning)
Motivation	Self-development	Self-development, competence	Collective and individual development through collaboration
Role of teacher	Facilitator, guide	Facilitator, guide	Mediator, mentor, actuator
Actions (by teacher)	Create opportunities for interacting with meaningful ideas, materials and others	Create opportunities for interacting with meaningful ideas, materials and others	Construct with students opportunities for interacting with meaningful ideas, materials and others
Role of peer	Construct meaning, social activity	Not necessarily encouraged but could stimulate thinking, raise questions	Assumed part of knowledge constructions, contribute to definition of knowledge, help define opportunities for learning
Role of student	Sense-maker, problem solver, reflective thinker	[a]Active construction within mind [b]Generator, constructor [c]Active thinker, explainer, interpreter, questioner	[a]Active construction with others and self in negotiating meaning [b]Co-generator,co-constructor, re-formulator [c]Active thinker, explainer, interpreter, inquirer, active social participator
Student view of self	[a]Process of inquiry [b]Explanation of reasoning	Sense-maker, problem solver	Sense-maker, problem solver, socially appropriate member of collective
Evidence of learning	Create new knowledge, progressive education	[a]Process of inquiry [b]Performance; explanation of reasoning [c]On-going assessment	[a]Process of inquiry, problem solving, socially competent participation in collective [b]Performance: explanation of reasoning, social performance over multiple sites [c]On-going assessment over multiple sites
Purpose of school	Platform to create new meaning and knowledge by students	Create new knowledge, learn strategies to continue learning	[a]Create new knowledge, learn strategies to continue learning [b]Prepare individuals as social members with expanding repertoires of appropriate ways of interacting
Critics	LaHaye, Robertson and Colson	Piaget Bruner, Vygotsky, Donaldson, Bower and Butterworth Bruner nil**	Gee, Hull and Lankshear
Supporters	Hickman and Phillips	Piaget Peel, Campbell, Inhelder and Szeminska Bruner Adey, Shayer and Yates	Doise, Mugny and Schaffer

[a]The basic variables in the left-hand column were first identified by Wink and Putney. To this, the researcher added Approach, Main key word(s)/phrase(s), Critics and Supporters; [b]Also, Wink and Putney used this table to discuss the (behaviourists), Piaget and Vygotsky. The researcher has extended it to include Dewey and Bruner; Adapted from: Bruner (1966, 1990), Dewey (1916, 1933, 1934, 1938, 1968), Marshall, Piaget (1972a, b), Vygostky (1978), Wink and Putney (2002) and Woolfolk (1995); *Researcher's interpretation; **According to Sutherland (1992), Bruner was not seen as a fundamentally original thinker in comparison to Piaget and Vygotsky. He was seen as having some qualities of Piaget and some qualities of Vygotsky, thus making it difficult to identify his critics

supporters and critics of each movement. Table 1 is based on the research of Wink and Putney (2002) but includes the researcher's own analysis of the key ideas of Dewey. Dewey is placed into Table 1 because as Boris and Hall have argued, cognitive and social constructivism was originally embedded in Dewey's idea of a collaborative constructivist approach to learning and training. As mentioned before, cognitive constructivists tended to focus on the individual construction of knowledge discovered or built during interaction with the surrounding environment. From this point of view, it was important for educators to foster active learning environments where students individually built and constructed new knowledge. Basically, the cognitive constructivist view regarded knowledge as internally re-presented in the mind of the student. Unfortunately, individual notions of constructivism had often failed to emphasise the vital social aspects of learning and cognition the collaboration, negotiation, dialogue and questioning of active learning environments. The emphasis on the individualist aspect of learning was then complemented by the ideas of social constructivists who viewed learning, as a process that occurred within a larger social context. The teaching methods that derive from this latter view focus on dialogue, instructor co-learning and the joint construction of knowledge. Social constructivism argued that students could with the help of instructors or peers who were more advanced, grasp concepts and ideas that they could not understand on their own. In social constructivism, teachers or instructors did not merely stand by and watch students explore and discover. Rather their role was to guide and advise students and encourage them to work in groups to think about issues and find solutions to questions in the empirical and theoretical worlds.

It is crucial to recognise that the branches of constructivism are not competitive, rather they are complementary. This is an important insight for the purposes of the present study. Cognitive constructivism helped instructors to understand why students learnt at differing speeds and how to tackle this. Social constructivism helped instructors to prioritise the importance of guiding students in a socially constructed environment in which the student was not alone but rather part of a wider body of thinking people engaged in a common curriculum of learning. Cognitive constructivism stressed the value of individual experience and the need to connect to one's prior knowledge. Social constructivism stressed that learning could not exist without the guidance of instructors or more able peers. Though students must exercise agency and independence to learn, their surroundings gave important support in the process of learning. Taken together, cognitive and social constructive learning theory might be able to offer a new paradigm into which scholars can locate the potential of educational technologies.

The modern application of constructivism to education: This study focuses on the application of constructivism to educational systems. The research of Kolb (1984) and Bloom (1956) will be used as the focus of this discussion as they are widely regarded as the key contemporary analysts on this question. The evolution of constructivist theory involved some of the most important thinkers of the 20th century, Piaget for example. Given this, it was only a matter of time before educationalists themselves began to reclaim Dewey. However to make Dewey's core ideas relevant to the modern world, his basic principles had to be re-formulated and re-stated in manner that made sense to contemporary society. Kolb's four stages of cognitive constructive learning model were based on his interest in the nature of individual and social change, experiential learning and professional education. Bloom was interested in thinking and its development. One of his greatest contributions was Bloom's Taxonomy a classification of cognitive, affective and psychomotor domains.

Kolb, using his four stages of cognitive constructive learning model, demonstrated how learning was based on series of re-shaping and re-interpretation of experiences (Harkin *et al*., 2001). Based on Dewey, the essential characteristics of his model exemplify how concrete experience allowed students to experience or immerse themselves in the doing of a task. At this stage, students simply carried out the task assigned without reflecting on it. The aim was to accomplish the task. Reflection on experience gave students the opportunity to review what had been done and experienced. The skills of attending, noticing differences and applying terms helped identify subtle events and communicate them clearly to others. Communication, thus required students to be fluent in any language in order to verbalise and discuss their perceptions. The next stage was abstract conceptualisations that required students to interpret and understand the relationships that existed. At this stage, theory might be particularly helpful as a template for framing and explaining events. Active experimentation or planning allowed students to absorb the new understanding and translate it into predictions about what was likely to happen next or what actions should be taken to refine the way the task was handled. Generally, students were able to enter the cycle at any stage and follow its logical sequence. The important point was that students were never conceived of as merely passive

recipients of knowledge, as they were constantly engaged in learning through adjusting their experiences and constructing new information.

There was one critical issue that arose from Kolb's cognitive constructive learning. The model took very little account of different cultural experiences and conditions of learning (Anderson, 1988). As most cognitive and communication styles are culturally-based, failure to consider this in the learning process might hinder students' progress in learning. As mentioned before, students' experiences play a vital role in their learning process. Thus, Kolb's Model might not be suitable for students from different cultural backgrounds. Attention needs to be paid to the different models of selfhood and the extent to which these might differ from the Western assumptions that underpinned Kolb's Model. Despite this, Kolb was still an important figure in constructivism as he managed to demonstrate the importance of experiences in aiding students' learning. This was because students learnt best by doing things rather than just thinking about how they had done them. In actual fact, students' previous experience aided them in deciding how best to do things. Effective learning was seen to have occurred when a person progressed through Kolb's four stages (Harkin *et al*., 2001). In essence, Kolb's Model provided a guideline for educators in monitoring and understanding students' learning progress. The model might also provide an outline to prepare challenging materials and tasks for students in classrooms organised according to constructivist principles.

The research of Bloom further illustrated how constructivism was transferred to an educational setting. Bloom emphasised the cognitive domain as the critical factor in most learning. Within this domain he identified six levels of intellectual behaviour. They ranged from simple recall or recognition of facts, through increasingly more complex and abstract mental levels to the highest level which was classified as evaluation. Once students had mastered the first level, it was assumed that they were ready for the next level. The six levels were knowledge, comprehension, application, analysis, synthesis and evaluation. Within a constructivist paradigm, the acquisition of all these levels would indicate students' ability to adapt old knowledge in order to construct new information.

Alonso *et al*. (2005) re-ordered Bloom's six levels of cognitive domains into three kinds of thresholds: Synthetic level (knowledge and comprehension), pragmatic level (application and evaluation) and semantic level (analysis and synthesis). Ideally, students would be more active the higher the level in Bloom's Taxonomy. Bloom's Taxonomy has impacted on much research into student-centred learning by presenting new and innovative methods for teaching various subjects for example critical reading and science subjects in classroom settings (Surjosuseno and Watts, 1999; Allen and Tanner, 2002). However, critics like Pring (1971), Seddon (1978), Paul (1993) and Nordvall and Braxton (1996) claimed that the taxonomy denied teachers the freedom to switch from one level to another as it promoted hierarchical and sequential links between each level. Furthermore, the taxonomy at its knowledge and comprehension levels did not acknowledge that some types of information were more difficult to remember and understand. Nonetheless, most educators agreed that although, the research on the validity of Bloom's Taxonomy was not necessarily conclusive, it was a useful tool for making a distinction between lower level and higher level orders of knowing and thinking (normally referred to as critical thinking) and for improving classroom teaching (Allen and Tanner, 2002).

In addition, in order to suit the contemporary debates on education, Anderson a former student of Bloom has further revised the original cognitive domains. These revisions are two fold. First, Anderson revised the terms used to describe the classification, for example the term analysis is revised to the term analysing. Second, the second last two levels of the cognitive domains are reviewed. The original last two levels were evaluation and synthesis. The revised version is now evaluating and creating, respectively.

Constructivists have been the strongest supporters of the idea of student-centred learning and teaching (Woolfolk, 1995). Yet, this common understanding did not resolve a persistent debate within the student-centred learning approach. That debate hinged on the question of the relationship between learning by doing and the role of technology. To begin with each of these will be considered separately and then the relationship between the two will be explored.

Learning by doing absorbed the energies of Schank and Prensky. In 1997, Schank criticised the assumption that if a lesson was clearly taught and tested, students would remember it. He stated that it was not what students remembered that mattered but the implications. Schank argued that students would remember situations that turned out to be different from those they expected that was why failing in interesting ways should be one of the goals of learning. By failing in a scenario in the learning process, students would not make the same mistakes again because they would remember what they had done incorrectly. Schank indirectly supported the use of e-Learning and simulations when he stated the basic premise of learning as (when learning is not fun, it is not learning) (Schank, 1997). He proposed that when doing something was fun as could be offered by e-Learning and simulation programmes, students had the chance to

participate, take chances, make mistakes, challenge themselves and learn. Importantly, he added that technology had made learning by doing a realistic option in many situations. Schank then emphasised on the need for student-centred learning. This idea was not new as it had many supporters for >2 decades.

However Prensky (2001), disagreed with Schank's claim that doing something would necessarily be fun. He believed that doing might be boring and that doing by itself did not automatically promise anything interesting. Prensky argued that one major question was missing in the how do students learn debate, namely how do they learn what?. As different students learnt facts, skills, behaviour, language and processes differently, learning by doing might not always be the best way of learning after all. Prensky (2001) further claimed that learning should engage students' attention. However, this has not always occurred as learning today seems dull to students because of its stress on memorisation and recitation of facts. Other forms of information including television and computer games, frequently offer more intellectual stimulus. Many students today have grown up playing computer and video games and they may, therefore have problems with old fashioned learning approaches. Traditional learning concentrated on the teacher or the content because teachers were considered to be the ones with knowledge. The transfer of knowledge was through lectures, textbooks or online text followed by assessment. Prensky referred to this as the tell-test education system and claimed that this approach was no longer effective. There was an urgent need to focus more on the students.

Schank's statement about the role of technology in the enhancement of the learning process had been recognised in the post-WWII world by Papert (1980). Papert was perhaps the most prominent researcher to explore the potential that computers had for providing a creative learning medium for students. He did this through the programme LOGO which was specifically designed for the teaching and learning of mathematics. Papert (1980) suggested that if students wanted to learn and if they had the opportunity to do so they would learn, even if the quality of teaching was poor. For him, this potential could be realised through the potential of the computer. More recently, Mitra and Rana (2001) studied how semi-literate slum children in India could learn using computers and do so in the absence of any formal instruction. They called this minimally invasive education. Working as part of NIIT's cognitive research centre, they placed computers into various facilities in urban and rural India and allowed school-aged children free access to these. It was found that the children could teach themselves many tasks, even though the language of the computers were English and their own language was not. This study supported Papert's idea that students were able to do things with computers even without instruction. In this instance, the children had become the centre of learning rather than teachers and it was the children who discovered what else to learn. No special content was imposed on them from outside. At the same time, the Mitra and Rana experiment had its limitations as they are the first to acknowledge. For example, the children quickly reached particular learning thresholds beyond which they could not move unless some kind of stimulus was injected into their world from outside. Typically, that stimulus took the form of either new computer programmes and/or minimal mentoring by a member of the NIIT staff.

To ensure that constructivism supports student centred learning environment, selected contents and activities are based on real life situations using authentic and various media to address differences in students' learning styles (Bonk *et al*., 2002). This could only be done through the use of technology to deliver suitable content and activities. Following the emergence of digital technologies, many educational technologists supported the need to shift from teacher-centred to student-centred approaches (Bracewell *et al*., 1998; Hannafin and Land, 1997; Harasim, 1990). Student-centred pedagogy concentrated on what students needed to learn what their learning preferences were and what was meaningful to them. Technology-based instruction gave opportunities for learning materials, tasks and activities to fit individual learning styles and preferences. Networks of learning information, such as digital libraries were available to facilitate student interests and ideas. Such environments also provided access to more authentic learning communities than typically found in conventional educational environments.

The emergence of e-Learning and simulation technologies converged with trends in new pedagogy that allowed for greater student control, personal responsibility and collaboration. Creating collaborative learning environments embraced the concept of active learning students actively constructed their knowledge with peers and teachers, creating an arena where different discourses and learning styles could comfortably co-exist (Roschelle *et al*., 2001). Self-directed students who wanted meaningful and engaging activities, as well as educators willing to experiment with a variety of techniques and practices to individualise learning, tended to be more attracted to e-Learning and simulation settings (Lewis *et al*., 1999; Wagner and McCombs, 1995). e-Learning and simulation provided a suitable platform in which student-centred principles were particularly

relevant as students became the centre of the learning environment. This views has been strongly supported by researchers who claimed that courses conducted through computer technologies required active learning strategies and participation (Harasim *et al*., 1995; Knowlton, 2000; Peirce, 2003; Moeller and Reitzes, 2011) and online pedagogy tended to be more student-centred than face-to-face teaching and learning (Berge, 1997; Bonk and Dennen, 1999). Furthermore in successful online courses, students might assume significant instructional roles, such as offering instructional tips and constructing new knowledge that were once the domain of educators (Harasim, 1993). This could prove especially relevant to the aims of most military institutions where students were expected to assume larger roles and take command and control of most situations.

e-Learning and simulations could provide opportunities for students to construct knowledge, actively share and seek information, generate a diverse array of ideas, appreciate multiple perspectives, take ownership in the learning process, engage in social interaction and dialogue, develop multiple modes of representation and become more self-aware (Harasim, 1990; Chong, 1998; Oliver and McLoughlin, 1999). In essence, technology-rich environments could support students' engagement in meaningful contexts, thereby increasing their ownership over their own learning (Chung *et al*., 1998). Thus, e-Learning and simulation appear to provide a viable teaching and learning platform for student-centred learning. Recently, more research has been undertaken on the question of how to engage the interest of students (Bonk and Reynolds, 1997). Levin and Waugh (1998) offered approaches such as online collaborative teaming, online questioning and answering, technology resource searching and evaluation, project generation and co-ordination and student publication of research. Oliver and McLoughlin (1999) argued for the development of tools for parallel problem-solving, information exchange, database creation and case-based projects.

CONCLUSION

Based on the discussion before, constructivism could be embedded in e-Learning and simulations technologies as it has the ability to promote active learning, constructive learning, intentional learning, authentic learning and co-operative learning (Jonassen *et al*., 1999). Classrooms could then be designed to focus on the transfer of learning. At the same time, this new science of learning would encourage classrooms to be student-centred. e-Learning and simulations reflected all these concepts in a variety of ways as put forward by Huffaker (2003):

- e-Learning and simulation applications could be personalised, provide feedback and utilise navigation to individual users to guide their learning path
- e-Learning and simulation applications involved communication tools that fostered co-operation and collaboration between students despite temporal and spatial constraints
- e-Learning and simulation applications could teach students fundamental concepts with real world treatments. Students could communicate with professional scientists or leaders, observe up-to-date scientific data and participate in projects that expand their knowledge

In short, e-Learning and simulation applications offer unique technical advantages, suggesting new opportunities in how to design the learning experience. Re-usable components that were scalable allow the ability to easily customise, modify and deploy educational content. The question now for the educators is whether they are aware of ready to embrace and believe in constructivism.

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