An Evaluation Of Constructivism For Learners With ADHD: Development Of A Constructivist Pedagogy For Special Needs

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Abstract

We examine whether constructivist eLearning tools can be used to help learners cope with special educational needs, such as difficulties with attention and concentration. Preliminary work is reported here, in which we seek to determine the reasons why a constructivist approach is difficult for learners with ADHD. This work is intended to lead to recommendations of how learners with ADHD could benefit from constructivist eLearning systems, e.g. through the managed use of multimedia technology. A preliminary model has been developed that illustrates the areas in which constructivist pedagogies need to address the limitations of ADHD learners. Further work will expand this model and eventually test it in a real environment (e.g. in a school with ADHD learners). The outcome will encourage a reconsideration of existing multimedia theories as they relate to learners with special needs, and provide new directions in order to support learners with ADHD.

Keywords: Multimedia learning, Constructivism, Constructionism, Cognitive Load Theory, Dual Channel, Special Educational Needs (SEN), Typically developing learners (TDLs), Attention Deficit Hyperactivity Disorder (ADHD).

1 Introduction

Constructivism is an educational theory developed by Jean Piaget (1954), which explains how people learn in practice. Constructivism learning theory focuses on the construction of new knowledge by the learner from active learner-driven experiences (Kirschner, 2006). The purpose of this paper is the issue of whether or not constructivism is an appropriate assumption for a pedagogy when seeking to teach learners who have been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). A great deal of research has been conducted aimed at developing educational tools for typically developing learners (TDLs). However, learners with learning difficulties or special educational needs (SEN) often find it difficult to learn in the same way as TDLs. As a result, learners with ADHD have not benefited from the same developments in multimedia learning systems as TDLs. It is the objective of this research to examine a basic question: "To what extent is the theory of constructivism appropriate for learners with ADHD?"

Multimedia based constructivist learning tools are widely employed in the education system on the assumption that an active learner-centred pedagogy (*e.g.* Constructionism by Symour Papert,

1980) is the most appropriate way to facilitate learning. There is little consideration given to the possibility that not every learner benefits from this approach. The research undertaken here is to improve understanding of the special educational needs of ADHD learners' in the context of eLearning. Consequently, this work may be applied to help designers of multimedia learning systems determine whether aspects of constructivism are appropriate.

To this end, the present research has investigated the links between constructivism and ADHD symptoms to produce a preliminary model, which is intended to be used to identify the areas in which further investigation is needed to establish the value and worth of constructivist systems for ADHD learners. This model is presented here as work in progress, and will be expanded through further literature and theoretical investigations. Once completed, the model is intended to be tested in practice at schools using multimedia eLearning systems and learners with ADHD.

This paper will start with an overview of current understanding of constructivism theory, the prominent work of Jean Piaget on constructivism theory, and the constructionism theory of Seymour Papert as an example of a constructivist pedagogy will be highlighted. The next section will provide a brief description of Attention Deficit Hyperactivity Disorder (ADHD) and its impact on those with the disorder. The paper will then proceed to discuss the links between constructivism theory and ADHD, followed by suggestions on how to overcome some of the problems.

2 Introduction to Constructivism Theory

In this section we review the principles on which the constructivist ideas rest. These principles will later form one component of the model we present. Constructivism is an educational theory which emphasizes pure discovery learning, and its core points include Piaget (1954), Vygotsky (1978). Kirschner *et al*, 2006, claim that although constructivism requires descriptive information, observation would be accurate as well. In fact, constructivism theory supports learners to develop their knowledge based on personal experiences, ideas, and learners' deep understanding of knowledge (Nie and Lau, 2010). The educational setting from the constructivism perspective of Seymour Papert concentrates on the need for *learner-driven learning*, which means learners are actively involved in the learning process to assimilate new information into their existing knowledge structure (Huang *et al*, 2010). In this regard the educator provides the learning environment for learners. Constructivism requires learners to be active in the learning environment, understanding from the content of study and enjoy learning, and learn to think in an efficient manner. Based on the studies of Piaget, constructivism is all about creativity (Huang *et al*, 2010) and knowledge. Therefore, in order to approach successful learning, educators modify instruction from passive to active learning.

Active learning refers to a mental representation of a learner to realize her/his own mental processing (Zhenlin, 2009). As a result, active learning allows learners to be highly creative and explore new knowledge by existing knowledge. This is because learning is a process through which learners discover concepts, facts and principles by themselves in order to have successful learning. In active learning the key point is the ability to combine ideas and concepts from prior knowledge (Tschang and Szczypula, 2006). This transfers learners into long-term memory to find out any connections between the new concept and the prior knowledge and retrieve them to the short-term memory. Therefore, the role of educator is to facilitate an appropriate environment as a facilitator, while the learner's role is to construct knowledge through interactions with the environment. This means the educational environment is transferring from educator-driven to learner-driven.

Turning to the next step, working memory focuses on knowledge construction and requires learners to use their prior knowledge. This needs a *strong short-term memory* to represent retrieved information from long-term memory and from new perceptions. In this regard, learners need to find the connections between the new concept and the knowledge that is already stored in long-term memory.

Accordingly, in order to generate knowledge, they need to recall concepts and items from permanent memory and establish the connections (Thorn *et al*, 2005). Successfully recalling from the long-term memory illustrates that the item was correctly reconstructed. This happening requires independency, which refers to active learning. On the other side, unsuccessful reconstruction attempts indicate no connections have been found between the concept and existing knowledge in the long-term memory. Therefore, strong working memory would be another principle in constructivism to the purpose of generating new knowledge. However, Anderson (1983, 1993) noted that the limited capacity in working memory simply avoid the existing knowledge to enter from long-term memory to short-term memory.

As individuals, each learner has a different learning style with different understanding and unique experiences of the world. Constructivist approaches incorporate both the process and the product of learning, which requires *integration of knowledge* (Young and Collin, 2004) (assimilation). Thus, learners need to find a relationship between prior knowledge to generate an integrative and coherent knowledge to reach to meaningful learning (Woo and Reeves, 2007). There is no possibility to integrate new knowledge without any structure developed from prior knowledge to build on. Integrating of knowledge supposed to be based on both verbal and non-verbal information. Selected information from verbal and visual channel requires being organized (Chandller and Sweller, 1991). Constructivist learners need to develop their awareness and autonomy. This means learners should feel responsible for their learning. Therefore, *motivation* would be another requirement of constructivism. Motivation has been recognized as an important aspect of constructing new knowledge (Piaget, 1954; Vygotsky, 1978). From educational perspective, the term "motivation" could apply to any process that activates and maintains learning behavior. Motivational process of learners' learning is one of the important goals teaching strategies in the current research.

Finally, *reflection* would be another characteristic of constructivist learner (Haung *et al*, 2010). Reflection refers to how making connection to existing knowledge with new information, in order to construct new understanding. This action allowed people to integrate content of study, develop new knowledge connections, and integration of prior knowledge. Reflections also include what they were feeling, and processing through the learning.

2.1 Criticisms and problems with constructivism

Although constructivism theory is one of the most widely adopted educational assumptions, there are valid reasons to suggest that it may not be applicable in some situations. Several cognitive educators have argued the fundamental issues of constructivism. Mayer (2004) defined pure discovery as unguided and problem-based instruction. He explains that not all educational techniques based upon constructivism are effective as a teaching technique. He claimed that guided discovery is efficient since it facilitates learners to meet two significant features for active learning: first constructing accurate and relevance knowledge to be used for reproducing of new incoming information and second, integrating new information with an appropriate knowledge base. On the other hand, pure discovery might be inefficient when it fails to promote the second features. This refers to the case that learners might not come up with precise information from their prior knowledge, thus have nothing to integrate with the new concept. Consequently, Mayer's results support the view that the guided approach would produce better outcomes in many situations.

Evidence from (Moreno, 2004; Tuovinen and Sweller, 1991cited in Kirschner *et al*, 2006) illustrates that students become lost and confused with the pure discovery learning system. From Moreno's perspective (2004) learners could perform better with guided learning than with pure discovery and observation. In addition, the quality of learning would be different in both cases of guided versus discovery. Learning via discovery showed no indication of greater quality of learning. In summary, evidence has shown that not only discovery learning is less efficient it might have negative influences

such as leading to misconceptions.

Constructivist multimedia learning tools can be useful environments for promoting interactivity, creativity, fun and motivating for special educational needs particularly ADHDs. The technology of multimedia presents significant learning tools to improve individual active learning.

2.2 Constructionism Theory

Seymour Papert introduced the theory of constructionism as a strategy of education, based on the Jean Piaget's constructivism learning theory. Constructionism emphasises that people learn in a constructivist learning environment (*e.g.* computer based learning, multimedia learning, or eLearning) with individual effectiveness while they are engaged in creating their new knowledge (Tenenbaum *et al*, 2001; Figueira-Sampaio *et al*, 2010). Therefore, constructionism would be pedagogy to assist in learning children by their mind.

In the current study the concept 'Constructivist pedagogy' refers to the teaching method such as constructivist learning environment as a general term to explain learning situations and processes (Tynjala, 1999). One of the requirements of constructivist pedagogy called '*experiential learning*' which describes learning through reflection.

2.2.1 Experiential learning

Experiential learning is an effective educational method considers on the learning process and individual experience through interactions between learner and environment. For instance, multimedia system would be an experiential learning environment which requires learner to be actively engaged to a task. In such a learning environment, learning process is based on experiment and discoveries which require some qualities including creativity, willingness of a learner, and reflect on the experience. Therefore, analysis the content of multimedia learning materials must be done by the mind of the learner in order to reproduce a new concept.

All these factors require learners' attention and concentration. As mentioned earlier, ADHD children have lack of attention and concentration. Therefore, it would be problematic for these children to learn without a facilitator. As a result, in this study we will consider on the experiential learning to check whether a constructivist multimedia learning system could be an appropriate system for ADHDs?

2.2.2 Application of Multimedia learning as a solution

Over the past two decades, several studies have been established the impacts of computer technology on special educational needs such as Autistic, Dyslexia, and Down syndrome (Khan, 2010; Doyle and Sanchez, 2010; Tan and Cheung, 2008; Gross and Voegeli, 2007; Alty *et al*, 2006). However, not much work has been done on the ADHDs educational system.

Multimedia learning system can be defined in many ways as provides a means for representing information. Richard Mayer explained two different materials of multimedia presentations including words and pictures (Mayer, 2001). Due to the importance of learning process through multimedia tool, it is essential to learn how pupils feel about the usage of this technology.

The *dual-channel assumption* (Mayer, 2001) suggests that humans can process information into different channels of auditory/verbal and pictorial/visual. The verbal system contains auditory, printed text or other modality specific verbal codes and non-verbal representation contain modality-specific images, symbols, animation and sounds. Mayer's multimedia model was developed for typically developing learners and does not provide adequate support for learners with special educational needs. Therefore, a successful constructivist approach aimed at TLDs would encourage the use of both auditory and visual channels. However, a major limitation that SEN learners face is that those

with auditory impairment may have to rely on their pictorial channel to compensate for inabilities with their verbal skills. For instance, as Autistic learners have verbal impairments, lack of information would have to be covered by presenting pictorial information such as images, animation, video, or symbols. Integration of knowledge would be harder due to the absence of sufficient verbal information. It remains to be seen whether this limitation would have a significant effect on constructivist learning approaches.

2.2.3 Constructivist eLearning environment

In order to encourage learners engage in meaningful learning environment, the constructivist approach should provide opportunities to challenge learners' prior knowledge, interactions between mental activities and reflect their ideas. Recent studies of educational technology illustrates that researchers have applied the constructivist theory to eLearning environment (Wen *et al*, 2004). In current article, learners' perceptions toward constructivist learning environments concerned two aspects: Firstly, the content-technical aspect and secondly, the cognitive and metacognitive aspect. The content-technical aspect focused on the relevance of materials and '*Ease of Use'* (Tsai, 2008; Wen *et al*, 2004) for the eLearning systems and, the cognitive and metacognitive aspect which assessed mental activities including '*reflective thinking'* and higher-order thinking.
The instructional content in the eLearning environments should challenge learners' existing knowledge. Otherwise, inquiry mental activities and reflective thinking will hardly arise. In terms of Ease of Use which is a technical scale, the eLearning systems should be user-friendly, so learners simply could engage to the environment.

3 Pedagogy

In education and academic arenas, the term pedagogy is an essential concept that has several interpretations. However, the main concern is used to refer to the quality of teaching method (Gore *et al*, 2004). Productive pedagogy dimensions have been also suggested by the mentioned authors including: Intellectual quality, Relevance, Supportive classroom environment, and Recognition of difference.

- Intellectual quality refers to the higher thinking, depth in knowledge, and deep understanding
- Relevance concerns on the knowledge integration
- Supportive classroom environment identifies the learners' control, engagement, and self-regulation
- Recognition of difference explains whether the teaching principally narrative

Our investigation has so far suggested that pedagogy is more complex than the interpretation above. In this paper pedagogy aimed at the following description:

Pedagogy is a combination of learning theories, teaching methods, and other factors such as: delivery mode, and feedback style.

- Learning theories: In education and psychology a learning theory has defined as a process of learning. Research illustrates different types of learning theories which explored different settings for learning. Multimedia learning, Behaviorism, Cognitivism, and Constructivism (Guey *et al*, 2010).

- Teaching methods: Teaching method can be defined as the principles used for instruction including lecture, workshop, projects, activities and practice.

- Delivery mode formats could be either technology-based or the classroom-based. Technology offers learning environments such as Web-based learning environment, Internet-base learning environment, Multimedia or single media learning environment.

- Feedback style including formative assessment, summative assessment, peer, and teacher. Wang (2008) explained formative assessment as a key factor in teaching activity in order to improve learning effectiveness. The feedback can be offered to learners while they engaging to a task through the question, short tests, and homework. In contrast, summative assessment means that the feedback should offer to the learners by the end of the task (Marriot and Lau, 2008).

4 Definition of ADHD (Attention Deficit Hyperactivity Disorder)

One of the prevalent neurobehavioral disorders during childhood is called Attention Deficit Hyperactivity Disorder (ADHD) that influences many learners worldwide particularly school boys (Jonsdottir *et al*, 2005). Study of Kewley (2005), estimated that 3% to 5% of school learners have been diagnosed with ADHD which is a very frequent circumstance in classroom. From the other side, studies of (Kaplan *et al*, 2001) illustrate that 80% of ADHD learners had another disorder. Suffers will be concerned in various ways. For instance, a child with ADHD is not capable to process information in the same way as typical learners. Brook and Boaz (2005) introduced another significant impairment of ADHD as a psychological behavioral circumstance which contains nervousness, sadness, and assertiveness.

The major symptoms are being inattentive, hyperactive and impulsive (Brook and Boaz, 2005). Learners who are inattentive can be easily distracted, move from one activity to another and get bored quickly. They may hardly pay attention when people talk and they find it difficult to concentrate. As a result, such learners like routine may become distressed when routines are interrupted. Approximately, a third of learners with ADHD have been inattentiveness (Loe and Feldman, 2007). Others may have been diagnosed with hyper activeness or over activeness. Hyper activeness, like inattentiveness, causes by lack of self-control. Therefore, the learners who are hyperactive find it difficult to stay without fidgeting in their seat and get up all the time. As learners get older, hyper activeness will be less among them but leads them to depression. Finally, impulsivity may also characterize as poor attentional skills. For instance, learners who are impulsive act before they think. Moreover, the difficulty they have is to be patient and also not to interrupt the speaker continuously. As a result, inattentiveness and verbal impulsiveness cause complexity with learning.

In summary learners with ADHD may experience the following difficulties:

- Difficulty in paying particular attention, listening to speaker without interrupting and distraction (verbal impulsiveness): this refers to learners with ADD who find it very hard to concentrate. For instance, attending to details and following the instruction which require sustained mental effort. The literature on attention in learners with learning impairments differentiates between selective attention and sustained attention. (Yehoshua *et al*, 2005) defined selective attention as a difficulty in concentrating on the relevant features of a task. On the other side, sustained attention is defined as a continuing attention over time allocating to a particular task. With this regard, inattention prevents many learners with ADHD from succeeding in learning.
- Difficulty in auditory processing and language: this is typically characterised by difficulties in language learning problems and understanding speech. These groups have been diagnosed with

dyslexia as well who have impairments in reading, writing and spelling (Rosen *et al*, 2010).

- Difficulty in waiting for a new circle of tasks: This means that they have difficulty in organizing to complete tasks and following throughout instruction and integrating of information. Thus, they jump from one activity to another without completing any of them.
- Difficulty to concentrate on essential points for tasks or activities
- Difficulty in motivation, reflective and satisfaction with particular task as the learning environment should be designed in a way to motivate them perform better and,
- Poor short-term memory as forgetfulness is one of the behaviors that ADHD learners associated with. Working memory is one of the important functions which do not work well among ADHD learners.

Brook and Boaz (2005) illustrates that IQ of these ADHD learners is normal. However, they are neurologically disabled. Some ADHD learners with high IQs may distracted by their own thoughts. As constructivism explains that learners generate knowledge from interaction between ideas and experiences they have, based on interpretation of ADHD's impairments, it seems that theory could not be apply for this learners. This could refer to the level of weaknesses in attention and concentration. From Tan and Cheung's perspective, ADHD learners are at the risk of difficulties in school with their tasks which shows the poor learning motivation, low self-esteem, behavioral and social problems. Multimedia technology could be a suitable environment for learners to motivate them and cause better learning. However, some studies suggest that the most effective computer instruction method for ADHD learners is the individualistic approach which explained disruptive behavior in peer among such learners (Solomonidou *et al*, 2004) cited in Tan and Cheung (2008).
Jonsdottir *et al*, (2005) added two more subtypes of ADHD: Specific language impairment (SLI) and non-specific language impairments. Results from their study illustrate that ADHD learners with SLI performed considerably lower than those without SLI on measure verbal working memory. Therefore, multimedia learning system should be designed specifically for ADHD learners as verbal impairments appeared. However, working memory deficits are not certain attributes of ADHD but are correlated with language impairments.

5 Relationship between ADHD and Constructivism

After reviewing literature, we have reached to the Table 1 below which presents the main result of current project so far. The table below illustrates the relationship between the requirements for constructivism as a learning theory to succeed, and difficulties experienced by learners with ADHD. The intention is to establish to what extent ADHD learners are able to satisfy the essential requirements criteria for constructivism to be viable.

The first row refers to constructivism requirements followed by: active learning, strong short-term memory, integrating of knowledge, reflection, and motivation. The first column refers to ADHDs impairments followed by: lack of attention, lack of concentration, poor short-term memory, lack of motivation, difficulty in auditory processing, difficulty in following the instruction, difficulty in reflection, difficulty in integrating of information, difficulty in waiting for a new circle of tasks, difficulty in organizing to complete tasks, difficulty in language learning, and difficulty in understanding speech. Based on research we have done on the constructivism learning theory and ADHD children's educational system, it can be seen that there are significant areas in which learners with ADHD are potentially incapable of meeting the requirements of constructivism.

Constructivism / ADHD	Active learning	Strong short-term memory	Integrating of knowledge	Reflection	Motivation (ARCS)
Lack of attention	X			X	X
Lack of concentration	X		X	X	X
Poor short-term memory		X	X	X	
Lack of motivation	X			X	X
Difficulty in auditory processing			X		
Difficulty in following the instruction	X				
Difficulty in reflection				X	
Difficulty in integrating of information	X		X		
Difficulty in waiting for a new circle of tasks					
Difficulty in organizing to complete tasks					
Difficulty in language learning					
Difficulty in understanding speech					

Table. Link between constructivism theory and ADHD

5.1 Link between constructivism theory and ADHD

Although studies have been conducted on ADHD and learning disabilities, no studies have been found that examine the relationship between ADHD and the use of constructivism theory. Thus, this work offers a new perspective on the development of support tools for learners with special education needs. The following section examines the associations indicated in Table 1 and presents an explanation of the impact of the relevant ADHD 'impairment' on a particular constructivism 'requirement'.

5.1.1 Active learning

As we considered above on the constructivism requirements, active learning an important perception of constructivism (Tynjala, 1999) requires learner to actively engage to a task. Studies of (Sesen and Tarhan, 2010), noted that according to *educator-driven* approach in learning, learners may not be able to integrate their knowledge. This could cause misconceptions and lower learning outcomes. Therefore, active learning in *learner-driven* approach could cause meaningful learning which they can construct their new knowledge effectively. Moreover, active learning requires self-monitoring (Rovai, 2004), self-organizing (Young and Collin, 2004), and highly creative thinking skills (Huang *et al*, 2010) in order to constructing a new concept.

Based on (Huang *et al*, 2010), in order to construct a new knowledge, learners need to be creative as well as a self-reflective. Therefore, creative thinking is other requirements that learners need to be facilitate with in constructivist learning environment. Although ADHD children has normal IQ, some ADHD learners with high IQs may distracted by their own thoughts. This may avoid them from creative learning. In addition, as creative learning is one of the main resources for constructivism in order to generate knowledge from interaction between ideas and experiences they have, based on interpretation of ADHD's impairments, it seems that the requirement could not be apply for such learners.

In order to construct new concepts, a child with ADHD should refer back into his/her long-term memory to find out any connections between the new concept and the prior knowledge and retrieve it to the short-term memory (Brooks and Shell, 2006). When learners are in a case of active learning, they may construct knowledge via interactions between individuals and environment (Huang *et al*, 2010). This requires a lot focus and concentration on the task. Unfortunately this is not true for

ADHD learners due to their weaknesses in attention and concentration in any activities.

5.1.2 Attention and Concentration

Users' attention and concentration are defined as to what extent users preserve exclusive focused concentration on one action (Liu *et al*, 2009). Moreover, concentration is related to the level of the pupils' attention considered on concerning activity. Therefore, users' concentration refers to short attention duration because of their limited time and information processing resources. Since learning is an active process, inattentiveness which is a major symptom of ADHD might avoid them not to be active in learning. Moreover, they might pick the wrong concept from their working memory which is not match with the new concept. This would be the result of inattentiveness.

5.1.3 Concentration

As mentioned above, concentration is one of the major aspects to build new knowledge and restructuring the mental structure. This means a child with ADHD need to be organized in his/her prior knowledge. Therefore, it has been found that ADHD learners have difficulties with the learning theory of constructivism due to distraction and lack of attention and concentration.

5.1.4 Strong short-term memory

Short-term memory (Baddeley, 1986) is another requirement which is necessary to employ constructivism theory. Learners should retrieve prior knowledge, idea and previous experiences from their long-term memory to short-term memory in order to construct new knowledge. This is because constructivism is based on generating knowledge from experiences. Therefore, it should be an interaction between short-term memory and long-term memory. However, poor short term memory of a child with ADHD and lack of focus among them shows impairments regarding the interaction. Thus, results illustrate that constructivism might not be an appropriate learning and teaching technique for them to employ, as they need to have strong short-term memory with a high level of focus.

Cognitive Load Theory (CLT) which has developed since 1980s illustrates interactions among information and prior knowledge of humans' mind in order to clarify instructional design. John Sweller in 1991 developed the term cognitive load theory which explains how the mind processes information. Miller suggested that individuals working memory are only able to hold limited amount of information in their short-term memory. Therefore, each learner has a specific amount capacity for processing information in any task. (Sweller, and Chandler, 1991) suggest that effectual instructional material is required for learning purposes by directing relevant cognitive resources. In contrast, ineffective instructional materials can cause extraneous cognitive load on learners' working memory. As a result, cognitive load is required to be control while dealing with special educational needs particularly ADHD as they have auditory impairments and poor short-term memory compared to typical learners. (Mayer, 2001; Pass *et al*, 2003, 2004; Sweller, 1999, 2004; Winn, 2003) illustrated that in spite of the supposed advantages of discovery learning environments to facilitate learners to approach meaningful learning, cognitive load theory explains that heavy working memory load would be generated in the highly complex environment which is negative to learning. This explanation is particularly vital in the case of learners with ADHD, who has impairments to integrate the new information with their prior knowledge. In addition, Tuovinen and Sweller (1999) indicated that discovery learning caused a larger cognitive load and poorer learning than guided learning. Overall, most studies of Sweller with regards of cognitive load theory noted that guided approaches of learning would produce more facts than unguided approaches.

5.1.5 Motivation

Constructivism theory assumes motivation as an essential condition and requirement for learning. Therefore, motivation is another important issue with regards to active learning (Rotgans and Schmidt, 2011). (Bolliger *et al*, 2010) defined motivation as one of the significant psychological theories in education in order to have a successful learning. When learners are learning, they need to use their existing knowledge, interests, goals, and beliefs to understand any new information. In order to have comprehensive learning, learners require effort and if effort is crucial then motivation would be required. Therefore, constructivist theory assumes motivation as a fundamental state and requirement for learning. The level of willingness to continue a task, and engagement in an activity would be difficult issue from the point of ADHD learners. As a result, based on the issues above constructivism would be failed as a learning theory of ADHD learners. Lack of motivation among learners might affect reflection and ability to be active learners. As ADHD learners have difficulties in focusing and attending to details, therefore, active learning would be fail among such learners. As a result, this requirement of constructivism would be rejected.

There are several approaches to motivation such as self-determination (SDT) by Rayan and Deci (2000) and ARCS model by Keller (1983). To the purpose of this research, we discuss here one theory that has potential to be applied in eLearning systems for ADHD learners as it addresses the important and central issue of motivation. Each of the other constructivism requirements will be investigated in future work in order to determine ways to enable the principles of this theory to be applied to ADHD learners' education.

We consider the ARCS model as it focused on the parameters which are more relevant to the ADHDs. The ARCS model of motivation (attention, relevance, confidence, and satisfaction) was developed by Keller in response to a desire to find more effective ways of understanding the main impacts on the motivation to learn and for systematic ways of identifying and solving problems with learning motivation. This model introduces four main conditions: attention, relevance, confidence, and satisfaction that each learner has to meet them all to remain motivated. According to the purpose of current research, one of the essential issues among ADHD learners is to provide a learning environment based on the constructivism in order to promote their motivation. In this regard, learners' perception of motivation requires to be analyzed in terms of attention, relevance, confidence, and satisfaction.

5.*1.6 Integrating of knowledge*

Other requirements of constructivism called integrating of knowledge. From Baddeley and Hitch's perspective (1974), working memory focused as a system for temporary space and management of important information for complicated cognitive tasks. Temporary space of information is facilitated by two subsystems including a phonological loop for verbal information and a visuo-spatial sketchpad regarding visual information. Both systems are managed by working memory, which is referred to an attention-controlling system. Based upon the constructivism perspective, learners need integrating of knowledge. Therefore, regarding a Dual-channel processing, information could process in two different channels of visual and verbal (Paivio, 1991). For instance, words process in the verbal channel and pictures process in the visual channel. As a result, both verbal and pictorial information require to be integrated. Since ADHD learners have difficulties with the verbal skills, pictures would be a suitable learning environment for them. So their pictorial channel could act accurately rather than their verbal channel. With this regard, a child with ADHD might not deal with integrating between verbal and pictorial knowledge. This may cause a failure of constructivism with the terms of integrating of knowledge.

Mayer (2002) concentrated on the scheme that individual processes information in verbal and pictorial channels. The visual structure contains information representing as video, illustrations, animation or on screen text, which mentally process in visual channel and verbal structure contains words and verbal sounds process in the auditory channel. As a result, these two channels, verbal mental model

and pictorial mental model, are interrelated with each other in working memory. Therefore, there is possibility between systems in order to integrate representational units. Dual coding theory describes that learning is enhanced when information codes shows the balance of both information of channels simultaneously. However, this cannot be true for ADHD learners as they have weaknesses in verbal skills.

5.1.7 Reflection

Liaw (2005) introduced a model called constructivist reflection cycle (CRC) which explains how individual minds construct knowledge in order to approach deeper theoretical understanding. According to *Figure 1*, reflection provides opportunities for learners to revise misconceptions and develop deficient understanding. A CRC model is divided into three concepts: Individual express (individual mental models), reflect on comments about their knowledge, and revise preliminary perceptions into new expressions.

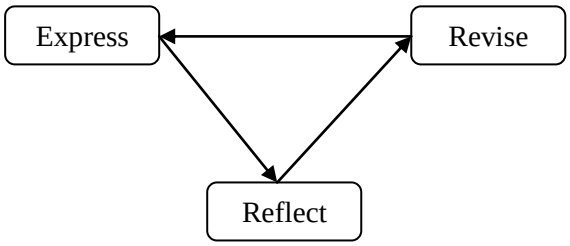

Figure 1. Constructivist reflection cycle

Constructivist knowledge analysis tasks (CKAT) developed by Johnson and Johnson (1992) represents knowledge into four categories: knowledge objective, knowledge gathering, knowledge analysis, and task knowledge structure. First stage, knowledge objective, refers to the individuals' attention on relevant activities and in the next stage find out relevant knowledge. Knowledge analysis is based upon individual prior knowledge and, final stage is outcomes of knowledge analysis used to create a model of tasks regarding the task knowledge structure which individuals reached through learning and prior task performance that structured into meaningful units in memory.

6 Conclusion

The fundamental principles of constructivism have been analysed, and it was found that several of these principles may be inappropriate demands on learners with ADHD. Where it is reasonable to expect typically developing learners to cope with the demands of active learner-centred learning (such as high motivation and strong focus), it may be difficult for ADHD sufferers to fulfil these requirements. Consequently, when the requirements cannot be satisfied, there is the potential for the constructivist approach to fail. In order for ADHD learners to benefit from constructivist approaches to learning, it is necessary to adopt suitable interventions that will support these learners in coping with the demands of constructivism, for instance, raising motivation and levels of concentration.

6 Future work

New constructivist pedagogy as a teaching method aims to promote higher levels of thinking skills. Future work in this area will need to focus on determining in greater detail the requirements for constructivist learning that are the most difficult for ADHD learners to cope with, and to establish suitable interventions that can help them overcome the barriers to learning. Further works need to prioritize areas of the Table 1 (crosses) for the supplementary examination and inclusion in the pedagogy.

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