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THE EFFECT OF USING HENDY'S 4CS MODEL ON TEACHING AND LEARNING SCIENCE IN MIDDLE SCHOOL IN MID-EGYPT

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Educational research and practice have proven that there are many benefits for applying learning theories' recommendations through teaching and learning of different subjects in all school levels. Based on interrelationships among learning theories of contextualism, connectivism, constructivism, and cognitivism, the researcher proposed an instructional model under the title of 4Cs model: contextualizing, connecting, constructing, and cognitivizing to take the learner through a mental trip from observing and examining real materials to long-term memory. However, the main purpose of this study was to identify the effect of using the proposed model on acquiring some scientific concepts, life skills, and multiple intelligences of middle school female students. To investigate this main purpose, three research statistical hypotheses were set regarding the three dependent variables. The study population was the second grade female students in middle school in Mid-Egypt. A random sample (72 students) was chosen and divided into two groups: an experimental group (37) and a control group (35). Three research instruments; achievement test, life skills scale, and multiple intelligences test were developed and controlled in respect to validity and reliability. After conducting the research experiment using the quasi-experimental design, administering instruments, and analyzing data, the results explored that there is an impact for the 4Cs model on acquiring scientific concepts, life skills, and multiple intelligences of middle school female students.

Keywords: 4Cs instructional model, Science teaching and learning, Life skills, Multiple intelligences, Middle school students.

Introduction

Developments that have happened on learning theories as well as thinking on how human brain works have led to many instructional models and strategies. Educators should develop new models based on learning theories that have proven effective learning such as contextualism, connectivism, constructivism, and cognitivism. Contextualism is a learning theory that focuses on learning from multiple real aspects of any learning environment whether in a classroom, a laboratory, or a workplace. In such environment, learners discover the main ideas and meaningful relationships between abstract ideas and their applications in the real world (TEXAS, 2016). The learning theory of connectivism has been developed as a result of a belief that there is a need for a learning theory that takes into account the manner in which society has changed as a result of the digital age (Siemens, 2004). So it seeks to assist in development of current practice in order that learning design will be developed based on digital means in the future (Al-Shehri, 2011). Constructivism is a learning theory that interprets learning as a process of constructing knowledge through experiencing things and using previous knowledge. Hein (1991) stated that the term

of constructivism refers to the idea that learners construct knowledge for themselves –each learner constructs meaning- as she or he learns. Cognitivism is a learning theory that was emerged to explore what happens inside our minds while we learn. Cognitivists presented two essential dimensions explaining occurrence of learning: the first is concerned with information processing; in terms of receiving, storing, and then remembering information when it is needed. The second is concerned with the meaningful learning; in terms of how learner forms and organizes new information coming to mind (Cruikshank and Others, 2006).

Statement of the Problem

Aldridge (1992) indicated that many learners perceive structured textbook-driven science subjects as difficult and not relevant to their lives. This point of view still exists in many schools around the world till now. There are many students in several countries still perceive science as tough and rigorous subject, and others believe that it is very difficult to learn. On the other hand, several research studies explored that many learners accept, understand, and retain knowledge through observing, connecting, constructing, processing, reflecting on, and applying ideas they learn. Dewy emphasized that each learner needs to use knowledge to be meaningful and retained (Liewellyn, 2002). So science can be very pleasurable for students if teachers would simply teach in a real context and provide them with opportunities to connect, construct, and cognitively process and apply what they learn. Here, the 4Cs model can help make science more understandable and applicable according to four phases of the model.

Theoretical Background and Previous Literature

The 4Cs Model

Although working on neuroscience and educational psychology have provided us with varied learning theories, thinking should continue to explore new applicable models based on those theories to promote and maximize the efficiency and capacity of learning. The current model (Figure: 1), which is based on learning theories of contextualism, connectivism, constructivism, and cognitivism, can be practiced according to four phases as follows:

Contextualizing

Contextual learning is based on the recognition that development of experiences requires learners develop procedural knowledge during learning situations (Pressley& Woloshyn, 1995); (Hartman, 2001). Instruction aims directly at knowledge and skills learners need to perform tasks they have explored as important to them in their everyday lives (Merrifield, 2000). So, through this phase of 4Cs model, learning situations depend on putting learners in instructional environments full of real life materials and events, as well as investing social events related to those components. Wenger (1998) referred that effective contextual learning focuses on the social nature of real world activities.

Beside the general roles of the teacher as a motivator and learner as an observer through the whole model, in contextualizing phase, while the teacher should plan effectively for learning situations, the learner should examine real materials and interact with others to make images for learning materials and events. Practicing those roles effectively can result in engagement of learners and exploration of main ideas behind the contextual situations.

Practically, a study conducted by Kurniati& Others (2015) found that using a contextual learning model helped to develop the level of learning and problem solving abilities to high school students in Indonesia. Hutchinson (2002) found that integrated contextual unites on science, mathematics, and technology helped develop motivation, self-direction, and retention for primary school students.

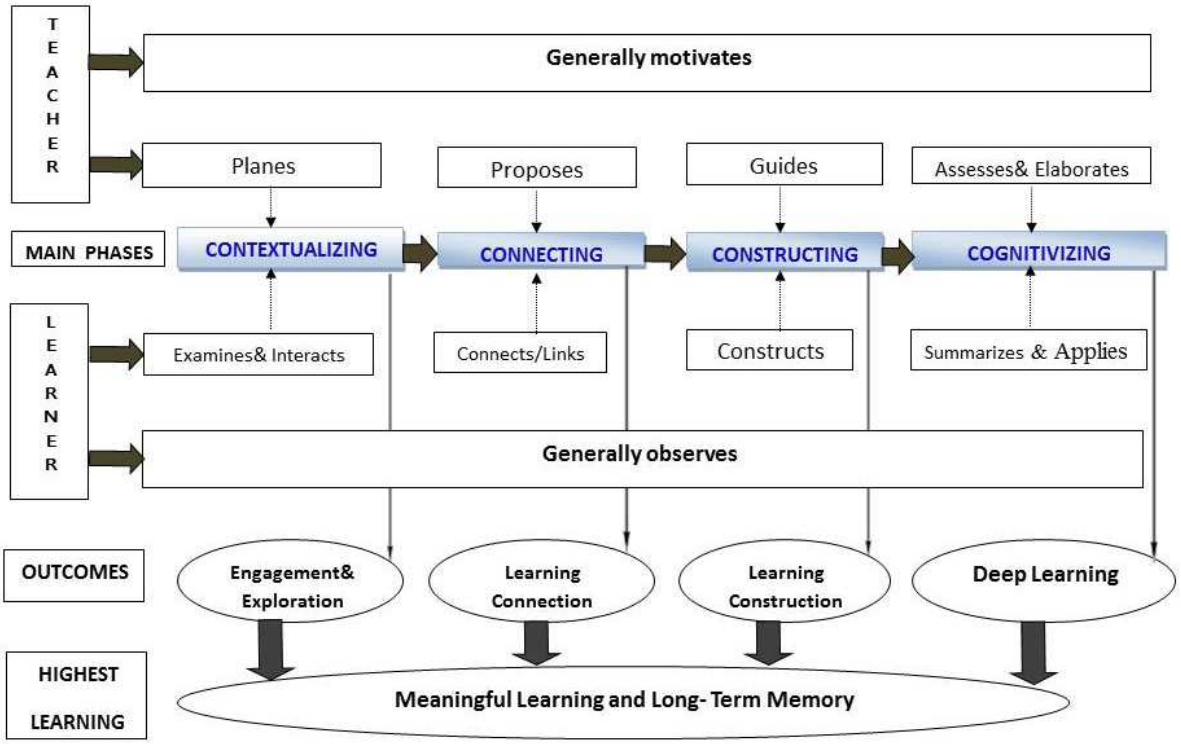

Figure 1. Hendy's 4Cs Model for Teaching and Learning

Although the contextual learning through this phase can establish varied real life-contexts and stimulate thinking on real materials and events, there are some limitations for contextual learning. For instance, contextual learning tasks mostly address the visual learning style while learners have multiple learning styles such as verbal, auditory, creative and so on; which need to be considered during learning. Also there is a difficulty of identifying the actual learning level that can be acquired completely through the contextual situation. Hereby, learners need to **connect** their learning to other situations and events verbally, virtually, and technologically.

Connecting

Once the learning tasks are being acquainted by learners through the previous phase, they can be pushed to connect what they have actually observed to other contexts technologically. Within a connectivist-learning environment, knowledge is considered to flow through a network which contains "nodes" that can be an individual or group resource (Bell, 2009). Therefore learners use technology to create networks; comprised of a variety of nodes from which they can choose and personalize the network and make it as self-responsibility (Guder, 2010) (Garcia& Others, 2013).

Generally, through this phase, learners are encouraged to connect learning through WWW, Emails, Wikis, Online Discussions, Social Networks, You Tube, and any other technological tools which enable them to learn and share information with others. Hereby, the teacher is responsible about proposing more materials and events for learners to connect and link technologically with what in the real context. Siemens (2005) explained that a key feature of connectivist learning is that much learning can be practiced through peer networks.

In this regard, Garcia& Others' study (2015) found that staff and students' roles changed as a result of participation in a connectivist learning model through cooperative electronic blogs. Dirks& Prenger (1997) found that educators realized that connecting instructional content to specific contexts of learners'

lives increased motivation to learn. Kizito's study (2016) recommended integrating connectivist perspectives in African higher education contexts.

Although connecting phase enhances and makes learning continue based on new technological inventions; and then learners make sense to new ideas, they still need to **construct** knowledge by themselves. So connecting phase works as an initial and pre-step for the following phase of constructing knowledge; the phase which is actually needed to prove that there is something built by learners.

Constructing

Knowledge is always the result of a constructive activity and therefore it cannot be transferred to a passive receiver. It has to be actively built by learners (Glasersfeld, 1992). Bransford, Brown, and Cocking, (1999) explained that effective learning begins with what learners bring to the learning situation. This includes cultural practices and beliefs as well as knowledge of academic content. Anyway, through this phase of 4Cs model, the current level of understanding -that resulted in the previous phases- is taken as a starting point for constructing new things. So while the teacher should guide learners to relate the current events and previous knowledge, the learner should observe, analyze, and use previous knowledge to construct new knowledge. This inevitably results in effective constructing of learning by learners themselves.

Practically, Anwar in her study (2015) found that a constructive learning strategy stimulated students' motivation, especially on the students' engagement in learning activities; that the more the students engaged, the more motivated they are. Arseven (2015) explored that using a mathematical teaching program based on a constructive approach was very necessary to motivate students, eliminate their anxiety and allow them develop positive attitudes towards mathematics.

Although constructive learning is based on sound theory and research, some criticized it as it works best with learners from privileged backgrounds who already possess essential skills and school-oriented attitudes and behaviors. Others still say that the overuse of constructive strategies can lead to "group think" and discourage independent thinking and creative problem solving by highly talented individuals (Johnston, 2005). Moreover, based on personal observations, it was noticed that some learners could not construct knowledge completely, either individually or cooperatively, through learning situations. So, many learners are in need to process information **cognitively** more and more through the coming fourth phase.

Cognitivizing

Through the current phase, learners process information more deeply. According to the cognitivism, a meaningful learning is based on an assumption that the more meaningful information provided to individuals, the easier for them to process, learn, memorize, and apply (Cruickshank& others, 2006). Cognitivists explained that there is an internal cognitive structure which is named 'Schema' by which the coming new information can be compared with information already exists. This internal cognitive structure can be extended or changed to adapt the new information received (Kathleen, 2004). Cognitivists also explained that there are three levels of memory: sensory memory, short-term memory, and long-term memory. To place information in long-term memory, which is an important benefit for this model, one must learn it in an effective way (Kathleen, 2004). So, while the teacher should authentically **assess** learning to make elaboration, the learner should summarize, apply and make decisions regarding her/his learning. Woolfolk (2004) in (Brown& Green, 2006) explained that as learners engage in the cognitive process, they actively reflect on and make decisions as they pursue goals.

Practically, a study by Moghaddam& Araghi (2013) tried to demonstrate the connection between new findings of the brain function and cognitive approach to the language learning practices. The findings explained that students would be able to understand according to their own abilities and to interact

effectively with teachers. Castro-Villarreal& Others (2014) explored the importance of a modified cognitive model and suggested that the cognitive motivational variables played important roles in promoting students' self-efficacy and final course grade.

What should be noted here is that some learners may do not have suitable internal schema that needed for some new information (Kathleen, 2004). Also there are what named 'contradictions' that may appear through encoding and storing new information when it does not consist with the personal schema. So practicing the processes of this phase with those of other phases (contextualizing, connecting, and constructing) effectively can overcome these challenges.

Based on above phases including roles of teacher and learner, several learning benefits can be attained by the 4Cs model:

- Practicing the model phases and procedures effectively can lead directly to development of learner engagement, exploration of main ideas, learning connection, construction of knowledge, and deep learning as general outcomes for the four phases respectively as shown in Figure 1.
- Attaining those outcomes together can lead to the highest level of learning that would be appeared in meaningful learning. Grabe& Grabe (2000) explained that meaningful learning occurs when new experiences are explored and related to what learner already knows. According to Ausubel, meaningful learning may be explained as a process of relating and connecting new material to old ones as a hierarchical fashion (Moghaddam& Araghi (2013).
- By experiencing real contexts, using previous knowledge, and reflecting on self-constructed knowledge through this model, information can be placed in long-term memory.
- It is expected that there is increasing in level of academic achievement, skills, attitudes, learning styles, multiple intelligences of learners.

Assumptions, Rationales, and Conditions of Using 4Cs Model

Based on learning theories and their recommendations, applications, and interrelationships among them as well as the personal experience of learning theories and practice, the current model was emerged and proposed according to the following assumptions, rationales, and conditions:

Assumptions

- Learning is still a big secret for many educators, teachers, and learners, so it maybe not completed effectively according to applications of only one learning theory.
- Since the nature of human being is complex, integrating among procedures related to some learning theories is better than depending on only one learning theory, specially that there is no one learning theory can cancel other theories, but can be integrated with them.
- New educational technology effect should be appeared within applications of learning theories; because it actually helps contextualize learning and help learners connect, construct and reflect on learning.
- Innovative learners should do something deeply after constructing knowledge; this already happens through the last phase of the model.
- We already live in an integrated and interconnected world; that needs integrated and multi-phase models for teaching and learning to help us acquaint life issues in an integrated way.

Rationales behind the 4Cs Model

- The model is based on actual learning theories that have evidences towards attaining effective learning for many learners in different ages.

- The model is an integrated mental trip that takes the learner from a contextual concrete situation to a full cognitive learning environment, and result in meaningful learning and long-term memory.
- The transition from contextual situation to knowledge application directly maybe not attained until learners connect, construct, process, and reflect on information.
- Putting learners in a real learning context at the beginning can lead them easily to connect, construct, and process information. Johnston (2005) stated that educators believe that learning is affected by the context in which an idea is taught.

Conditions for learning effectively through this model

- Continuous observation by learners, and continuous motivation by the teacher.
- With learners' increased interaction, involvement, and work, the teacher should be effective in managing her/his classroom physical environment, time, and movement and communication among learners.
- To attain an effective cognitive trip through this model, the teacher should accept changes in her/his roles, and also changes in learning environment.

Using the 4Cs model in Teaching and Learning of Science

Schawartzkroin (2009) explained that science always represents the business of asking, understanding, and explaining of how things work. According to Hurd (1997), science is a productive knowledge discipline that helps prepare individuals to practice, work, and produce not only to talk. Aldridge (1992) stated that we should ignore the traditional ways by which science courses are taught. So, in order to help learners become more productive members in their societies today, they need to observe, ask, connect, construct, process, and reprocess information; then produce, develop, reflect on, and make decisions on their learning. All these aspects and others cannot be attained depending on one trend of thought, but on using recommendations and applications of multiple learning theories and trends. So, the key is to find the right mix of methods for students being served and the content being taught (Johnston, 2005). By looking at the components of the 4Cs model and roles of the teacher and learner, several challenges from above can be manipulated.

In addition, Aldridge (1992) stated that motivation is a fundamental approach for an effective science education and relevance may well be a key component of good motivation. In the current model, learning is more relevant to the real life, and motivation is a continuous procedure that should be followed through the all phases of the model. Aldridge (1992) added that all learners can learn how science be applied to their lives when it taught to them in a coordinated way from the concrete to the abstract. This is exactly consistent with the nature of the current model which starts by putting learners in contextual situation full of concrete real materials, and move gradually to use mind in processing, reprocessing, summarizing and reflecting on information. Moreover, Matthews (1992) stated that constructivism is one of the major influences in present day science education. Here, constructing learning is a core phase through the 4Cs model that helps learners experience things and events and use their previous knowledge to build new ones.

Purpose and Objectives/Hypotheses

The main purpose of this study was to determine the effect of using Hendy's 4Cs model for teaching and learning of science for middle schools students in Mid-Egypt. Taking the details of this purpose in account, three research hypotheses were set as follow:

1. There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group regarding scientific concepts test.
2. There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group regarding life skills scale.
3. There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group regarding multiple intelligences test.

Methodology

The target population of this study was the middle school second grade female students in Mid-Egypt. The research sample consisted of 72 second grade female students enrolled in a middle school in Beni-Suef City through the academic year of 2015/2016. The sample was divided into two groups; the experimental group was 37 students, and the control group was 35 students. Based on the study purpose, three instruments (achievement test, life skills scale, and multiple intelligences test) were developed. The achievement test consisted of 40 multiple choice questions regarding some concepts and ideas related to a science unit under the title of "Reproduction". The second instrument was the life skills scale consisted of 22 items that addressed students' life skills. The third instrument was a multiple intelligences test that was presented to students to measure two kinds of intelligences (natural and spatial intelligences). Content and face validity of the instruments were determined by a panel of experts specialized in teacher education and middle education fields. The reliability coefficient was calculated for the three instruments using Cronbach's alpha. It was 0.77 for the achievement test, 0.89 for the scale of life skills, and 0.86 for the test of multiple intelligences. The study adopted the quasi-experimental design (two-group experimental design). After conducting the experimental treatment and administering the research instruments as post-tests with the two groups, data was analyzed using Statistical Package for Social Sciences (SPSS) to examine the research hypotheses.

Results

Hypothesis 1: There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post test of the control group with respect to the achievement test. The hypothesis was tested using independent T test at $p < 0.05$.

Table 1. Means, standard deviations, and T value regarding research sample responses on the achievement test

Test	Group	N	SD	M	T	Sign.
Achievement test	Experimental group	37	4.3	36.04	9.79	0.00
	Control group	35	2.2	27.98		

It is shown in table (1) that T value is (9.79) which revealed that there is a significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post test of the control group in favor of the experimental group.

Hypothesis 2: There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group with respect to life skills scale. The hypothesis was tested using the independent T test at $p < 0.05$.

Table 2. Means, standard deviations, and T value regarding research sample responses on the life skills scale

Test	Group	N	SD	M	T	Sign.
Life Skills Scale	Experimental group	37	9.19	81.13	7.49	0.00
	Control group	35	6.32	66.94		

It is shown in table (2) that T value is (7.49) which revealed that there is a significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group in favor of the experimental group.

Hypothesis 3: There is a statistical significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group with respect to the multiple intelligences test. The hypothesis was tested using the independent T test at $p < 0.05$.

Table 3. Means, standard deviations, and T value regarding research sample responses on the multiple intelligences test

Test	Group	N	SD	M	T	Sign.
Multiple Intelligences Test Totally	Experimental group	37	3.2	23.16	7.32	0.00
	Control group	35	2.7	18.17		
Natural Intelligence	Experimental group	37	1.9	12.11	7.013	0.00
	Control group	35	1.5	9.23		
Spatial Intelligence	Experimental group	37	1.7	11.01	5.704	0.00
	Control group	35	1.4	8.88		

It is shown in table (3) that T values were 7.32, 7.013, and 5. 704 for the total multiple intelligences test, natural intelligence, and spatial intelligence respectively; which revealed that there was a significant difference between the mean scores of the post-test of the experimental group and the mean scores of the post-test of the control group in favor of the experimental group in respect to the identified two multiple intelligences.

Conclusion/Discussion and Recommendations

Based on the above results, the following conclusion was formed: Middle school second grade female students' achievement of scientific concepts, life skills, and multiple intelligences were improved as a result of studying the scientific unit of 'Reproduction' according to the proposed 4Cs model. This conclusion -based on the above results- came to support the previous writings about the importance and benefits of the four learning theories such as TEXAS (2016) on contextualism, (Siemens, 2004) and (Al-Sheri, 2011) on connectivism, (Matthews, 1992) on constructivism, and (Cruikshank and Others, 2006) on cognitivism. Generally the results of the study came to be consistent with what Johnston (2005) recommended about finding the right mix of methods for students being served and the content being taught.

Moreover, increasing and improving of academic achievement of scientific concepts through this study means that there was a meaningful learning; this is consistent with what Grabe& Grabe (2000) and Moghaddam& Araghi (2013) believed on occurrence of meaningful learning as a result of relating new experiences to what learners already know. The results also came to agree with previous literature and

studies on importance of models driven from those theories like Kurniati& Others (2015) Hutchinson (2002) on contextual learning, and Carcia& Others (2013) Garcia& Others (2015), and Kizito (2016) on connectivist learning, and Anwar (2015), Arseven (2015) on constructive learning, and Moghaddam& Araghi (2013), Castro-Villarreal& Others (2014) on cognitive learning.

Regarding the impact of using the 4Cs model in teaching science specifically, the results of the study came to support Aldridge's opinion (1992) that science learners should know how and when to ask questions, how to think critically, and then how to be able to make important decisions based on reason rather than on emotion or superstition; the aspects that were practiced through the phases of this model. The results also proved the importance of constructing scientific concepts through this model; the issue on which Matthews (1992) stated that constructivism is one of the major influences in present day science education.

According to the above results, conclusions, and discussion, the current study recommends:

- Science teachers should be trained on -or at least should be acquainted with- how to use modern models based on real and effective learning theories.
- Follow up study should be conducted to measure the retaining of improvements in achievement, life skills, and multiple intelligences of middle school second grade female students.
- Future research studies should be continued to develop the 4Cs model and using it in more science topics and units, and in other school subjects.

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