

CONCEPTUAL CHANGE THEORY AS A TEACHING STRATEGY IN ENVIRONMENTAL EDUCATION

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Abstract

The theory of conceptual change came to education as an analogy drawn from the history and philosophy of science as a result of the difficulties people experienced in changing from one explanatory framework to another. Today, other fields of enquiries like environmental education are charged with the task of helping learners in formal and non-formal educational settings to change their long held conceptions, ideas and attitudes which are domineering, destructive and unsustainable towards the environment to a healthier, sustainable and preserving ones that provides the necessary knowledge and skills to solve existing problems and prevent further ones from threatening our harmonious existence with nature. This paper examines the Conceptual Change Model (CCM) proposed by (Posner, Strike, Hewson & Gertzog, 1982) as a variant of the conceptual change theory and how this theory can be applied in environmental education (E.E.) teaching and learning. In an attempt to change misconceptions, practices and attitudes among learners in formal education. The paper practically examines the tenets of the theory and show how it can be used to discover learners' misconceptions about some aspects of the environment and how it can be applied along with other teaching/learning tools in environmental education to affect permanent change in behaviours.

Keywords: Conceptual change, teaching strategy, environmental education

Introduction

Man is inherently a learning organism. He lives by learning, and learning makes him what he becomes. This notion of the educability of man posited by Isangedighi (2004) is in consonance with Bobduru (2001) who opines that given appropriate opportunities and channels of education, humans of all ages are environmentally educable. In the theory of knowledge called epistemology, learning experts present different positions about knowing (learning). One of such positions is the constructivist point of view. According to Adesanya (2009), constructivists maintain that people actively construct new knowledge as they interact with their environment. Everything one hears, sees, feels, reads and touch is tested against ones' prior knowledge and if it is viable within ones mental world (Mental ecology), one may form new knowledge, such knowledge is strengthened if used successfully in ones wider environment.

The conceptual change theory is one of the modern theories of learning that has helped to expand our understanding of constructivism. The learner, as was erroneously proposed by early behaviorists like John Locke and his followers, was considered as one that comes into learning situations blank (a tabular rasa). This view shaped the traditional approach to learning which was that all students' minds process information in the same linear pattern. Williams (2006) asserts that this pattern became the model or teaching template for countless decades of instruction having the same basic steps:

- (1) Teachers present the information while the students listened carefully;
- (2) Students take notes and memorize them
- (3) Teachers interacted with the students through teacher- directed Questions and answers;
- (4) Students returned these information to the teacher to prove they had learned the content of instruction.

According to Williams, learning is not all easily diagramed 1-2-3-4 process, where the teacher was looked upon as the custodian of knowledge because the teacher's ideas were superior and the learners' mere receivers since their prior knowledge is assumed to be insignificant. But studies have shown that students come to study classrooms with a set of well-established conceptions, which are often deviant to those being presented to them by the teacher (Hewson, 1981). These prior conceptions are typically labelled by scholars as alternative conceptions, naive conceptions or preconceptions and misconceptions (Driver 1989, Scott, Dyson & Gater, 1987, Hewson 1982). Their researches further reveal that these misconceptions help to block proper cognitive development of concepts and principles thus making it difficult for learners to gain meaningful learning. To this end, traditional

behaviourist teaching approaches and strategies have been heavily criticized, and consequently other alternative epistemologies have emerged.

Constructivism, one of the new learning theories got its roots from the Socratic dialogue, John Dewey and Jean Piaget's researches on child cognitive development. The new movement also called progressive education, advocates the constructivist learning theory which assumes that learning is a process of gradual re-crafting of existing prior knowledge. The fact that the constructivist learning theory only recognized that new knowledge develops from a base of prior knowledge did not properly address the character and the influence of learner's prior misconceptions in the process of knowledge construction (Ozdemir & Clark 2007). This awareness has given birth to one of the most prominent conceptual change theories which correspond to Kuhn's notion of paradigm shift or Piaget's notion of accommodation proposed by Posner, Strike, Hewson & Gertzog (1982) called conceptual change theory.

This paper discusses the tenets of the conceptual change theory against the backdrop of learners' misconceptions in relation to the teaching and learning processes in Environmental Education.

Conceptual Change and the Conceptual Change Model

Conceptual change can be seen as the “process of using strategies to bring children's thinking in line with that of scientists” (Westbrook & Rogers 1992). From this definition, conceptual change is seen as a set of teaching strategies employed where the students' views are seen as wrong and that of the teacher or scientist is right and as such, it is expected that the student must change their view points to conform to the teacher's views for learning to have taken place.

Conceptual change from the understanding of Tobins (1992), can be seen as “a social process of making sense of experience in terms of extant knowledge... in a socio-cultural context”. This definition sees conceptual change as a normal social interaction where the two parties (teacher and learner) are involved in the exchange of ideas.

But according to Ozdemir and Clark (2007), the conceptual change theory proposed by Posner *et al* (1982), sees conceptual change as more than just a sociocultural interaction or a teaching strategy but as a process of identifying prior misconceptions which the learners carries into the environment in order to help the learner exchange the misconceptions or add new conceptions that are more useful, plausible and intelligible. The assumption that knowledge is gradually crafted (constructed) from a base of prior knowledge by constructivist is what is at variance with modern conceptual change theories and have attracted the following questions. How can a misconceived knowledge base which interfere with learning be

replaced and not resists instruction but support students' knowledge construction? (Ozdemir & Clark 2007)

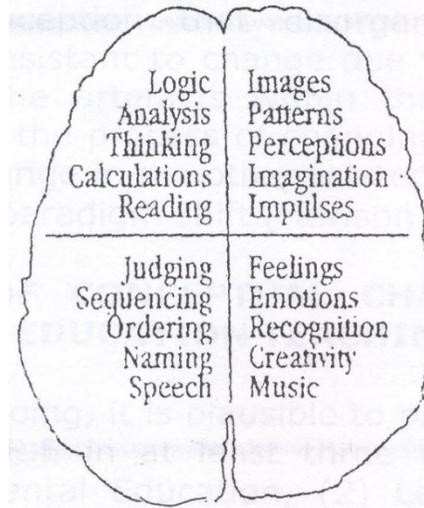
The above observation points out that for constructivism to be taken seriously, the mistaken character of misconceptions in the prior knowledge base of the learner has to be reconsidered. In other words, other ways of dealing with the problem of misconceptions is to enable the learner construct his/her own knowledge without obstructions. From the above, conceptual change refers to what happens in the learner who has come to the learning environment with prior knowledge that might be a misconception that need to be changed or erased in order to accept a better conception.

The concept of change itself can be misleading if it is not properly defined. According to Hewson (1992), change can be seen to have three different contextual meanings as the case may be - change can be understood to mean extinction. Change can be understood as an extension or addition. Change can be seen as an exchange. The new conceptual change theory of learning sees the acquisition of knowledge as a process of extension of knowledge and as a process of exchange of misconceptions with meaningful knowledge, to this end, the teacher is expected to ensure that the student's prior knowledge is identified and worked upon as a basis for helping the student to construct meaningful learning in their schemata (Diseno Curricula Base (DCB), 1989; Champagne, Kloper & Gunstone 1982).

In other words, for the learner who has developed a misconception in his/her prior knowledge, and has carried it to the learning environment, it is required that the status of the conceptions be reduced in the process of learning. The above view of conceptual change led Posner *et al* (1982), to develop a model of learning called Conceptual Change Model (CCM). According to Hewson (1992), the CCM is divided into the following two components. (i) The conditions that need to be met (or no longer met), in order for a person to experience conceptual change, and (ii) the conceptual ecology of the learner, that provides the context in the conceptual change occurs.

The conceptual ecology of the learner refer to the many different kinds of knowledge - epistemological, metaphysical beliefs, analogies and metaphors, etc. acquired by the learner at home or elsewhere, as it has been established that learning do take place without instruction that might serve to structure new information (Ozdemir & Clark 2007). This view is collaborated by evidential research done about the human brain by American neurobiologist Dr. Roger W. Sperry who in 1981 won the Nobel prize in physiology/ medicine for his experimentation on the functions of the brain's left and right hemispheres. His research shows that the left and right hemispheres of the brain each perform different highly specialized functions.

So that some functions are associated with different quadrants of the brain, as represented below.



Source: Adapted from Bryce N. K. (2003)

Gleitman, Fridlund, Reisberg (2004) support this assertion when they affirmed that “thinking can be localized in many different part of the brain. The Occipital cortex is active when people are thinking about visual event or forming a mental image. Broca’s and Wernicke’s areas are active when people are thinking about linguistic materials. The pre-frontal cortex is active in many aspects of thoughts and may provide the natural basis for working memory” (Pp 317).

The above diagrammatic representation adapted from Bryce N. K. (2003) can be said to be the conceptual ecology of the learner. This implies that to learn a new concept the learner must understand it, accept it, and see it as useful. But if the new concept conflicts with an existing conception within the learner’s conceptual ecology, it cannot be accepted until the status of the conflicting conception is lowered. Depending on the exposing event which the teacher presents, the learner may make only moderate changes to his or her conceptions and this is called “conceptual capture” (Hewson 1981), or “weak restructuring” (Carey 1985). But if the prior knowledge need to be abandoned so as to accept a new conception this is a more radical change and is called “conceptual exchange” (Hewson ,1981) or “radical restructuring” (Carey 1985).

Posner *et al* also added that for the new conception to be assimilated or accommodated, it must be intelligible (clear enough), plausible (reasonably true) and fruitful (potentially productive). He and his associates further added that these cognitive conditions must be met during the learning

process as the teacher lead the learners towards creating cognitive conflicts to make the learner dissatisfied with his/her existing conception. This is necessary because a misconception that disorganizes and constraints learning is highly resistant to change due to the web-like links it has formed with the artefacts within the learner's conceptual ecology. Therefore, the process of changing one concept requires a corresponding change in the other related concepts in ways that resemble a kind of paradigm shift (Hewson, 1992).

Implications of Conceptual Change Theory for Environmental Education Teaching and Learning

From the foregoing, it is plausible to propose that conceptual change can be integrated into E.E. in at least three ways: These are; (1) Teaching environmental Education, (2) Learning environmental education, and (3) learning how to teach environmental education. Hewson (1992) had suggested the same for the teaching of science. For the purpose of this paper, we shall consider the first and second points. Many environmental educators believe that the solution to environmental degradation or problems is purely behavioural in content. They highlight attitude change as one of the most important goal to be attained in E.E and training efforts as it will help individuals change towards nature and other life forms (biodiversity), and to empathize with and care for the environment so as to engender lasting environmental friendliness. (UNESCO 1977, Agiande, 2006).

The crucial need for correction of attitude through education to from the old domineering mind set to a new nature respecting ones has been extensively documented by (Denga, 1999; Thurstone, 1977; Hollaran, 1977 in Agiande, 2006). Researchers on attitude define attitude as the sum total of a man's inclinations and feelings, prejudices or biases, preconceptions, dispositions, threats and convictions about any specific thing which may be positive or negative that translate into positive or negative behaviour towards the same.

Emeh (2004) stated that in recent years, concern for the environment has become fashionable and environmental organizations have proliferated but the environment has continued to deteriorate at an alarming rate. One reason for this is that much of what pass for E.E. has remained at a superficial level of mere awareness creation that has not addressed the goal of formal E.E. It has therefore become necessary to adopt more result oriented approaches to change peoples negative attitudes towards the environment, especially in utilizing the formal classroom environment. Long held opinions, attitudes, practices that learners comes to learning situations with as prior knowledge often prevent the reception of desirable knowledge and the acquisition of new skills that will engender appropriate actions

towards the environment. These can be changed, altered or replaced using the conceptual change theory.

Take for an example the National or state sanitation exercises of various administrations in Nigeria which have failed to keep our cities and towns clean because the educators used the indoctrination approach. Nigerians are being indoctrinated to clean up their environments on a certain day of the month. This approach stresses persuasion at the expense of lasting education. According to Ukpong (1991); Nigerians are manipulated with threats of penalties for non-compliance rather than taught and it fails to provide people with the skills necessary to make decisions in the future. This may be why the attitude of most Nigerians towards the environment and identified environmental problems is still poor in comparison to other developing nations.

Teaching Environmental Education Using Conceptual Change

Environmental education is prescribed to be taught through the channels of formal education and non-formal, out-of-school mediums. Many Nations teach E.E. from the primary to the tertiary tiers of education. But in Nigeria, meaningful E.E. is only taught at the senior secondary and tertiary levels. In a typical teaching situation, the teacher is solely in charge of imparting knowledge. The onus then is on a teacher to ascertain students' conception on any E. E. topical issue to be taught at the point of entry behaviour or set induction, the teacher can recognize what constitute misconceptions about such aspects of the environment. Posner and his associates posit that through the use of essential questionings and discussions, student's prior knowledge can be elicited. It can also be done via oral or written communication. Sessions of questioning and collaborative discussions such as open-ended investigations on specific environmental phenomena as flood and erosion, effects of bush burning, endangered plant and animal species can be investigated as co-operative group work process.

Selvam (2009) propose that teachers of E.E. should provide real life situations that link environments to life, as it provides opportunities for learners to explore their environment and see for themselves and experience firsthand existing environmental problems *in situ*. It is in this wise that Hewson and Hewson (1988) in a bid to characterize students' conceptions of a subject (science) before appropriate conceptual change teaching, reviewed researches on students' conception of natural phenomena, teachers' thinking and conceptual change teaching. The Hewsons recommend as part of reporting their findings that to reach for conceptual change, teachers should:

- Know the phenomena, the methods, concepts, principles and theories that constitute what they teach.

- Know what conceptions their students hold about the units to be taught, and the extent to which they are scientifically acceptable.
- Be aware of the role played by students existing knowledge in understanding new material.
- Be convinced of the need to use conceptual change teaching strategies particularly when student's existing concepts conflict with those being taught, and
- Be able to plan and perform teaching action that give effect to these strategies

Learning Environmental Education through Conceptual Change

In learning new content, students are influenced by their current ideas, in ways that may hinder or help their learning. It is therefore useful to think of learning outcomes as a process of conceptual change, including both extensions of knowledge and exchange of conceptions. This implies that the notion that it must be a teacher that will teach before learning can take place should be removed by the learner. It is possible for learning to occur even as the learners interact with the environment (self-directed learning). The assumption that if learning has not occurred that teaching has not taken place may be wrong because in between teaching and learning could be the barrier of misconception (Hewson, 1992).

Environmental education is an outdoor discipline and proponents of E.E. teaching strategies at all levels of education suggest that it be treated as a mission-oriented discipline, first, to get students involved in out-of-class activities, including problem solving and community action. Teachers' role here is to expose them to the necessary environmental knowledge, principles, skills and attitudes and commitment to preventive and mitigative action. Bryce (2003) an expert in modern teaching and learning styles stated that the teacher's role in learning has long changed from that of an instructor to a facilitator of learning and a mediator between the learner and curriculum contents. The teacher now serve to catalyze the learner to always respond actively to learning for selves and also from each other, as the teacher is off the center stage, freeing him/her to work with individual learners, observe groups, assist where necessary, thus ensuring that the burden of learning is where it belongs - on the shoulders of the students. This approach increases learners' direct involvement with the learning situation(s).

The Use of "Futures Wheel" As a Complementary Tool for Conceptual Change Teaching in a Typical Environmental Education Classroom Situation: An Analogy

A hypothetical senior secondary class two (SS II) classroom setting in a rural area of Northern Cross River State is used as an analogy. This

location is chosen because here, youths have grown to imbibe the practice of setting bushes on fire at certain season of the year - dry season to hunt for rodents, and other Bush animals that serve as delicacies and source of meat/protein intake and supplement. Bushes are also burnt each year as part of clearing plots of land for the yearly planting of their food staples which are yam, cassava and rice, etc. Students in this setting have the conceptual mindset that bush burning is unavoidably right, unharmed to the environment, hence it has been practiced for years and the bushes have not totally disappeared, a teacher attempting to teach the ills of this practice will have to deal with this conception before teaching the notion of the negative effects of bush burning across the world to these youngsters in an E.E. lesson.

Two questions arise here. First; How will the teacher go about ascertaining these students' misconception? Second, how will the teacher go about teaching for Conceptual Change? To begin with, the teacher will need to formulate specific objectives to guide the lesson to a logical outcome. The lesson should be planned to include a sequence of learning activities that will provide answers to these questions at the end of the lesson. By way of suggestion, these could be as concisely articulated below:

By the end of the lesson, students should be able to:

- Define bush burning
- Identify some major human activities that promote bush burning
- State some effects of bush burning on the natural and built environment
- Demonstrate how to use the "futures wheel" tool to determine the far-reaching effects of bush burning
- And finally be able to demonstrate the extent to which the futures wheel has affected, altered or changed learners conception of this generational practice.

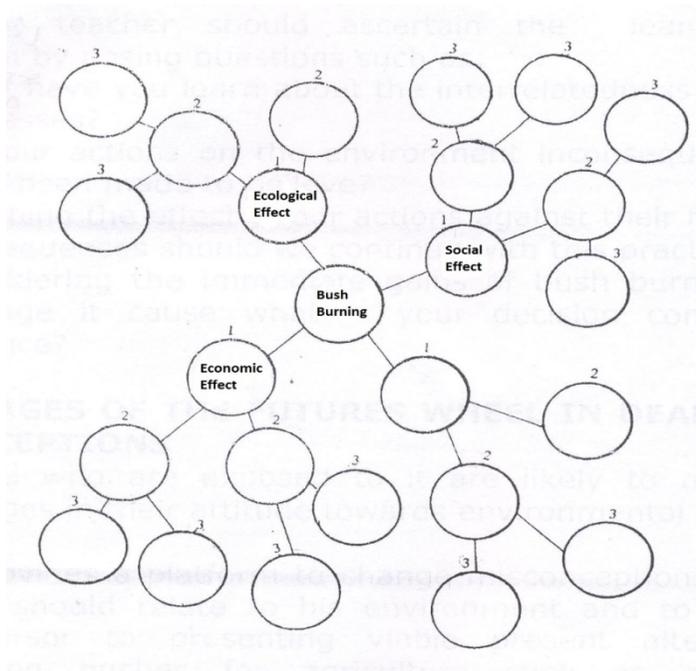
The Futures Wheel

According to Inyang Abia (1993) in Esu, Umoh and Obi (1995) the futures wheel is a teaching tool used to teach in a way that it clarify our actions on the environment on us, our immediate surroundings and distant environment. It enables us to see the consequences of our actions by categorizing them in terms of the interrelationships of these actions with those of others. The tool places the facts about the consequences of our individual and collective actions on the environment through practices like bush burning, pollution of water bodies among others that have been perpetuated for a long time.

It is an analytical tool like 'concept mapping' used in the science to explain complex concepts. The process of outlining and plotting the futures wheel, identify a practice like bush burning, 'show its multifaceted effects before learners and help them make informed decisions based on facts, effects and consequences – such decisions that make for lasting change in the way people conceive, perceive, relate to and influence their total Environment, Inyang - Abia (1995).

The method is useful in imparting new values to learners while at the same time changing old conceptions. It is a student centred, easy-to-use tool that many student as individuals or as a group can use at the same time. It encourages brains-storming as it combine principles of critical thinking and problem solving. Inyang Abia (1995) theorizes that to use the futures wheel for instance to determine the consequences of bush-burning on an individual community, nation and the world now and in the future, the following steps should be employed.

1. First, design an "Activity sheet".
2. Identify the core circle (that is, the one at the centre representing the environmental practice. (In this case it is Bush Burning)
3. Identify all circles numbered 1,2,3, which represent your — mediate, intermediate, and distant (ultimate) environment, respectively
4. Write in the appropriate circle one effect of burn-burning on;
 - a. Your immediate family, community and Local Government Area (L.G.A.) either immediately or in the future. For instance, the effect could be ecological, economic, social or political;
 - b. Your intermediate environment that can affect your state and nation immediately and in the future;
 - c. Your distant or ultimate environment that can affect the neighbouring countries and the earth (the global effect) immediate and future;
- Join with a smooth line the different effects which you think are closely interrelated irrespective of whether they are social, political, ecological or economic;
- Discuss how the various effects interrelate personally, locally, nationally, internationally and globally;
- Discuss how these effects impact on the environment now and the consequences they may have in both immediate and distant future (Inyang-Abia 1995).



An illustrated ‘futures wheel’ consequences of bush burning

Source: Adapted from Inyang-Abia (1993)

Following the example above of the effects of bush burning on our immediate and extended environment and its immediate and future consequences, the facts presented will help to confront and handle learner's misconceptions about bush burning by providing detailed and proven facts about the negative effect of this practice while at the same time providing alternative conception.

The teacher can after this presentation allow the learners to process the facts. This process will fulfill the leaning principle that "sometimes the best learning is un-learning". The procedure of highlighting the pro and con of bush burning by the learners themselves will help them form an alternate conception after which the teacher should ascertain the learner's current conception by posing questions such as:

1. What have you learn about the interrelatedness of ecological Processes?
2. Are our actions on the environment inconsequential as we have been made to believe?
3. Weighing the effect of our actions against their far -reaching consequences should we continue with this practice?
4. Considering the immediate gains of bush burning and the damage it causes, what is your decision concerning the practice?

Advantages of the Futures Wheel in Dealing with Misconceptions

1. Those who are exposed to it are likely to make lasting changes in their attitude towards environmental problems.
2. It provides a platform to change misconceptions about how man should relate to his environment and to serve as a precursor to presenting viable present alternatives to burning bushes for agriculture such as agro-forestry strategies, conservation farming, etc. and the many modern alternatives to bush meat as a source of protein intake; it is expected that any concept being taught if properly outlined as exemplified by the futures wheel presents facts I consequences and the extended effect of a practice that has been misconceives beneficial albeit its consequences.
3. The futures wheel confront the leaner with all the facts and the sides of environmental problems thus creating conflicts with a learners prior conception thus, causing the learner to form a fresh or alternate conception by oneself with or without a teachers' help.
4. The greatest merit of this conceptual change tool in E.E., is that once learners, who are mostly youths, young adults, change their prior conceptions that are domineering of the environment to new ones, they will serve as vectors of know edge to the larger society influencing parents and others in the community.
5. Where superficial solutions like mere creation of awareness about environmental problems will not reduce the problems as observed by Emeh (2005) in Agiande (2006) the futures wheel teaching tool can to a large extent engage and dislodge prior misconceptions of learners as it present the enormous reality of such problems and at the same time create a forum for brainstorming as learners engage in finding solutions to them.
6. It serves to clarify the values long placed on harmful practices while pointing the way to a shift to modern, sustainable practices.

Summary and Conclusion

The idea of conceptual change came to education as an analogy drawn from the history and philosophy of science that was helpful in understanding the difficulties people experienced in changing from one explanatory framework to another. Conceptual change has however expanded considerably since then, from a way of thinking about problematic learning in science to ways of thinking about other types of learning, about learning in domains other than science and about teaching that facilitates conceptual change learning. It does so in ways that are coherent and complementary that provides good explanations of many educational events that continue to raise good questions about current practices and that

suggests fruitful ways of reorganizing these practices. For all these reasons, conceptual change is a powerful teaching concept and teachers should take advantage of it and apply it in other domains of learning beside science and environmental education.

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