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Epistemic Motivation for Conceptual Change In Integrated Science Classrooms In Non-Western Cultures

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Abstract

An analysis of phenomenology as epistemology, and existentialist epistemology was carried out in this paper. The central focus of the two is a view of the world that aims at describing things as they appear to our private consciousness and emphasis on the affective, rather than the rational dimension of man. The problem of developing knowledge is mainly that of human feeling. Knowledge, from this perspective, is developed by feeling rather than by reason. Using this as a substratum, this paper argues for epistemic motivation of integrated science students by the teacher while applying conceptual change pedagogy. This will help to reposition integrated science classrooms for developing human resources for nation building.

Keywords: Epistemic motivation; conceptual change pedagogy; integrated science classrooms.

1. Introduction

The first exit from the educational system in the National Policy on Education (Federal Republic of Nigeria, 2004), is after the junior secondary school education (grades 7-9). This structure of education also is used in Ghana and some of the developing countries in Africa. This means that a part of the citizenry will have only junior secondary school education and will contribute to nation building to the extent they are educated. It is generally accepted by educators and economists that education is an investment in the stock of human skills for national development or nation building. It is aimed at human resource development, which in turn is used for nation building. Oriaifo (1997) says that development is a holistic and multi-dimensional concept which can be considered as an aggregate project that edifies human kind and it commands a wide interpretation that aims at the reformation and improvement of:

- essential goods and services available for human well being,
- the personality and overall qualities of the people in focus; and
- the environment at large.

Development is a project which makes it possible for human kind to reform themselves and their society with due consideration for environmental conservation in such a way as to make it possible for the people to live in harmony with nature. This requires, among others, a holistic approach to learning which integrated science provides.

Integrated science is one of the subjects taught at the junior secondary school level, which is before the first official exit of students from the school system. Integrated science, like other types of integrated curriculum, apart from making learning more meaningful, is centred on life-problems in the society. The latter makes learning of integrated science to be related to life situations. This characteristic, as well as its holistic approach to content or themes and methodology, amplifies its relevance for national development. The purpose of this article is to canvas for the use of conceptual change pedagogy while teaching integrated science. Particular attention is paid to epistemic motivation, which emphasizes feeling rather than reason in the development of integrated science knowledge for nation building in non-western cultures. Underachievement in science in Nigeria and other non-western cultures has been explained, in part, by the observation that science education is not culturally sensitive (Urevbu, 1987, Lewis, 1990; Apple, 1992; Kyle, 1993). Specifically, Lewin (1990) says that researchers and science educators had a long way to go in developing ways of representing science that are not 'foreign, expert, and culturally unsympathetic' (p. 18). Cobern (1996) asks the questions, 'To what extent does western garb inhibit the learning of scientific concepts?' and 'Must African nations, for example, adapt to science and adapt science to African culture exactly as the west has done?" He goes on to say that to effectively address these and other questions, 'researchers must have a view of learning that is transferable across, and appropriate for, different cultural environments' (p. 293). This view of learning, according to Cobern (1996), is constructivist thought. Conceptual change pedagogy is premised on constructivist approach which solicits active participation of students in the construction of knowledge and development of affective components of learning from it.

2. Conceptual Change Pedagogy

Ausubel's (1968) statement, 'the most important single factor influencing learning is what the learner already knows, ascertain this and teach him accordingly' (p. iv) has influenced school science teaching, especially in the developed educational system, tremendously. For instance, emphasis is placed on investigating the ideas that primary and secondary school students bring to their science classrooms. Several techniques are used over the years, to determine these ideas in a range of topics. Such techniques include: word association (Shavelson, 1974; Preece, 1976), concept mapping (Glass, Holyoak & Santa, 1979; Stewart, Kirk & Rowell, 1979; Novak, 1981, 1990; Okebukola, 1990), sentence completion (Head and Sutton, 1981), demonstrate, observe and explain (Champagne, Gunstone & Klopfer, 1981, 1985), interview-about instances (IAI) (Pines, 1977; Deadman & Kelly, 1978; Osborne & Gilbert, 1980a, 1980b; Abimbola, 1985, 1986; Igwebuike, 1990).

The use of these techniques has indicated that the students' ideas about scientific phenomena and objects differ significantly from scientific conceptions. This is mainly because they rely most of the time, on direct observation of facts, which are instances of the phenomena and objects in question. Other reasons for the difference, according to Osborne, Bell & Gilbert (1983), are:

a) Children tend to view things from a self-centred or human centred point of view and tend to consider only those entities and constructs that follow directly from everyday experiences.

b) Children's experiences of the world are limited and tend not to include contrived experimental situations, e.g. water boiling at low pressure, frictionless situations.

c) Children tend to be interested in particular explanations for specific events and tend not to be concerned with the need to have mutually coherent and non-contradictory explanations for a variety of phenomena.

d) The everyday use of language tends to be subtly different from the language of science particularly with regard to basic and important words like "animal", "friction", and "force", and these everyday meanings tend to shape children's constructions.

Some specific examples of children's ideas that are dissonant to science concepts as presented by Osborne, Bell and Gilbert (1983), are: gravity is something which holds us to the ground, if there was no air there would be no gravity; in a gas burner, the flames are eating up the gas; electric current flows from battery to bulb and is used up; plant take in food from the soil, air is weightless and makes things go up; animal is a furry four-legged creature, an earthworm is not an animal; a plant is something growing in the garden, a carrot from the garden is not a plant; human energy makes a piece of stone to be catapulted; energy is the same with energy resources like fuel, battery etc; when candle is burning there is no energy change; etc. These and many other preconceptions (Clement, 1982) or alternative conceptions (Gilbert & Watts, 1983; Abimbola, 1988) can be restructured. The process of restructuring is referred to as conceptual change (Vosruadou, 1999) and instruction that facilitates it is conceptual change pedagogy.

Conceptual change pedagogy is that approach to science teaching, which recognizes that:

(i) Children bring ideas which may differ a great deal from scientific ideas;

(ii) Children interpret what they are taught or what they see in the light of these ideas they bring to the science classrooms;

(iii) Children are not mere receptors of scientific ideas but have to "reconstruct" them in some personal manner to enable them accept scientific ideas;

(iv) Learning of science involves series of construction and reconstruction of meanings the children give to experiences;

(v) Constructing meaning is an active process;

(vi) Children are generally committed to their ideas, a phenomenon often referred to as epistemic commitment, and which can result to tenacity of such ideas if the lesson is not well handled;

(vii) Learning science involves conceptual change and children should be adequately motivated to facilitate the conceptual change; and

(viii) Epistemic motivation can reduce epistemic commitment on the part of the children, to their ideas and can therefore facilitate conceptual change.

Zhou (2010) delineates two models of conceptual change. The first is the 'cold' model while the second is the 'warm' model. The 'cold' model is premised on elaboration by Posner, Strike, Hewson, and Gertzog (1982) that some cognitive conditions must be fulfilled before any conceptual change can take place. These conditions are in terms of students' dissatisfaction with their alternative conceptions and the intelligibility, plausibility and fruitfulness of the scientific conception. Posner et al (1982) based their enactment of these conditions on Kuhn's (1970) theory of scientific revolution which tries to describe the process of scientific progress. In the process, some anomalies which arouse dissatisfaction with otherwise a stable old paradigm are detected by the scientific community. If a new paradigm can help to solve more problems, make more accurate predictions, among others, there can be scientific revolution.

Based on this model of conceptual change some strategies are suggested for managing classroom interactions. For instance, Bussbaum and Novick (1981) suggest that the teacher should (a) make children's alternative conceptions explicit to them, (b) bring about dissatisfaction by presenting evidence that is anomalous, and (c) present the new (scientific) conception and explain how it can account for the anomaly. Minstrell's (1985) proposal has four steps: (a) engaging students' preconceptions (b) using lab activities or other experiences that are discrepant with the students' preconceptions, (c) encouraging students to resolve the discrepancies through class discussion, and (d) providing students with opportunities for application of the new scientific conceptions.

Tenacity of children's ideas results from the use of this 'cold' model of conceptual change. Children, as established in some studies (Osborne, et al, 1983; Hewson, 1985; Osborne, 1985; Igwebuike, 1987; 2000; 2008; 2011; Hewson, Tabachnick, Zeichner, Lemberge, Marion, Mayer & Park, 1994; Wandersee, Mintzes & Novak, 1994, Stoffleth, 1996) resist changing their ideas. This is largely because conceptual change has been misconstrued as a purely rational process of cognitive restructuring or replacement of old ideas with new scientific ideas. According to Novak (1977) affective experiences, which bring about conceptual change, are not transmitted directly in the same way that knowledge is transmitted. There is still much, he continues, to be learned about how to help the children enjoy better affective experience. But unfortunately, this area is not yet open to the kind of rational analysis that we can apply to cognitive learning studies.

While it is important to create situations, which will challenge the children's ideas and beliefs to bring about conceptual changes, their feelings and dispositions are an important aspects of the process (West & Pines, 1983). The argument is that answers should be sought to these questions by the conceptual change agent or teacher: does the child feel good or proud or satisfied? Alternatively, does he feel bad, demeaned or dissatisfied? They are supported by Strike & Posner's (1992) admission of the necessity of addressing motivational and emotional issues that arise during conceptual change as well as the cognitive aspects of the conceptual change pedagogy. Strands of criticism of this 'cold' model have been converged by Zhou (2010). The criticism is rooted on the assumption by Posner et al (1982) that learning is a rational activity. The model therefore neglected 'the irrational characteristics of learning.' Zhou (2010) argues that the learner characteristics entail existing knowledge and motivational factors, and that the strength and coherence of a learner's existing knowledge and his or her commitment to it influence the likelihood of conceptual change. Motivational factors, according to Zhou (2010), refer to a learner's interest and emotional involvement, self-efficacy, value, need for recognition, as well as the social context that supports or not, his her motivation. An implication is that there is more to conceptual change pedagogy than mere creation of cognitive conflict or dissonance and arousal of dissatisfaction by the student.

The second model is the 'warm' model which incorporates motivational factors into conceptual change pedagogy. Zhou (2010) uses the 'warm' model to suggest an approach to conceptual change pedagogy. This approach is argumentation. He argues eloquently that argument is an essential tool in the development of scientific body of knowledge and that science should be taught in a way that reflects the nature of science. Argument, according to him, is a social process because it brings about dialogues between at least two sides. It addresses the importance of motivation and collaboration in the learning process as well as metacognitiion which is crucial for learning through conceptual change. He demarcates six steps in the argument approach to the teaching science. The steps are: (a) Present problem context (b) Elicit student ideas (c) Create cognitive conflict (d) Construct scientific notions (e) Defend the scientific notions (f) Evaluation. He supports the efficacy of this approach with evidence from a project called Modular Approach to Physics (MAP) in which he participated

Zhou's (2010) argument approach to conceptual change is similar to negotiation approach which Jegede and Taylor (1998) suggest should be a significant part of science teaching strategies. Negotiation is a classroom social practice in which teacher and students jointly and actively interact to arrive at a consensus of meaning ascribable to an event (McCarthy, 1991). They both have the goal of achieving a consensus of meaning between the teacher and his students or between groups of students. If semantics were to be a major consideration negotiation is a more subtle term than argumentation. But both of them are based on the 'warm' model which, as mentioned before emphasizes the role of affectivity during conceptual change.

The contention in this article is that both argumentation and negotiation approaches can provide epistemic motivation for conceptual change in integrated science classrooms/laboratories. Epistemic motivation, among others, will facilitate conceptual change in integrated science classrooms. The question now is, what is epistemic motivation? Secondly, what is the relevance of a distillate from the analysis of phenomenology and existentialist epistemology as a substratum for epistemic motivation for conceptual change pedagogy in integrated science classrooms?

3. Epistemic Motivation

Within the context of this article, epistemic motivation is the learner-friendly "force" or reason for not just believing the scientific concepts but knowing them. There is a gulf or chasm between knowledge and belief. Knowledge is justified true belief. A teacher using the tenets of conceptual change pedagogy can be said to carry out epistemic motivation when he provides a learner – friendly propulsion for himself and the learner to justify what they believe. Exponents of conceptual change pedagogy (Driver and Oldham, 1986) emphasize the difference between knowledge and belief. For instance, they say that a learner may not believe that electric current is not used up by the bulb (the example given earlier). At this point, the learner should be given opportunity to justify the belief. The opportunity is provided through epistemic motivation.

It is considered auspicious at this time to provide more elucidation of epistemic motivation by presenting brief analyses of phenomenology and existential epistemology.

4. Phenomenology as Epistemology

Phenomenology is a view of the world that aims at describing objects and phenomenon as they appear to our private consciousness (Kneller, 1971). This method consists of an intuitive grasp of one's conscious experiences with objects and phenomena and after this, the conscious experiences are expressed using ordinary language. The expression is subjective and can hinder the acquisition of objective knowledge.

The founder of phenomenology, Edmund Husserl (1959-1938) refers to such expressions as prior assumptions, belief, prejudices or pre-suppositions about the objects or phenomena of our investigation (see Omoregbe, 1998). He advises that they should be put aside so that we can investigate the phenomena with open, "free and presuppositionless attitude". The same thing should be done to a phenomenon under study. We put aside all the attributes or characteristics of the phenomenon to allow us focus attention on its essence as it reveals itself to our consciousness.

There is consonance between phenomenology as epistemology and conceptual change pedagogy. Both accept that an individual developing knowledge by studying a phenomenon has a set of ideas, or beliefs, assumptions. These are put aside to enable him focus on the essence of the phenomena as it reveals to his consciousness. A major difference however, is that the ideas, beliefs etc are put aside with care, in the case of conceptual change pedagogy, so that the feelings of the learner are not hurt. For this reason, children's ideas about scientific phenomena, irrespective of the degree of dissonance with scientific conceptions, should not be referred to as misconceptions but alternative ways of looking at scientific phenomena (Igwebuike, 1987; 1991). This suggestion agrees with existentialist epistemology.

5. Existentialist Epistemology

Existentialism is not an epistemological doctrine per se (Omoregbe, 1998) but a philosophy of human existence. It focuses on nature of the human predicament – his experience of freedom and constraint, his self-creating possibilities, his search for meanings. According to Harper (1955), "existentialism is concerned principally with liberal education freeing man from his isolation and his anonymity, freeing his mind from the confusions that prevent him from seeing his situations and his powers" (p. 227).

The existentialists regard scientific empiricism as a means to the understanding of objects and phenomena and not as an end in itself. An existentialist teacher would say to his pupils, "these things have been found to be true by many people; now see for yourself whether they are true or not. If you do not find them true, say so and let us discuss them together" (Kneller, 1971:78). An instance of this is that it is not enough for Newton's laws of motion to be true for scientists. The learner, must find them to be true himself and incorporate them within his view of the world. The teacher presents scientific ideas, for instance, and asks his pupils how they feel about those ideas. After which there is negotiation between him and his pupils.

To this extent, existentialists believe that feeling rather than reason, differentiates man from other animals. In this case, man is an affective or feeling animal (Omoregbe, 1998: 101). Miguel de Unamuno, one of the existentialists, objects to Descartes' "Cogito ergo sum", meaning, "I think therefore I am". He says that the primary reality about man is not the fact that he thinks but the fact that he feels. It is better, he argues, to say, "I feel, therefore I am".

He also says that "understanding the so-called problem of knowledge there is simply this human feeling". He further argues that knowledge is acquired more by feeling than by reason. He however, does not deny that reason is part of knowledge acquisition. Piaget and Inhelder (1969) say that affectivity is a driving force for behaviour patterns and that there is no behaviour pattern, no matter how intellectual, that does not involve affective patterns as motives. This position further supports the existentialist treatise on man as an affective being. Zhou (2010) summarizes by presenting a clarification that affectivity "is a doorkeeper. It controls whether or not the mechanism of assimilation, accommodation and equilibration, happens during certain experiences" (p. 103).

The existentialists therefore express the important role of feeling in human life and in epistemological pursuit, a fact that, according to Omoregbe (1998) philosophers in the past tended to ignore. Science educators and teachers have also ignored the role of feeling in the pursuit of knowledge in science, a fact which is partly responsible for underachievement in science in the Nigerian experience. Emphasis is not placed on feeling at the interface between justifying belief systems by the students and acquiring scientific knowledge.

6. Confluence of Phenomenology and Existentialist Epistemology

Pious hopes can be placed on conceptual change pedagogy which utilizes the confluence of phenomenology and existential epistemology. The pedagogy carefully explores pupils' ideas, beliefs, assumptions etc, and provides the environment for them to justify the ideas etc in such a way that their feelings are respected. When their ideas are valued and their feelings are respected; epistemic motivation is created for the breakdown of their epistemic commitment to their ideas. This in turn will facilitate conceptual change to scientific knowledge. The major question now is "how can epistemic motivation be carried out specifically, to bring about conceptual change?"

7. Ways of Bringing about Epistemic Motivation

To bring about epistemic motivation for conceptual change pedagogy, an integrated science teacher can follow the sequence provided below, as appropriate:

i. Exploring students' ideas using learner –friendly devices like interview-about-instances (IAI) and interview-about-events (IAE), and concept mapping (see Igwebuike, 2001). These devices are different from examination questions. The students will not think that the teacher is testing them when he uses any of the devices. They will interact with the teacher within an atmosphere that is free from tension characteristic of examinations and tests.

ii. Clarifying ideas from the students and sensitising them about their own ideas.

iii. Interacting with the students in a way that will make them realize that the teacher values their ideas. No matter the degree of dissonanace with the scientific conception (Igwebuike 1991), the students' ideas should not be referred to as misconceptions but as alternative conceptions (see also Abimobola, 1987).

iv. Carefully presenting (existentialists will say, offering) the scientific conception, which is the subject matter of study.

v. Providing the environment for the students to justify their ideas and for the teacher to justify scientific conception. We have mentioned earlier that knowledge is justified belief.

vi. Watching out for students' feelings, whether negative or positive. The teacher can ask the students how they feel. He can devise new ways of making their feelings to be positive.

vii. Helping students to develop positive affects like, goodness, enjoyment, likeness/love, excitement, interest, sympathy, readiness, happiness, curiosity, instead of negative affects like frustration, fear, anxiety, 'chilly' interaction patterns, upset, confusion, annoyance/anger, pressure, hate, unstable, discomfort, avoidance, withdrawal, embarrassment etc.

viii. Relating their positive feelings to different forms of extrinsic reward.

ix. Explaining to the students the need to change conceptually.

These suggestions are supported by a number of studies carried out in some advanced educational systems. For instance, Pintrich, Marx & Boyle (1993) criticized lack of focus on affective characteristics of students by teachers and researchers using scientific conceptual change pedagogy. Stofflett (1996) reinforces the criticism. Strike & Posner (1992), and Dadds (1993) emphasize the need to address motivational and emotional issues that arise during conceptual change, in addition to the cognitive aspects of the process. Dadds in particular, maintains that the distinction between affect and cognition is in fact a false one. Maxwell, (1994) suggests that there is need for fundamental changes in the nature of rational inquiry in order to address the role emotions play (perhaps in response to the tenets of existentialist epistemology).

8. Implications for Nation Building

Integrated science, as one of the science subjects, plays important role in nation building. Fafunwa (1971) says that any country that does not recognize this truism does that at its own peril. It helps at the basic education level, to prepare scientists and technologists as well as scientifically literate citizenry. Igwebuike (1998) also argues that the solution to the problem of national development lies in part, with pursing scientific and technological literacy and numeracy in the citizenry. The students who will terminate their formal education after the junior secondary education, may not study science within the formal school system again. Such students should be scientifically literate before they leave the school system.

Teaching integrated science in a way that will place much premium on students' ideas about scientific conceptions, and their feelings while making a conceptual shift will help to increase the percentage of scientifically literate citizenry needed for national development. Scientific literacy is a combination of cognitive aspects and motivational and emotional issues.

Let us take the problem of environmental conservation which is very phenomenal in our cities, and which negates national development, as an example. One of the themes in the Nigeria Integrated Science Project (NISP) is "You and Your Environment". Some of the issues about environmental conservation are raised in the NISP. But the problem now is, "how is such a theme developed in the students?" The teaching concentrates on the cognitive aspects and does not utilize the ideas about environmental conservation that students bring to the learning situation. The same thing happens when the other themes are taught.

Epistemic motivation for integrated science teaching, within the conceptual change pedagogy, will help to harness the affective aspects of scientific literacy for national development. It is therefore a sine qua non or an essential condition for utilizing integrated science teaching for national development especially in non-western cultures where western science is foreign.

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