COGNITIVE COACHING: A TOOL FOR BOOSTING STUDENTS' ACHIEVEMENT IN BASIC SCIENCE

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ABSTRACT

As part of the sustained efforts by science educators at improving learners' academic achievement, this paper examined the effectiveness of Cognitive coaching as a conceptual change strategy in teaching and learning of Basic Science. 154 male and female students from 4 intact classes taken from 4 randomly selected junior secondary schools in Kwara state, Nigeria, participated in the study. 2 students randomly selected from each treatment group were made to participate in a video recorded debriefing protocol. One research question was answered while three hypotheses were tested. Three instruments were developed and validated to track students conceptual change process in the study. These include: Self-Concept Inventory, Basic Science Cognitive Achievement Test and a Basic Science Conceptual Change Debriefing Protocol. Results revealed an improvement in conceptual understanding of selected concepts in the Cognitive coaching group over those in the Conventional group. It was recommended that students should be encouraged by their teachers to develop confidence in themselves since their participation in Cognitive coaching will enable them to communicate their thoughts in simple correct language of discussion. It will also encourage them to take control of their learning therefore resulting in improved performance.

Keywords: *Cognitive Coaching, Self-Concept, Achievement, Conceptual Change, Basic science.*

INTRODUCTION

In theory at least, when contrasted with evidence that contradicts existing assumptions, rational observers will accommodate their thinking to fit the latest observations. The Nigerian education system has undergone several developmental stages moving from rural science, the one preparing students for a totally agrarian society to one where industrialization and technology have come to stay. This shift has formed the basis for the selection of subjects to be offered in schools as well as the contents of the curriculum deemed necessary for the acquisition of knowledge and skills by the learners. It is in the light of the pursuance of the global demand by National Standard and goals for reforming science education for more academic rogour in teaching

and learning of complex subject matter (American Association for the Advancement of Science, AAAS, 1993; National Research Council, NRC, 2000) that the Federal Government of Nigeria embarked on educational reform which necessitated the appraisal of the science curriculum at the Universal Basic Education (UBE) level.

The outcome of this reform is the unification of Integrated and Technology sciences into Basic Science (Nigeria Educational Research and Development Council, NERDC, 2007). This new project stressed that science education shall cultivate inquiry, knowing and rational thinking for the conduct of a good life and democracy (FGN, 2004). Despite the efforts of science education reformers to publicize the relevance of the subject to technological development of the nation, the recurrent students poor achievement recorded in their end of basic education examination has become a worrisome phenomenon to all stakeholders. In order to ameliorate the situation, quite a number of researchers have reported the impact of some approaches that could remedy the persistent students' failure, taking into cognizance the fact that a credit pass in Basic Science is a prerequisite requirement for students to study science related courses at the advance levels. Among such approaches are the use of: Self-learning strategy (Aiyelaagbe, 1998), Computer and Text-assisted programmed instruction (Udousoro, 2000), Concept mapping (Ige, 1998; Asan, 2007), Information Communication Technology (ICT) (Aladejana, 2007), a constructivist model (Anyanechi, 2008) and Teacher-directed and Self-directed strategies (Adesoji, 2008).

It seems however, that some other factors needed to be addressed alongside the teaching innovations. This compelled the researchers to extend their search to considering students existing knowledge before instruction and the need for conceptual change where necessary. If really we want to lead students to understand and acquire scientific conception, we need to make use of strategies that can expose students' prior knowledge and facilitate conceptual change. The Cognitive coaching strategy is conceived to be an innovation in this direction. Cognitive coaching is based on the idea that meta-cognition which involves the modeling of self-appraisal and the self-management of cognition by an expert foster independence in learning. As proposed by Costa and Garmston (1994), it enables people to modify their capacity in order to modify themselves. It has three maps as:

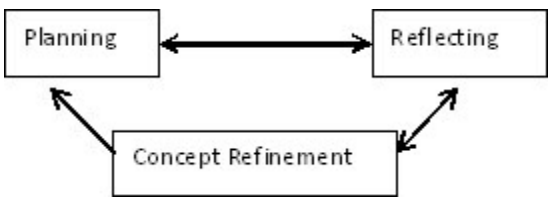

Fig 1.1: Adapted Cognitive Coaching Maps (Koestler, 1972)

When applied to Basic Science learning and a student reflects on certain concepts to be learnt, thinking begins about the next activity and planning follows based on what to be learned from reflecting on previous experience. Conceptual change can come from a student feeling 'stuck' or can be part of reflecting or planning. When the student is 'stuck' in thinking, it is usually one or more of the states of mind that are causing the 'stuckness'. The main tools of Cognitive coaching are: rapport, meditative questioning, response behaviours, pacing and leading. It is crucial that the students learn these tools and use them since the major focus of Cognitive coaching is trust and rapport. For a purposeful application of Cognitive coaching, it distinctively demands that the people involved in its application undertake the following steps:

- build trust by developing physical and verbal rapport,
- facilitate thinking, questioning and developing greater precision in language,
- develop a student's autonomy and sense of community by increasing his/her sense of efficacy and self-awareness,
- apply coaching skills which enhance the intellectual process of performance.

It is assumed that Cognitive coaching would help to reveal that thought and perception produce most behaviour; that teaching is constant decision-making and that to learn something new requires engagement and alteration in thought. This would influence students' ability to achieve better in their academic activities when compared with conventional method. Here, it is believed that for learners to develop the ability of right understanding of scientific concepts through the use of Cognitive coaching there exist a link between the strategy and the learners' self-concept. Self-concept is that tendency to regard oneself as an object which could be favourable or unfavourable. A favourable self-concept is essential for personal happiness and effective functioning, both in the student and in the adult (Aremu, 1997). Low self-concept has been identified by Salami (1987) and Busari (1991) to be responsible for poor academic achievement in science subjects. It is imperative therefore to reflect on the efficacy of Cognitive coaching strategy on students' self-concept over academic achievement.

The relevance of Basic Science to technological development in Nigeria is very vital and the knowledge of the concepts in the subject is a pivotal to the scientific academic careers of students. This notwithstanding, only negligible sample of students made it to offer science courses at higher levels due to their recurrent mass failure in the Junior Secondary Certificate Examination (JSCE). In spite of researchers' efforts in bailing students out of this menace, not much success has been recorded. It is germane therefore, to source for and address such other latent challenges which may be responsible for this goal denial phenomenon. This can be by finding out what students prior experiences are like and developing ways of monitoring their processes of conceptual

understanding. This is why the present study investigated the use of Cognitive coaching as a booster of students' achievement in Basic Science. This study is significant in that it would expose Basic Science Teachers to a variety of exploits made by their counterparts in the area of science teaching all over the world through the application of conceptual change strategy to their classroom activities. It would as such give them the necessary impetus to aspire to do such seemingly impossible task through the use of the strategy.

Findings of this study would as well provide a fore-knowledge to both the teacher and students on variables that may impede or enhance students learning outcomes in Basic Science so that they would be equipped to forestall the impediments while embracing and learning positive re-enforcers. The findings of this study would cause teachers to be to understand why student-related variables (self-concept) might make or mar any significant contribution to students' academic progress. Thus, does the strategy employed affect learners' conceptual change? This constitutes an important question to ponder.

Hypotheses

Ho_1: There is no significant effect of Cognitive coaching strategy on students' achievement in Basic Science.

Ho_2: There is no significant effect of Self-concept on students' achievement in Basic Science.

Ho_3: There is no significant interaction effect of Cognitive coaching strategy and Self-concept on achievement in Basic Science.

METHODOLOGY

The study adopted a pretest-posttest, control group, quasi-experimental design. In addition, students' scientific conceptual change was captured through structured debriefing protocol. The strategy used in this study was planned to prove the essence of: creating conditions in which students can evaluate empirical evidence that is contrary to their experience; providing clear explanations of scientific concepts; improving students interaction, preferably through communication/verbal expression; and promoting intentional learning that is plausible, purposeful and convincing through high level of meta-cognitive awareness and self-regulation. 154 junior secondary school II students in 4 intact classes from 4 randomly selected schools were purposively assigned to treatment from Ifelodun and Moro local government areas of Kwara state. They received treatment on Energy and Simple Machine in this study. A pretest was administered on all the students. A debriefing protocol was conducted before and after each concept's treatment on 2 students randomly selected from each group.

Each class had three periods of 40 minutes per week for 8 weeks. The Cognitive coaching strategy group was facilitated by a teacher who created rapport, guided students to build trust by developing physical and verbal rapport, facilitate thinking through questioning and developing greater precision in

language, developing individual autonomy and sense of efficacy and self-awareness. It further involved the monitoring of one's thoughts and their effects. Students in small groups of 3 were made to rehearse coaching interactions that were congruent with the concepts learned as well as applied coaching skills that enhance the intellectual process of performance. Students were supplied with materials to work with, read related passage from text, write their discoveries in a workbook and swapped work for scoring. Discussions were made on discoveries to clarify misconceptions. The usual convention in the control group was not interrupted. Three instruments provided data for analysis.

(i) A 30-item Self-concept inventory (SCI) was constructed and validated to have a reliability coefficient of 0.79 using Split-half. It was used to solicit for students self favourable or unfavourable perception on a 4-point scales: Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD).

(ii) A 30-item Basic Science Cognitive Achievement Test (BSCAT) developed from past objective questions of final JSS state examination based on the concepts taught only. It was validated having a difficulty index of 0.54 and a reliability index of 0.73 using KR-20.

(iii) A Basic Science Conceptual Change Debriefing Protocol (BSCCDP) that contained 4 tasks on each of the concepts considered was purposely meant to expose students' weaknesses in scientific conceptual understanding. It has a reliability index of 0.67 using Scott's ? method.

RESULTS AND DISCUSSION

The extract from the replayed video compact disc (VCD) of students' response to tasks on the debriefing protocol indicates a change in conceptual understanding of selected concepts for students' (Yunusa and Sakirat) exposed to Cognitive coaching strategy. They displayed better scientific conception than their counterparts in the control group (Alabi and Victoria). Yunusa and Sakirat improved each, from 1 correct answer at pre treatment to 3 correct answers at post treatment debriefing on energy. They also improved from no answer at pre treatment to 4 correct answers at post treatment debriefing each on Simple Machine. Alabi and Victoria however, could only grow from zero at pre treatment to 1 correct answer at post treatment debriefing respectively on energy while scoring zero and 1 at pre treatment respectively to 1 each at post treatment debriefing on simple machine.

It was observed that the students in the Cognitive coaching strategy improved significantly in their scientific conception of the concepts selected from pre treatment to post treatment while those in the conventional method did not display any significant conceptual change. This result indicates clearly that the strategy (Cognitive coaching) used in this study did effectively alter

learners' conceptual framework of selected Basic Science concepts. There was improvement in their way of thinking and of talking about scientific concepts than observed by learners' in the control group. This finding corroborated the result of the study embarked upon by Georghiades (2002) who submits that the type of strategy employed in teaching and learning a given subject matter helps a lot at promoting better metacognitive understanding and intentional learning required to produce more desirable conceptual change in science education.

Test of hypotheses

Ho_1: There is no significant main effect of Cognitive coaching strategy on students' achievement in Basic Science.

Table 1: ANCOVA of post Test Achievement by Treatment and Self-concept

Source of variance	Sum of squares	df	Mean square	F	Sig (p)
Covariates Pre-achievement	2207.045	17	207.521	20.521	.000
Main effect (combined)	410.744	2	82.149	8.142	.000
Treatment	214.85	1	107.192	10.624	.000*
Self-concept	42.900	1	42.990	4.261	.040*
2-Way Interactions (combined)	60.843	1	7.605	.754	.644
Treatment					
Self-concept	7.698	1	3.849	.382	.683
Model	754.798	14	41.933	1.156	.000
Residual	2058.251	139	10.089		
Total	2813.049	153	12.671		

Source: Survey 2010. *Significant at P<.05

The result as indicated on table 1.1 shows that there is a significant main effect of treatment on students achievement in Basic Science ($F(1, 153) = 10.624$; $P < .05$). This implies that there is a significant difference in the mean achievement scores of students in the Cognitive Coaching and control groups culminating in the rejection of the first hypothesis.

Ho_2: There is no significant main effect of Self-concept on students' achievement in Basic Science.

It is also revealed on table 1.1 that self-concept had a significant main effect on students achievement in Basic science ($F(1, 153) = 4.261$; $P < .05$). This affirms that students with favourable self-concept differ significantly from those with unfavourable self-concept, so the second hypothesis was rejected.

Ho_3: There is no significant interaction effect of Cognitive coaching strategy and Self-concept on achievement in Basic Science.

A further look at the table shows a no significant interaction effect of treatment and students' self-concept on their achievement in Basic Science concepts ($F(1, 153) = .382$; $P < .05$), thus the third hypothesis was not rejected. To determine the magnitude of the significant difference, table 1.2 shows an MCA of achievement by treatment and self-concept.

Table 2: Multiple Classification Analysis (MCA) of Achievement according to Treatment and Self-Concept Grand mean = 8.56

Treatment + Category		Predicted Mean					
	N	Un	AFC	Un Dev.	Eta	AFCD	Beta
Treatment Cognitive	67	9.00	8.85	.44		.29	
Coaching	87	7.51	7.68	-.98	.224	-.88	.205
Control							
Self Concept							
Low	73	8.03	8.11	-.53		-.45	
High	81	9.08	9.00	.52	1.48	.44	.126

Source: Survey 2010. R = .469, R squared = .220

N/B:Un= Unadjusted, AFC=Adjusted for factors and coveriates, UnD = Unadjusted Dev, AFCD = Adjusted factors and covariates Dev

Table 2 reveals that students exposed to the Cognitive coaching strategy had higher mean score (= 8.85; adj. dev. = .29) than those in the conventional method (= 7.68; adj. dev. = -.88) in achievement. This could be because students in the Cognitive coaching group created rapport, sought precision, refinement and mastery from learning resources and monitored their own values, thoughts and behaviour as well as the effects of these. Thus learners selected different means most appropriate for each situation in an effort to better regulate their learning. This is because the strategy enabled the learners to adopt the conditional knowledge of metacognitive awareness which foster them with knowing when and why to apply various cognitive actions (Gerner, 1990; Lorch, Lorch and Kusewitz, 1993). This finding is in consonance with the submissions of Costa and Garmston (1994) who proposed that Cognitive coaching supports instructional change while Edwards (2005) as well as Ellison and Hayes (2006) opine that it enhances peoples thinking.

The Cognitive coaching strategy employed in this study resulted in new experiences and new ways of thinking and experiencing among members of the group. This helped to build students' knowledge structures as well as change their erroneous impression about scientific concepts. Thus, the use of Cognitive coaching as conceptual change strategy in Basic Science learning can be appreciated since it has effectively improved students understanding of selected Basic Science concepts.

In the same vein, students' self-concept was found to have a significant main effect on students' achievement. Students with favourable self-concept had higher achievement mean score (= 9.00; adj. dev. = .44) than their unfavourable self-concept (= 8.11; adj. dev. = -.45) counterparts. This finding also agrees with what Guay, Marsh and Boivin (2003) obtained in their study that there exists a mutual causality between the academic self-concept and the academic achievement of students. The students with favourable self-concept could have benefited considerably in academic achievement due to the fact that they tend to invest more time to engage in learning activities in correspondent learning subject. On the other extreme the unfavourable self-concept students may have shown passive investment to learning thereby resulting in weaker achievement.

From all indication therefore, it could be established that students who perceive to be more effective, more confident and more able, accomplish more than students with less positive self-perceptions. This implies that academic self- concept has motivational properties in which changes in academic self-concept can lead to changes in subsequent academic achievement and vice-versa. In consonance, Marsh (2003) maintains that as children grow older, their academic self-concept response become more reliable. This reliability on self-concept responses is of course a fuel necessary to keep the engine of academic achievement running efficiently. The interaction effect of treatment and self-concept did not reveal any significance in this study; this means that one's perception of self and Cognitive coaching strategy did not jointly influence students' achievement. This indicates so as speak, that the consideration of Cognitive coaching or conventional method alongside students' self-concept on their achievement is of no importance as to view each singly.

Teachers' roles need a paradigm shift from an authority to a facilitator who stimulates learners' active participation in the learning process by equipping them with all the rudiments of Cognitive coaching strategy which will enable students to develop more effective and plausible scientific conceptions. Educators should acknowledge the importance of self-concept in mediating the success in academic achievement. When teachers are aware that the direction of causality can be from self-concept to academic achievement (self-enhancement model) as revealed in this study, the Basic Science teachers might be justified in placing more effort on enhancing students' self-concept rather than fostering achievement.

CONCLUSION AND RECOMMENDATIONS

This study has revealed that Cognitive coaching strategy is suitable for conceptual change as well as at improving students' achievement in Basic Science. Similarly, self-concept exerts an influence on students' achievement. However, the strategies interacting with self-concept could not show noticeable influence on achievement. The study has hereby confirmed that the use of Cognitive coaching in Basic Science learning can boost students' achievement. The use of Cognitive coaching which allows students' active participation is recommended for learning Basic Science by the students.

Students should be encouraged by their teachers to develop confidence in themselves so as to be able to communicate their thoughts in simple correct language of discussion. Teachers should enhance students' self-concept and achievement alongside each other to sustain achievement over a long lasting period. Curriculum planners should consider Cognitive coaching strategy as indispensable tool for teachers especially nowadays that students do not read books as much; thus, there is need for a workshop for teachers to be exposed to its procedure. The family should encourage a free socially interacting environment in order to help enhance favourable self-concept in students.

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