British Journal of Humanities and Social Sciences

ISSN 2048-1268

British Academic Journals

Volume 3 (2), January 2012

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Cognitive Acceleration in Mathematics Education Lesson (CAMEL) in Nigeria

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Abstract

The study was designed to explore Cognitive Acceleration in Mathematics Education lesson in Nigeria's Upper Basic II education. As an empirical study it comprised of one broad research questions and hypotheses at 0.05 level of significant. Sample to the study comprised of twelve public secondary schools from which twelve mathematics teachers, twelve counselling officers and one thousand four hundred and forty students of upper basic II were selected based on their even positioned on the school's register list. Three instruments 'Achievement test in Mathematics' (r_1=0.88), process questionnaire (r_2=0.72) and CAMEL package were adapted, validated and used for the study. Data were analysed through mean and standard deviation, t-test, one way ANOVA statistical analyses. Findings revealed in the verbal and formula post test mean scores that there was gender significant difference in the performance of students (t-cal>t- ratio, df=478; P<0.05) but in the conventional group that there was no gender significant difference in their performances (-t-cal>- t-ratio, df=478; P>0.05) for both the pre-test and post test scores. Similarly, in the verbal and formula post test mean scores there was a significant difference in the performance of students across the identified groups (F-cal>F- ratio, df = (1,478); P<0.05). However, the study revealed in the conventional group that there was no significant difference in the performance of students in either the pre-test and post test scores (F-cal<F-ratio, df= (1,478); P>0.05). The implications of the findings were discussed and recommendations suggested towards Cognitive Acceleration in Mathematics Education Lesson (CAMEL).

Key words: Cognitive, Acceleration, Mathematics, Lesson, School

Introduction

Teachers who inspire know that teaching is like cultivating a garden (classroom) and those who would have nothing to do with them must never attempt to gather flowers (students). Teaching is exciting when the teacher is able to impart the requisite content knowledge to the students whom the society expects there should be a relatively change in behaviour over a period of time. When students perform better in any given function, though teachers contribute a lot, the praises go to such students in particular and to their parents in general. No one has ever remembered the hidden engines (teachers) to be praised for the success achieved in spite of different odd situations encountered in the process of imparting the knowledge to the students. On the other hand when there is dismal performance of students in the course of a programme though students are blamed in part but bulk of the blames go to the teachers that handled the affected subject while parents who might not be privileged to witness what transpired in the course of teaching abstained themselves from such blame. In most cases society either by omission or commission closes her eyes to the fact that knowledge transmission to the students should not be sole responsibility of the teachers but complementary to make the students succeed in life. Although one might be justified to say that teachers are custodian of the curriculum designed to achieve the societal goal yet it behoves on every member of the society to make a useful contribution towards the attainment of this goal. Within the school system the role of mathematics teachers go beyond handling of the subject as some administrative job to complement their tasks often play vital role in the attainment of general goal. Apart from this the nature of subject which teachers handled and the society's premium emphasis on it determine to a large extent the level of appreciation of the work of such teachers.

Mathematics is one of the core subjects in the nation educational system and every student is expected to register and pass because of its prerequisite nature to advance in knowledge in the subsequent level. Number of students expected in such subject is no doubt to be larger than any other subjects in the nation curriculum; and this is one of the challenges which mathematics teachers have to contend with. Apart from the class size Mathematics itself is divided into different areas due to the specified objectives for which the subject is expected to attained, and between these forces teachers are expected to make the headway. In some frustrating situation comparison is made of students' performance in some subjects that have low number of students in relation to Mathematics without examine the inherent forces that are pertinent to each subject at a point in time. Situation that makes the mathematics teachers look as if they are not doing their work as they ought to have done. For instance the 2006 WAEC examiner's report indicated some areas of Mathematics where there was students' dismal performance like general equation of circle, coordinate geometry, probability laws, concepts of median and percentile just to mention a few with the advise that mathematics teachers should look into possible ways of improving their teaching in order to avert the future occurrence of dismal performance yet the question of quantity of work on mathematics teachers and cognitive acceleration of students ought to be identified as teachers might patterned their teaching towards examination at the detriment of the students' knowledge acquisition. As a result the study is designed to explore cognitive acceleration in Mathematics Education lesson in upper basic II of education in Nigeria.

Theoretical framework of CAMEL package

Cognitive Acceleration in Mathematics Education Lesson (CAMEL) has nothing to do with untiring animals of Asian continent that are often used in the desert area; instead it was an attempt to solve perennial thinking of students' insurmountable Mathematical problems. It tries to examine and provide solution towards improving examination results of students in long term as it enhances students' knowledge of Mathematical procedures and thinking ability. Study (Abimbade, 1995) has shown that cognitive development in children was first given attention by French-Swiss psychologist, Jean Piaget, sometimes sixty years ago in Geneva. This work had contributed greatly to the teaching and learning of Mathematics as cognitive structure was divided into four main stages, namely the sensor-motor stage (0-2 years), pre-operational stage (2-7years), concrete operational stage (7-12 years) and formal operational stage (12 years+). Each stage has significant implication to the learning of Mathematics as the sensor stage is characterized with children manipulate and control the muscles by making use of sensation coming to them from outside world. Secondly, pre-operational stage is characterized with the integration of language use and as well as signs and symbols but the constraint is that children could not manipulate reversibility of an activity earlier performed; and this why it is important for the teacher to develop the language of communication with the children in order to stimulate learning. At the third stage children could think and engage in fruitful interaction with many things around but concrete materials are essential to consolidate learning. The last stage is characterized by assumption of reality in the neighbourhood of possibilities and diverse reasons towards logical conclusion. What Piaget was emphasising was that learning of Mathematics should be structured according to their ages, ability and their immediate natural environment, which incidentally allows learning activity to become real life practice as against rote learning. His theory made it clear that adult should never mistake to judge children's answers to any given question on the premise of right or wrong; instead it should be regarded as the learning process that demand correction or reinforcement. Base on the Piaget's structure of cognitive development among children found a premium space for the learning of Mathematics which demands reasoning based on diverse assumption. It was based on this that basic II Mathematics course contents relied on and brought about the use of CAMEL to improve learning of Mathematics. Corroborating the idea of Piaget (Adey & Shayer, 1994) in a Cognitive Acceleration in Science Education (CASE) intervention programme classified lesson to pattern handling variables such as control and exclusion of variables with their classification, relationship between variables which comprises of ratio and proportionality, compensation and equilibrium, correlation and probability; and formal models as constructing and using formal models towards logical reasoning. In the CASE lesson the whole class is divided into smaller unit with each focusing on a concept characterizing by group discussion unlike the conventional classroom situation. The role of teacher is to facilitate the environment under which learning takes place so that each unit group would come-up after to explain the finding to the entire class with teacher in attendance, though not taking active teaching like in normal classroom situation. At this point teacher plays a mediating role between the children and what are expected to learn called learning activities. This situation, according to Adey & Shayer, (1994), followed Vygotskyan (1978)'s postulate that the mediation role played by adults or peers in bring about more cognitive development as learning take place within the Zone of Proximal Development(ZPD) through peer collaboration and teacher mediation. The concept of ZPD, according to Mbano(2002) while quoting Adey & Shayer (1994), refers to the distance between a child's

Actual developmental level as determined by independent problem solving and the higher level of potential development as determined through problem solving under adult guidance or in collaboration with more able peers

Meanwhile, the premium position of language in cognitive development cannot be overemphasised as it serves as a psychological tool of cognitive development. Though CASE was advocated to emanate from group discussion before the entire large class is involved yet the nature of and position of Mathematics in the school curricula made it imperative to ensure the smooth continuity of the package especially in bridging the gap of what children have learnt in a small group situation into the larger ones. To ensure better understanding of the lesson Mbano (2002) observed that pupils are expected to map out strategies already evolved in the smaller groups and make imagination of its further application in other situations. This, according to him, was referred to Bridging as coined in the Feuerstein's Instrumental Enrichment programme (FIE) (Feuerstein et al., 1980) since bridging aims at enhancing the transfer of learning from CASE lessons to other subjects or to real life

Different studies (Adey & Shayer, 1993; Shayer, 1996; Jones & Gott, 1998) conducted earlier in CASE have shown considerable improvement on pupils' achievement in Science, Mathematics and English as corroborated by Mbano (2002) yet the climatic classroom situations in term of verbal interaction and formula trend in Mathematics towards cognitive development in students is important. As a new dimension introduced into the study the application of formula drive in the construction of activity of the CAME lesson was to see the extent to which students could surmount problem solving skills. Although the study seemed to assume that CAMEL interactions group would perform better than the conventional method yet the variance of the formula drive introduced in one of the CAMEL package could not be substantiated to over greater effect on students' cognitive acceleration in the verbal groups.

In a bid to evolve a comprehensive an observation schedule, Mbano (2002) quoting Galton (1979) on the need survey the existing ones in other to capture all intended objectives of the study. Based on this assumption, he suggested Science Teaching Observation Schedule (STOS), an instrument developed by Eggleston et al., (1976), but however caution on its use due to the smaller group of subjects it could accommodate. Mathematics as core subject at the upper basic level of education in most cases has larger class, and it is imperative to include various shades of subject in order not to make the finding biased, hence the adaptation of process instrument of Olaoye (2004) that was close in nature to STOS but could be used on a wider scope. The schedule has parallel sections for the teacher and pupils, where mathematics teacher section coded their action/utterance in whole class and small group activities.

In the course of pilot studying the CAMEL packages which comprised of two forms namely the verbal and formula interactions, having study carefully the application of the former one in the works of (Adey et al., 1989; Adey & Shayer, 1994; Adey et al., 1995), researcher incorporated the knowledge gained and infused into the latter approach with the hope of making comparison. The selected mathematics teachers were so briefed on the need to work within the neighbourhood of the packages without derailed. And to ensure that in each experimental school a school counsellor was invited to monitor the extent to which these mathematics teachers conform to the laid down rules. Meanwhile, the CAMEL observation schedule which is an adaptation CASE lesson is given in table I showing examples of categories for each phase.

Table I: Examples of categories for each phase of a CAME Lesson

Phase	Label	Category
Concrete preparation	Tcp 6	Teacher asks students question requiring practice of new word
	Scp 4	Students identify variables, characteristics and or their values
Cognitive conflict and construction activity	Scc 2 Tcc 4	Students give evidence for a relationship deduced Teacher asks students to make prediction
Meta-cognition	Tmc 1	Teacher asks students to state why they found activity easy or difficult
Bridging	Sbr 2	Students apply reasoning patterns just learnt in another situation.

Statement of the problem

The study was designed to explore cognitive acceleration in Mathematics Education lesson in upper basic II education in Nigeria. Specifically, study tried to seek answers to the following research questions and hypotheses:

RQ_1: What are the:

(i)genders' pre-and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics?

(ii)pre-and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics?

As a result the following hypotheses were generated for the studies at significant level 0.05,

Ho_1: There is no:

(i) genders' significant difference in the pre- and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics

(ii) significant difference in the pre- and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics

Methodology

Research Design

The research design for the study was an empirical as the researcher was trying to see the efficacy of CAMEL package on students' performance in Mathematics.

Population

The population to the study involved all the secondary schools mathematics teachers, school guidance and counselling officers and their students in Nigerian public secondary schools. It comprised of the senior secondary schools II levels.

Sample and sampling techniques

Twelve public secondary schools in Lagos and Oyo States were selected due to logistic reason, nature of the two states, and available and cooperating mathematics teachers at the senior secondary school levels. In each school one guidance and counselling officer was used as an observer to make sure that mathematics teacher used the prescribed interaction with the students, and they were rated appropriately. Out of the twelve mathematics teachers that had been handling the selected students, four were trained on camel verbal interaction, four were trained on camel formula interaction packages for one week while the remaining four were allowed to use their conventional mode of instruction. With access to the register list of the schools that comprised one thousand four hundred and forty students researcher chose every even positioned students via the assistance of their mathematics teachers.

Lesson observation schedule for CAME Lessons **Teacher's Talk**

	Minutes	3	6
Date	**Concrete preparation**		
	Teacher talks/ questions referring to		
	Tbr 1 recall and or application of concepts previously learnt		
School	Tbr 2 recall and or application of reasoning patterns		
	Tcp 2 materials		
	Tcp 2 identifying variables, characteristics, and/ or their values		
	Tcp 3 activity to be done		
Teacher	Tcp 4 new technical word/formula		
	Tcp 5 data collected(for recording, not interpreting)		
	Tcp 6 other concrete preparation activity		
Class	**Cognitive conflict and construction**		
	Teacher talks/questions referring to		
Numbers of students	Tcc 1 deducing and or using relationships between variables		
	Tcc 2 giving evidence of relationship		
	Tcc 3 explaining observation		
Number of groups	Tcc 4 making predictions		
	Tcc 5 designing further investigations to be done		
	Tcc 6 giving a general rule for solving similar problems		
	Tcc 7 other cognitive conflict and construction activity		
Topic/ TS activity			
	Meta-cognition		
	Teacher talks/questions referring to		
Name of observer	Tmc 1 explaining how a problem was solved		
	Tmc 2 explaining why the task was easy or difficult		
	Tmc 3 explaining how their thinking has changed		
	Tmc 4 explaining what they have learnt in the lesson		
	Tmc 5 other meta-cognitive activity		
	Bridging		
	Teacher talks/questions referring to		
	Tbr 3 Suggesting situation where reasoning pattern learnt could be used		
	Tbr 4 apply reasoning pattern just learnt in new situation		
	Tbr 5 other bridging activity		

Adapted from Mbano (2002)

Instruments

Three instruments tagged 'Achievement test in Mathematics',' process questionnaire' and CAMEL verbal and formula interactions package were used for the study. Achievement test in Mathematics comprised of forty multiple choice objectives designed in line with the West African Examination Council (WAEC) format. The first part contained students' bio data and the second part contained forty multiple choice objectives. CAMEL was a package meant for mathematics teachers to use in the classroom.

Validation of Instruments

The first draft of 'Achievement test in Mathematics' was given to three different mathematics teachers in different public secondary schools to advise on adequate coverage of areas of Mathematics in upper basic II of education; and later it was administered through the assistant of public secondary school mathematics teacher on twenty students in Sokoto state where researcher went for the annual conference of science teachers in Nigeria (2007). The same instrument was represented to the same set of students after one week interval, so that bad distracters were reframed to the level of comprehension.

Reliability of Instruments

The original draft instrument contained sixty multiple choice objective was reduced to forty multiple choice objective items after the second presentation where some questions that were considered ambiguous, were expunged towards ensuring high rate of consistence of the instrument; and it was computed via Alpha Cronbach formula which gave reliability coefficient to be 0.88 while process questionnaire ($r = 0.72$).

Procedure for mathematics teachers

As a result of three groups of students and the mathematics teachers identified for the study such as camel verbal interaction, camel formula interaction and conventional modes of instruction groups teachers of the camel groups given one week training on the packages while conventional group's teachers were told to go on about their normal teaching of Mathematics class.

Administration of Instruments

Each mathematics teacher was informed of the objective of the study and the need to ensure maximum cooperation towards successful attainment of the prescribed goal. At the inception pre-test in Mathematics was administered on all the students that were involved so as to validate their knowledge of Mathematics, and they were scored.

Procedure for data collection

In a bid to ensure accurate collection of data researcher entrusted the conduct of the test into the hands of respective mathematics teachers, who in turn assisted to collect the test on the spot of administration though each school did the test at different day due to the school calendar and activities were strictly taken into consideration.

Data scoring and analyses

As a multiple choice objective test each correct answer was scored one mark and the wrong answer attracted zero marks. The overall students' score was converted into 100% in order to make clear comparison to the West African Examination Council's standard. Meanwhile, the data was subjected to descriptive mean and standard deviation, t-test and one way ANOVA at 0.05.

Findings and discussions

RQ_1: What are the:

(i) genders' pre-and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics?

(ii) pre-and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics?

Table 1: Pre-and post tests performances of students in the administered test in Mathematics

Interactions		Verbal		Formula		Conventional	
Genders		Male	Female	Male	Female	Male	Female
Counts		249	231	230	250	167	313
Percentage		51.9	48.1	47.9	52.1	34.8	65.2
Pre-test	Mean	52.9	58.7	56.3	52.6	53.7	51.7
	Deviation	28.0	28.2	29.0	29.4	28.4	28.9
Post test	Mean	54.3	52.6	58.5	52.0	53.5	54.3
	Deviation	28.4	28.3	27.1	29.1	27.9	26.6
Ground mean	Pre-test	55.7%		54.4%		52.4%	
	Post test	53.5%		55.1%		54.0%	

Table 1 describes the pre- and post tests scores of 1440 students that participated in the study which grouped them into three interactions namely verbal, formula and conventional so that each group had 480 students. In the verbal interaction group there were 249 male students represent 51.9% and 231 female students represent 48.1%. Meanwhile, the mean pre-test score of male and female students in this group were 52.9% and 58.7% respectively, showing that female perform better than their male counterparts. However, the trend was reversed in the post test mean score where male students perform better than their female counterpart of the same verbal interaction group. In the formula interaction group where there were 230 male students represent 47.9% and 250 female students represent 52.1%, it was found that the mean pre-test score of male and female students were 53.3% and 52.6% respectively; and this shows a slight and marginal performance of male students over that of female counterpart. Meanwhile, there was clear better performance of male students than their female counterparts in the post test score with 58.5% and 52.0% to the male and female students respectively. In the conventional group where there were 167 male students represent 34.8% and 313 female students represent 65.2%, finding revealed pre-test mean score of male students to be slightly better than that of female students with 53.7% and 51.7% respectively. However, the trend was not the same in the post test mean score reversed in the post test where female students perform marginally better than their male counterpart.

On the other hand, the mean scores of students in the pre- test were 55.7%, 54.4% and 52.4% for the verbal, formula and conventional interaction groups respectively; which favoured the verbal interaction group most. Similarly, finding revealed in the post test mean score to be in favour of the formula group with the mean score of 55.1% while the other two groups had 53.5% and 54.0% for the verbal and conventional groups respectively. The finding indicated that much academic progress on the part of students could be made if mathematics teachers allow the students to explore situations by themselves. Mathematics teachers should make the learning environment accessible to the learners instead of dominating the classroom activities under the premise of imparting knowledge.

Ho_{1a}: There is no genders' significant difference in the pre- and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics

Table 2: t-test of genders in the pre-and post tests performances of students

Interactions	Tests	Gender	Mean	Deviation	df	t-cal	t-ratio	Significant
Verbal	Pre-test	Male	52.9	28.0	478	-0.807	±1.960	P>0.05
		Female	58.7	28.3				
		Total	55.7	-				
	Post test	Male	54.3	28.4	478	2.827		P<0.05*
		Female	52.6	28.3				
		Total	53.5	-				
Formula	Pre-test	Male	56.3	29.0	478	-1.590		P>0.05
		Female	52.6	29.4				
		Total	54.4	-				
	Post test	Male	58.5	27.1	478	2.413		P<0.05*
		Female	52.0	29.1				
		Total	55.1	-				
Conventional	Pre-test	Male	53.7	28.4	478	-1.572		P>0.05
		Female	51.7	28.9				
		Total	52.4	-				
	Post test	Male	53.5	27.9	478	1.038		P>0.05
		Female	54.3	26.6				
		Total	54.0	-				

*Significance

Table 2 described the gender's performance of students via the t-test statistical analysis where varying significance were obtained. In the verbal pre-test score finding revealed there was no gender significant difference in the performance of students (-t-cal>-t- ratio, df=478; P>0.05) but it was a contrary situation in the post test mean score which showed that there was gender significant difference in the performance of students (t-cal>t- ratio, df=478; P<0.05). Also, it was observed in the formula pre-test group that there was no gender significant difference in the performance of students (-t-cal>- t-ratio, df=478; P>0.05) while there was gender significant difference in the performance of students (t-cal> t- ratio, df=478; P<0.05). However, the study revealed in the conventional group that there was no gender significant difference in the performance of students (-t-cal>- t-ratio, df=478; P>0.05) and (t-cal< t-ratio, df=478; P>0.05) for the pre-test and post test scores respectively.

Ho_{1b}: There is no significant difference in the pre- and post tests performances of students exposed to camel verbal instruction, camel formula and conventional modes of instructions in Mathematics

Table 3 described group's performance of students through one way ANOVA where different levels of significance were obtained. In the verbal pre-test score finding showed there was no significant difference in the performance of students taking other groups combined (F-cal<F- ratio, df = (1,478); P>0.05) but the situation in the post test mean score was not the same as it showed that there was significant difference in the performance of students across the identified groups (F-cal>F- ratio, df = (1,478); P<0.05). Secondly, it was observed in the formula pre-test group that there was no significant difference in the performance of students (F-cal>F-ratio, df=(1,478); P>0.05) but there was a significant difference in the performance of students in the post test score(F-cal> F- ratio, df=(1,478); P<0.05). The finding that confirmed what was obtained in a related study of Mbano (2002). However, the study revealed in the conventional group that there was no significant difference in the performance of students in either the pre-test and post test scores (F-cal<F-ratio, df= (1,478); P>0.05).

Implications

Problems facing the teaching and learning of Mathematics would not have developed into what are happenings as students see the subject as most dreadful of all subjects if the teachers have not been assuming a dominator's stance, rather they should have confined themselves to an explorer that make the learning situation conducive for learning. There is no iota of truth that students themselves have nothing in their manual central processing unit but what they need is somebody to bring it into limelight. This was shown when one noticed the performance of students that were exposed to both the CAMEL verbal and formula instructional modes as compared to those exposed to the conventional mode of instruction in spite of the fact that they were taught by their teachers and not a stranger. It should be acknowledged that much reasoning in Mathematical concepts could only be understood at the formal operational stage as enunciated in the Piaget's theory of learning. Meanwhile it behoves on mathematics teachers to structure situations that would ensure a meaningful learning environment.

Table 3: One way ANOVA of pre-and post tests performances of students

Interactions	Tests	Variations	SS	MS	df	F-cal	F-ratio	Significant
Verbal	Pre-test	Between(C)	4019	4019	1	1.972	3.84	P>0.05
		Within	973937	2038	478			
		Total	977956	-	479			
	Post test	Between(C)	6319	6319	1	7.992		P<0.05*
		Within	377960	791	478			
		Total	384279	-	479			
Formula	Pre-test	Between(C)	1660	1660	1	1.943		P>0.05
		Within	408243	854	478			
		Total	409903	-	479			
	Post test	Between(C)	12137	12137	1	5.822		P<0.05*
		Within	996522	2085	478			
		Total	1008659	-	479			
Conventional	Pre-test	Between(C)	509	509	1	0.619		P>0.05
		Within	392706	822	478			
		Total	393215	-	479			
	Post test	Between(C)	803	803	1	1.078		P>0.05
		Within	356127	745	478			
		Total	356930	-	479			

*Significance

Conclusion and recommendations

Modern technology is feasible through an articulated science whose language of imparting knowledge lies in Mathematics. As a result continual dismal performance of students in Mathematics to attain any nation technological advancement depends solely on the students' non-phobia drive towards the subject. Learning of Mathematics ought not to be stereotype instead it should be an activity oriented and practical as what one sees and practice last longer than what is done without one's practice. More importantly, it surface to be observed that mathematics teachers need to change in line with the contemporary dictate of strategising knowledge dissemination in Mathematics classroom otherwise no student might be found to do the subject any longer. By direct implication, their own justification as knowledge dissemination is put into questionable, and at the same time threats their own livelihood as soon as the patronage is longer forthcoming. Since Mathematics is not the only subject in the nation school system it is suggested that similar study be carried out in others where students are experiencing similar problem of knowledge assimilation as demonstrated in their performance. Secondly, representative study could be carried out in the higher level of school system like colleges of education where their primary function is to prepare teachers for the lower level of nation educational system. And continual knowledge update should be conducted for the serving teachers in form of seminar and conference where they could be exposed to recent developments like this, and be able to adapt it into practice in their daily practices. By so doing, the nation educational system would improve tremendously on one hand and attrition rate of students from Mathematics classroom could be reduced to minimal level. However, it is suggested that studies be conducted in CAMEL along the nature of schools, students' parental educational status and teachers' experience as these variables contribute to the cognitive development of children.

References

Abimbade, A. (1995) Works of Bruner, Piaget, Gagne and Dienes and their Implications for Mathematics Learning. Ibadan External Studies Programme Series TEE 333 Mathematics Methods II. Publication of the Faculty of Education, University of Ibadan, First Edition, Mustao Printing Press, Ibadan

Adey, P., Shayer, M., & Yates, C. (1989) Thinking Science: student and teachers materials for the CASE intervention London: Macmillan

Adey, P., & Shayer, M.,(1993) An exploration of long term far transfer effects following an extended intervention programme in high school curriculum. Cognition and Instruction, 11(2), 1-29

Adey, P., & Shayer, M.,(1994) Really Raising Standards cognitive intervention and academic achievement. London: Routledge

Adey, P., Shayer, M., & Yates, C.,(1995). Thinking Science: student and teachers' materials for the CASE intervention London: Thomas Nelson.

Adhami, M, Johnson, D.C, & Shayer, M. (1999) 'Tensions in planned mathematics lessons' in Bills, L(edt)(1999) Proceedings of the British Society for Research into Learning Mathematics Vol.19. No.3, pp 35-41

Eggleston, J.F., Galton, M., & Jones, M.E., (1976) Science Teaching Observation Schedule London: Macmillan

Feuerstein, R., Hoffnung, Y., & Miller, R.,(1980) Instrumental Enrichment: an intervention programme for cognitive modifiability. Baltimore: Baltimore University Park Press

Galton, M.,(1979) British Mirrors: A collection of classroom observation systems. Leicester: University of Leicester

Jones, M., & Gott, R.,(1998) Cognitive acceleration through science education: Alternative perspectives. International Journal of Science Education, 20, 755-768;

Mbano, N., (2002) The effects of a cognitive acceleration intervention programme on the performance secondary school pupils in Malawi. International Journal of Science Education

Mbano, Nellie (2002) Verbal interactions in CASE lessons in Malawi African Journal of Research in Science, Mathematics and Technology Education Volume 6, pp 83-94

Olaoye, L.A.A. (2004) An Evaluation of the Mathematics Curriculum of the Nigerian Certificate in Education programme Unpublished Ph.D. Thesis, Teacher Education, University of Ibadan

Shayer, M.,(1996) The long term effects of cognitive acceleration in pupils' school s achievement: London: Kings' College London

Shayer, M. & Adhami, M. (2007) 'Fostering cognitive development through the context of mathematics: results of the CAME project' in Educational Studies in Mathematics (2007), 64, pp 256-291.

Vygotsky, Len S.(1978) Mind in Society. Cambridge, Mass: Harvard University Press