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SUSTAINING DEVELOPMENT IN SECONDARY SCHOOL MATHEMATICS THROUGH CONSTRUCTIVIST FRAMEWORK: A MODEL LESSON PLAN

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ABSTRACT

This paper exposed the meaning of constructivism and constructivist instructional framework; explored the distinction between constructivist framework and traditional teaching approach; identified the implication of the constructivist model to classroom instruction; and provided a model lesson plan on the constructivist framework. It is recommended, among others, that teacher education programmes should be redesigned to enable prospective teachers acquire current innovative instructional models that would enable secondary school students to appreciate mathematics, and sustain their development in mathematics.

INTRODUCTION

The state of mathematics education in Nigeria has been giving an enduring concern. Reports on mathematics education have over the years indicated poor academic performance and negative attitudes of Nigerian students (Agwagah, 1993; Ezema, 2000). Students' enrollment in tertiary mathematics in Nigeria has remained very low over the years. Much of the recent research on mathematics teaching and learning demonstrated one major reason for this persistent pattern of under-achievement. According to Ezema (2000), traditional mathematics teaching is still the norm in our nation's schools. It has continued to dominate the mathematics classroom.

Numerous scientific studies have shown that traditional methods of teaching mathematics not only are ineffective but also seriously stunt the growth of students' mathematical reasoning and problem solving skills (Battista, 1999). In other words, traditional teaching method is not able to sustain the development of children in mathematics, especially in secondary school education.

According to Battista (1999), traditional methods ignore recommendations by professional organizations in mathematics education, and they ignore modern scientific research on how children learn mathematics. Current studies on how children learn science and science-related subjects such as mathematics have started revealing new ideas and approaches that have proved efficacious. One of such innovative approaches, which educators have advocated recently as an appropriate guiding framework for teaching mathematics to children, is the constructivist instructional approach (Airasian and Walsh, 1997;Cleminson, 1990; Pateman and Johnson, 1990; Roth, 1990). However, teachers often do not know how to implement the theories in the classroom (Stenberg, Torff and Grigorenko, 1998). Thus, most teachers in our nation's schools may not be familiar with the concept of constructivism and its application in the classroom. This paper explores the meaning of constructivism and provides a model lesson plan on the constructivist framework for teachers' guide.

MEANING OF CONSTRUCTIVISM

There are many interpretations of constructivism. As with so many educational terms, it means different things to different people.

Airasian and Walsh (1997), see constructivism as an epistemology of how people learn. It describes how one attains, develops and uses cognitive processes. It is based on the fundamental assumption that people create knowledge from the interaction between their existing knowledge or beliefs and the new ideas or situations they encounter.

Central to constructivist perspective is the premise that a learner constructs meaning from new information and events as a result of an interaction between that individual's prior concepts and his or her current observations. Some existing knowledge or prior ideas had been described as misconceptions (Novak, 1983); alternative frameworks (Driver, 1993); and children's early experiences (Adeyegbe, 1989). Students' prior ideas or knowledge therefore is a source of alternative conception or perceptions possessed by them before formal instruction takes place. It is believed that children construct their own mathematics out of their actions and their reflections on those actions (Pateman and Johnson, 1990).

Constructivism, therefore, is the instructional approach, which holds the view that knowledge is personally constructed and reconstructed by the learner based on his prior knowledge or experiences. Von Glasersfeld (1989), explains constructivism as a set of beliefs about knowing and learning that emphasizes the active role of learners in constructing their own knowledge. In this view, the learner constructs knowledge in an attempt to integrate existing knowledge with new experiences. When the learner is presented with new information, he/she will reformulate his/her existing cognitive framework only if the new information is connected to the knowledge already in memory. The learner must actively construct knowledge onto his/her existing mental framework for meaningful learning to occur.

Constructivist strategies are organized into four categories, namely: invitation, exploration, proposing explanations and solutions, and taking actions (Yager, 1992). Yager went further to explain that constructivist practices require teachers to place students in more central position in the whole instructional program. This means that students' ideas should form a basis for discussion and investigation in the classroom. The students should be viewed as thinkers with emerging theories about the world. This is in contrast to traditional teaching approach.

CONSTRUCTIVISM VERSUS TRADITIONAL TEACHING APPROACH

Educators have decried the traditional teaching approach which Bruer (1999) described as the "factory model education" in which experts create knowledge, teachers disseminate it, and students are graded on how much of it they can absorb and retain. This supports Airasian and Walsh (1997) assertion that the traditional teaching approach is a "transmission" model, in which teachers try to convey knowledge to students directly. The constructivist approach, on the other hand is an active learning model in which students are actively engaged in learning and guiding their own instruction. The constructivist approach is a most appealing contrast to the decontextualized, role learning typified by traditional education (Brooks and Brooks, 1993).

In the traditional classroom, mathematics lessons follow the process of: definition or rule, example, and drill and practice (Becker and Jacob, 2000). In other words, mathematics lessons begin with the teacher telling the students a fact or giving them the steps in an algorithm or rule. The teacher then works a textbook example and assigns students to work exercises from the

With the constructivist approach, students should be given opportunity to construct the algorithms that are now prematurely imposed on them. Focus should be on the basic skills of problem solving, reasoning, justifying ideas, making sense of complex situations and learning new ideas independently. In this information age and the web era, obtaining the facts is not the problem; analyzing and making sense of them is (Battista, 1999). Hence, students should be allowed to do mathematics by recognizing and describing patterns; constructing physical and/or conceptual models of phenomena; creating symbol systems to help them represent, manipulate and reflect on ideas; and inventing procedures, generalizations or rules to solve problems. They should not be forced to blindly follow the rules invented by others, and when they ask questions of 'why', we 'clamp down' on them as if they committed a crime by asking questions.

Another implication of constructivism for teaching mathematics is that the teacher must focus his goals and objectives on students thinking rather than on their writing correct answers. This gives students opportunity to make sense of mathematics, and develop powerful conceptual structures and patterns of reasoning that enable them to apply their mathematical knowledge and understanding to numerous real – world situations.

Furthermore, the teacher must encourage students to agree or disagree among themselves rather than reinforce right answers and correct wrong ones. According to Piaget in Kamii (1990: 27), "an exchange of ideas and mutual control (the origin of the need for verification and demonstration) are essential for children's development of logic". Perret – Clement (1980) and Diose and Mugny (1984) experimentally verified this statement. They found that the children in experimental groups who had a chance to agree, disagree, and convince each other in small groups demonstrated higher – level thinking on the posttest than those in control groups, who did not have this opportunity. They noted however, that other people's arguments could cause students to reexamine their own thinking and to construct a higher level of thinking from within.

A MODEL LESSON PLAN ON THE CONSTRUCTIVIST FRAMEWORK

Subject:	Mathematics
Class:	SS1
Date:	03/09/03
Time:	35 min.
Average Age of Students:	15 years.
Topic:	Sequences and Series
Content:	Arithmetic Progression

Objectives:

i Distinguishing between examples and non-examples of arithmetic progression.

ii Explaining the defining attributes of an arithmetic progression.

iii Developing a definition.

iv Explaining why the following relationship holds:
$Tn = a + (n-1) d$
Where Tn is the nth term of an arithmetic progression, a is the first term and d is the constant difference between any two consecutive terms.

v Finding the nth term of any given arithmetic progression.

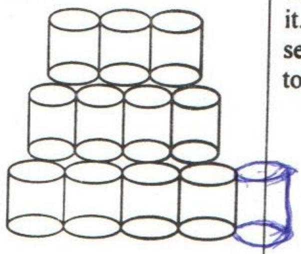
Entry Behaviour:

Students are supposed to be familiar with some number patterns, such as square numbers, triangular numbers, etc, and some other patterns in real life. Also, they already know what a sequence is.

Instructional Materials:

i. Ten to fifteen milk cans.
ii. Charts showing a stack of bags of groundnuts as can be seen in the northern part of the country and a stack of blocks, respectively.
iii. Textbook
iv Chalkboard

Instructional Procedure

Content development (CD)	Teachers Activities	Students' Activities	Strategies
	Teacher arranges a Stack of milk cans on The table. He stacks 5 Cans in the bottom Row, 4 cans in the next Higher row, 3 in the Next higher row as Shown below:  Teacher asks students The number of cans That will be needed to Complete the stack. Teacher asks students to explain why they have given the answer. Teacher asks students to write the sequence of numbers, and the total number of cans.	Students respond to Teacher's questions – 3 cans will be needed to complete the stack. Students explain that each row has 1 can fewer than the row below it. Students write the sequence: 1,2,3,4,5, totaling 15 cans.	Questioning

Content development (CD)	Teachers Activities	Students' Activities	Strategies
Distinguishing Between examples and Non-examples Of arithmetic Progression, Explaining the Defining attributes and Developing a Definition.	Teacher writes the following examples and non-examples of arithmetic Progression on the board. Examples (a) 15,10,5,0,-5,-10... (b) 3,3.1,3.2,3.3,3.4,3.5,3.6... (c) 6,11,16,21,26... Non –examples (a) ... 16,9,4,1,0,1,4,16... (b) 1,1,2,3,5,8,13,21... (c) 7,0.7,0.07,0.007... Teacher directs the students to take some minutes to examine the two lists and then state a conjecture as to how the examples are like one another and how they are different from the non – examples. Teacher engages the students in a Question and discussion session, calling up one student at a time to speak. Teacher allows students to agree or disagree with each others views, and he calls up a student to take notes on the board of the points on which they all agree. When a student states a conjecture, teacher asks another student to test it to find out if it is correct. Teacher explains that each member of the sequence is called a term. He asks students to find the difference between each consecutive terms in the examples and non – examples. Teacher explains that the examples are called Arithmetic progressions and asks students to define it. Teacher asks students to formulate two more examples of sequences.	Students examine the list, and respond to teacher's questions. Students discover that for each of the examples, the difference between any member and the member immediately before it is constant, but it is not so with the non – examples. Students define arithmetic progression as one that has the same difference between any two consecutive numbers.	Questioning Discussion, Explanation

Content development (CD)	Teachers Activities	Students' Activities	Strategies
Explaining the Relationship $T_n = a+(n-1)d$	Teacher asks students to state the Difference in the sequences they Formulated. He explains that it is called the common difference on the sequence. Teacher asks students to state the three variables that determine an arithmetic progression - the first number, which is represented by a, the common difference represented by d, and the last term represented by n. Teacher asks students to develop an arithmetic progression, given that the first term is a, the common difference is d, and the last term is n. He allows them some minutes to ponder and compare their ideas.	Students respond to the teachers questions, and develop the arithmetic progression, by the help of the teachers leading questions – 1[st] term=T_1 = a 2[nd] term=T_2=a+d = =a+(2-1)d 3[rd] term=T_3 = a+2d =a+(3-1)d 4[th] term= T_4 = a+3d = a+(4-1)d Following this pattern, n[th] term = $T_n = a+(n-1)d$	Questioning Discussion, Explanation
Finding the n[th] Term of an Arithmetic progression	Teacher asks students to write 6 terms of an arithmetic progression whose first term is 2 and the common difference is 3. Teacher asks students to find the 6[th] term of the sequence 6,11,16,21,26... He guides the students by asking them questions such as: what is the first term a-6; what is the common difference d-5: what is n-6. Teacher asks students to formulate their own problems and call on any student to explain and solve it.	Students write the six terms of the progression as 2,5,8,11,14,17... students respond to teacher's question and then find the 6[th] term of the given sequence: $T_6 = 6+(6-1)5$ $= 6 + 25$ $= 31$	Questioning Discussion, Explanation Verification
Performance Assessment	Teacher gives the following Exercises: 1. Which of the following sequences is an Arithmetic Progression? a. ½,0, -1/2, -1, -1 1/2, -2 ... b. −13, -2,9,20, ... c. 1,2,4,8,16, ... d. 5,10,15,20, ...		

Content development (CD)	Teachers Activities	Students' Activities	Strategies
	e. 0,0,0,0,0, … f. 1,4,9,16,25… g. 3,7,12,18,25, … h. 2,6,14,30, … 2. Which of the following statements is true? An arithmetic progression is – A. One that has the same Difference between any two Numbers. B. One that has the same Difference between Consecutive numbers. C. One that has first term, Common difference and last term. D. One in which the Common difference between two numbers is always positive. 3. Find the missing number in each of the following: a. 2,7,12,17, _, 27, … b. 3, -6, -15, _, … c. 9,7, _, 3 … d. 19,15,11, _, 3 … e. –5, -1; _, 7 … 4. Find a formula for the nth term of 12,5,-2 … 5. What is the 9th term of 5,9,13,…?		

CONCLUSION/RECOMMENDATION

The concept of "Constructivism" which recently has been receiving a great deal of attention elsewhere, is yet to be translated into classroom practices in our nation's schools. It seems our teachers are not yet familiar with this concept and how it can be translated into classroom practices. Hence, this paper has tried to provide a model lesson plan on the constructivist framework. It is therefore recommended that

1. Teacher education programmes should be redesigned. Teacher education courses must help prospective teachers to present subject matter effectively to a diverse group of students using approaches that will sustain the development of students in mathematics, such as the constructivist framework.
2. Workshops and Seminars should be organized by associations such as the Mathematical Association of Nigeria (MAN) and the Science Teachers Association of Nigeria (STAN) and government, for teachers, on the application of the constructivist approach to classroom instruction, and on other new ideas.
3. Teachers should develop a reading culture. They are hardly aware of innovations in educational practice because they lack the reading culture.

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