

# Activity -Based Learning Strategies in the Mathematics Classrooms

Azuka Benard Festus  
National Mathematical Centre, Abuja, Nigeria  
\*Email : benardazuka@yhoo.com

## Abstract

The teaching and learning of mathematics in Nigerian schools have been in a dismal State as both the students and the teachers experience difficulties in the processes. The result of this is poor performances of students in school and public examinations. One major factor affecting students' performances in mathematics is the pedagogy of the teachers. Most teachers in Nigerian school system have been using the traditional or convectional method of teaching. This method has been revealed by research as being ineffective. Hence, there is now a need for a paradigm shift from the traditional method of teaching to effective learning method including active-based learning. But many teachers have the problem on how to identify and use the effective strategies for activity-based learning in the mathematics classroom. This paper is focused on the strategies of achieving activity-based learning in the mathematics classroom. The strategies include discovery approach of teaching, appropriate practical work, use of teaching aids, cooperative learning or small group learning, and discussion in class. The paper concludes that teachers of mathematics should move away from traditional method to activity -based learning strategies.

## 1. Introduction

Many students in primary and secondary schools experience difficulties with the learning of some aspects of the mathematics curriculum. Just as students find difficulties in learning mathematics, teachers equally find difficulties in achieving effective teaching in Nigerian school system. This has created challenges for parents, students, teachers and educationists. Teachers are now faced with the problem of achieving effective teaching that would result to better performances of students in both internal and external examinations.

It has been observed that among the factors that influence the achievement of learners of school mathematics, teachers' effectiveness as measured through the acquisition and use of good instructional skills and methodologies appear very prominent (Max, 1988). The method used in teaching by a teacher is very important as this affects the interest in the subject by the students. Supporting this, Mstem in Emaikwu (2012) reported that teaching method affects the response of students and determines whether they are interested, motivated and involved in a lesson in such a way as to engage in learning.

As at now many teachers in Nigerian schools still use the traditional or lecture method in which teachers talk and students listen and copy notes. The situation is worst at the primary school level where a teacher is made to teach all the subjects in a class irrespective of his area of subject specialization. Due to the paucity of qualified mathematics teachers, many unqualified teachers are made to teach mathematics at the primary school level in Nigeria even when it is not their area of study. In my personal contact with teachers during the National Mathematical Centre organized workshops from 2002 to 2013, I discovered that over 90% of the primary school teachers still use the traditional or lecture method of teaching. One major reason for this situation is because majority of the teachers are not trained mathematics teachers. Another reason is that the teachers were taught in their school days by unqualified teachers who mainly used the lecture method of teaching and so the teachers of today only copy the way they were taught. The teachers even confessed to these. Supporting these, Okpala and Onocha in Kaka (2007) found that the pattern of interaction between teachers and students in schools was lecture Method.

Ajewale, Ayobasile and Okebukola in Kaka (2007) observed that lecture method is not suitable for the nature of science and the age of the students in schools because it hinders active participation of the learners in the teaching and learning processes. The method has been described as ineffective by researchers and educationists worldwide. This implies that if the teachers do not begin to employ activity -based learning in the mathematics classroom the students may not attain effective learning in mathematics. Then schools will still continue to grope in the darkness of poor performances of our students. Now there are intensive workshops for teachers in Nigeria on the utilization of Activity – Based Learning strategies. But many teachers are still struggling to adjust to this emerging pedagogy. Hence, teachers of mathematics in schools need to be acquainted with the strategies for activity-based learning in the mathematics classroom.

Teaching as being practiced today in mathematics using the lecture method has been found to be ineffective. The teachers do not give learners the opportunity to think and contribute to the learning process. According to Dodge in Stoblein (2009) the thinking required by students attending a traditional pedagogy class has been low level of

comprehension that goes from the ear to writing hand and leaves the mind untouched. The activity based learning pedagogy is expected to make students feel responsible for their learning and support their own personal development. This ineffectiveness traditional method of teaching comes to focus through the students results in examinations. For instance, the results of Nigerian students in mathematics West African Senior Secondary Certificate Examination for 2010, 2011 and 2012 for Nigeria as published by WAEC Office which are 24.94%, 38.98% and 48.88% respectively representing the percentage pass at credit level in mathematics.

Hence, there is need now for a new emphasis for a shift from traditional or lecture teaching method to active learning process in the mathematics classroom. The traditional pattern as is the pattern in which the teacher revises the previous day's lesson first, then the teacher-directed explanations is used to present materials for the new lesson without much involvement of the learners. Using this method, the author has observed that:

- (a) The teacher is very active while the students are passive in the teaching and learning processes.
- (b) The teacher tells students formulae and concepts in mathematics and students just try to listen and copy.
- (c) Retention and recall of concepts by students are not enhanced. Hence students forget concepts few days after lesson.

For effective teaching of any topic in mathematics, the teacher through the lesson plan is expected to answer the following questions:

- What is the topic?
- How is it calculated or solved?
- Why is it calculated like that or how does the formula come about?

For instance, in a lesson plan on the area of a circle the teacher is expected to indicate, besides other things, the topic, the formula as  $\pi r^2$ , and how the formula is derived through practical activities before solving examples with the students in class. For now, many teachers can only provide answers for the first two questions and fail to provide answer to the third question. Teachers just state the formula and solve examples in the class with the students. Even when students attempt to ask questions on how the formula is generated, the usual answer is that "it is the rule in mathematics". This singular act by teachers makes students feel that mathematics is an abstract and a difficult subject. To the extent that a mathematics teacher provides answers as to how a formula is generated, to that extent the teacher makes the lesson active and practical.

## 2. Activity-Based Learning

"Activity-based learning as the name suggests is a process whereby learners are actively engaged in the learning process, rather than "passively" absorbing lectures. It is based on the core premise that learning should be based on doing some hands-on experiments and activities rather than just listening to lessons only. Activity-based learning involves reading, writing, discussion, practical activities, engagement in solving problems, analysis, synthesis, and evaluation. Active learning is also defined as any strategy "that involves students in doing things and thinking about the things they are doing" (Bonwell & Eison, 1991). If a child is given opportunity to explore the learning environment by themselves and provided an optimum learning environment then learning becomes joyful and long lasting (Wikipedia, 2012).

Active learning is defined as a method where the teacher only acts as a facilitator and learners are at the center of the learning process by their high involvement in practical activities and discussion. It is the mode of learning guided by the assumption that (i) Significant learning takes place when the subject matter is perceived by the learners as relevant to their own purpose.(ii) Much significant learning is acquired through doing. (iii) Learning is facilitated by the learner's responsible participation in the learning process (iv) Self initiated learning involving the whole person- feeling as well as intellect – is the most pervasive and lasting type of learning(Okwudishu, 2011). Active learning is based on the premise that students learn best when they are actively involved in the learning process. Active learning "derives from two basic assumptions. (1) that learning is by nature and active endeavor aid (2) that different people learn in different ways" according to Meyers and Jones in Kathleen (1996).

Bonwel and Eison (1991) states that the characteristics of Active Learning as follows: Students are involved in activity more than listening, less emphasis is placed on transmitting information and more on developing student's skills, students are involved in higher-order thinking (analysis, synthesis, evolution), students are engaged in activities (e.g. reading, discussing, writing) and greater emphasis is placed on student's exploration on their own attitudes and values.

Research shows greater learning when students engage in active learning. According to Morable in Okwudishu(2011) activity- based learning offers the following benefits: Reinforces course content, develops team building skills, enhances learners self esteem, promotes participatory learning, allows for creative problem solving, and promotes the concept of discovery learning. Others benefits are that it energizes and invigorates the participants, strengthens learners bond, offers variety that accommodates divers learning styles, allows for

practical application of course content, enhances communication with diverse learning, offers an enjoyable and exciting learning environment, helps improve learners retention and motivation, provides an avenue for learners recognition and reward, and promotes fun.

As against traditional approach the author observes that in Activity- Based Learning:

- (1) Both the teacher and student are active in the teaching and learning processes.
- (2) The students discover the formulae and concepts in mathematics under the guidance of the teacher.
- (3) Retention and recall of concepts are enhanced. Hence students taught using this method hardly forget the concepts.

Research suggests that the use of activity-based learning techniques may have positive impact upon students' learning. For example several studies have shown that students prefer strategies that promote active learning rather than traditional lectures. Also, Emaiku (2012) reported that the performance of students taught using activity –based learning method was better than those taught using lecture method and discussion method. Other research evaluating students' achievement has demonstrated that many strategies promoting active learning are comparable to lectures in promoting the mastery of content but superior to lectures in promoting of students skills in thinking and writing (Wikipedia, 2008).

Active learning is an umbrella term that refers to several models at instruction that focus the responsibility of learning on the Learners (Wikipedia, 2008). According to Chickering and Gamson (1987) learning is not a spectator sports as students do not learn much just listening to teacher, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write reflectively about it, relate it to past experiences, and apply it to their daily lives. They must make what they learn part of themselves. It has been suggested that students who actively engage with material are more likely to recall information according to Bruner in Wikipedia (2008)

### **3. Strategies for Activity- Based Learning in the Mathematics Classroom**

Contemporary research on effective mathematics teaching focuses on instruction that promotes students involvement and activity. The new instructional pedagogy requires teachers to move away from lecturing and move towards activity- based learning. Most teachers in the school system often teach the mathematical sciences by the “telling method”. This involves making lesson notes, passing on the information to the students and then evaluating the students. The teacher becomes very “active” while the students are very “passive”. This does not lead to a lasting learning on the part of the students. Students do not easily understand and comprehend the lessons taught. This makes students to forget the lessons taught and therefore perform poorly in the examinations. Active learning implies the strategies where the students touch, feel, participate, discover, reason, deduce and infer facts and ideas in the learning process. This could be achieved using the following strategies in the mathematics classroom:

#### **3.1 Discovery Approach of Teaching**

As the name suggests, discovery approach is a method where the learner is guided by the teacher to discover mathematical facts and formulae through observations and organized activities. In this approach the teacher provides the necessary teaching materials and guides the students to carry out some activities which would lead the students to arrive at a new knowledge. Such discovery activities could be done individually or in groups of few students. This approach enables students to actively participate in the learning process and discover things for themselves. For instance, to teach the students that the sum of the angles of a triangle is  $180^\circ$ , the teacher should allow the students to draw their triangles, measure the three angles and add them together. The students would discover that the sum of the angles is  $180^\circ$ . Alternatively, the students could draw triangles on papers, cut out the three angles and arrange them together to form a straight line and the sum of angles on a straight line is  $180^\circ$ . Teachers are now encouraged to apply discovery approach which enhances active learning in the mathematics classroom instead of the “telling method”. Another example is to show that the sum of the angles of a quadrilateral is  $360^\circ$ . Here, students are to draw any quadrilateral, measure the four angles and add to discover that it is  $360^\circ$ . The emphasis here is that teachers should not just tell the students the formulae in mathematics and give examples on the topic. Rather teachers should create activities for the students to discover mathematical facts, formulae and concepts.

#### **3.2 Appropriate Practical Work**

For most students, practical work provides the most effective means by which understanding of mathematics and sciences can develop. When a subject is presented as a mass of sheer facts, students are unable to form patterns and establish meaningful relations among the stimuli, or link them with their own past experiences. The result is a distorted concept formation and a distressing tendency to avoid the subject later in life (Elliot, Thomas & Joan, 2000). This idea is also supported by the popular Chinese proverb which states that “what I hear I forget; what I see I remember; what I do I understand”. This means that until a child practicalises a concept or participates in the learning process, he cannot understand the concept.

Teaching is for more than transmitting facts and information. For it is said that: “A poor teacher tells; An average teacher informs; A good teacher teaches; An excellent teacher inspires” (Ukeje, 1979). To evaluate the job of teaching is to evaluate the extent the students have been inspired to think and create ideas. This can only be achieved through practical activities which make students to be active in the teaching-learning process. Hence, there is need for teachers to teach mathematics using the laboratory approach. For instance in teaching area of a rectangle, the teacher should guide each student to draw rectangles and make unit squares in it to determine the area. Also, practical work should be applied in the teaching of volume, capacity, and nets of solids such as cylinders, cuboids, cubes; graphs, probability, construction etc. For instance, the volume of a cylinder could be practically demonstrated by arranging a pile of circles of the same radii to form a cylinder. Then guide the students to see that a cylinder is a pile of circles and hence the volume is  $\pi r^2 h$ . Students should cut, measure, arrange objects and draw conclusion from their findings. All these will make the students to actively participate in the learning process.

### 3.3 Use of Teaching Aids

Teaching aids help to make mathematical concepts real and demystify the mysteries of mathematics. In teaching of mathematics the general principle is “things before ideas and ideas before words” (Ukeje, 1979). Teaching aids help to arouse and sustain the interest of students in teaching and thereby improve the performance of students. For instance Suydam and Higgins in Education Resource Information Centre(2012) reported that using manipulative materials have a higher probability of producing greater mathematical achievement than do non manipulative lessons. Use of both manipulative material and pictorial representations is highly effective but symbolic treatments alone are less effective. The use of materials appears effective with children at all achievement levels, ability levels, socioeconomic levels.

Most teachers in our school system do not use teaching aids in the classroom and this compound the difficulties of the teaching and learning of mathematics. This is why the National Mathematical Centre, Abuja has developed mathematical kits for primary and secondary schools. The primary mathematics kits are now being used to retrain teachers all over the country. During the workshops, primary school teachers confessed that lack of teaching aids made their teaching in the classroom not to be active. The teaching aids enhance active learning in the classroom.

For example, to teach the circumference of a circle, let the pupils have circles of various radii. Guide the pupils to determine the value of (Pi). This is obtained by dividing the distance round a circle by the diameter. Pupils can measure these using tread and ruler. When the pupils divide the circumference by the diameter, they will all have about the same answer of about 3.142. This constant is called *Pi* by the Greeks and the symbol is  $\pi$

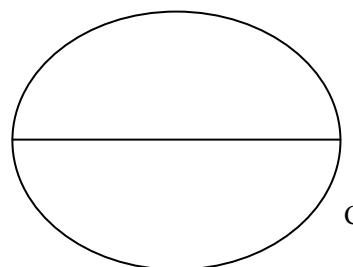
Thus

$$\frac{C}{D} = \pi$$

$$C = \pi D$$

$$C = \pi \times 2r, \text{ since } D = 2r$$

$$C = 2\pi r$$

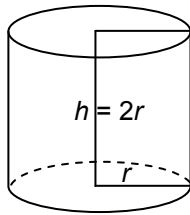


Also, the concept of number bases can be demonstrated by leading students to group counters in various number bases. These activities would make the students active in the classroom and also understand the topics. In teaching probability, total surface area cuboids, surface area of spheres, area of circles, volume of cylinders etc concrete materials are necessary. The use of teaching aids makes students active in the lesson and enhances understanding and retention of mathematical concepts.

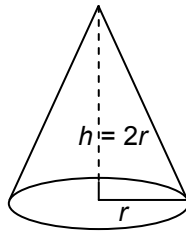
### 3.4 Cooperative Learning or Small Group Learning

Cooperative learning or small group learning is one of the best practices that encourage active participation in the learning process. Cooperative learning creates environment that engages students who might not otherwise be engaged in their own learning in meaningful ways. When a mathematical task is given to students in small groups, it enables each student to contribute to the learning process. Group work stimulates academic discussions which are beneficial to the learners. This makes learning deeper, more engaging, meaningful, active and effective process

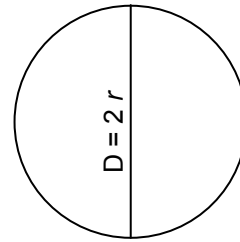
For example, give a group of student special cylinder, cone and sphere and ask them to determine the relationships in their volumes.



Cylinder



Cone



Sphere

- (1) Guide the group to fill up the cylinder with water and pour it into the cone. How many times does it fill the cone?
- (2) Let them fill the cylinder and fill the cone and the sphere with it. What happens?
- (3) Let the group also fill the cone with water and turn it into the sphere. How many times does it fill the sphere?

The group will discover that:

- (i) The water in the cylinder will fill the cone three times

Vol. of cylinder = 3 x vol. of cone.

$$\begin{aligned} \text{Hence, vol of cone} &= \frac{1}{3} \times \text{vol of cylinder} \\ &= \frac{1}{3} \pi r^2 h. \end{aligned}$$

- (ii) That the volume of cylinder is equal to the volume of cone and the sphere. That is,

Vol. of cylinder = Volume of cone + Volume. of sphere

$\therefore$  Vol. of sphere = Volume of cylinder – Volume of cone

$$\begin{aligned} &= \pi r^2 h - \frac{1}{3} \pi r^2 h \\ &= \frac{2}{3} \pi r^2 h \\ &= \frac{2}{3} \pi r^2 \times 2r, \text{ since } h = 2r \\ &= \frac{4}{3} \pi r^3 \end{aligned}$$

- (iii) Volume of cone =  $\frac{1}{2}$  x volume of sphere  
 (Adetula, 2006; Azuka, 2012).

### 3.5 Discussion in Class

Discussion in class is one of the most common strategies promoting active learning. “To promote long-term retention of information, to motivate students towards further learning, to allow students to apply information in new settings, or to develop students’ thinking skills, then discussion is preferable to lecture” (Mckeachie, 1986). Teachers are encouraged to engage the pupils in discussion of the topics in the class. However, to achieve effective discussion, the teacher should plan out the guided discussion towards achieving the objectives of the lesson. Guided discussion brings about active learning in the classroom. Discussion helps to generate ideas on the topic and would keep the students active in the learning process.

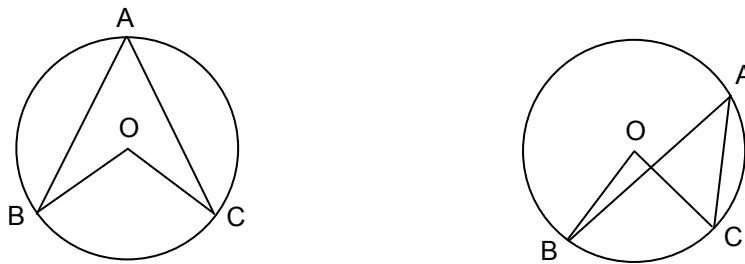
#### 4. Illustration of Activity- Based Learning Process on Teaching Circle Theorem

The first step in teaching circle theorem is to create activities which would enable students to appreciate and agree with the theorem before the proof and examples (Azuka, 2001). This should be practically demonstrated through students' activities in the classroom. Below is an illustration of teaching a circle theorem using the activity based method.

*Theorem:* The angle subtended by an arc of a circle at the circle is twice that which it subtends any other part of the circumference.

Sept I. Using questions, revise arcs of circles, measuring of angles using protractor, making of circles using of pair of compasses etc with the students.

Sept II. Let every students draw circles and form angles subtended at the Centre and on the circumference as shown below.



Sept III. Guide every student to measure angle BOC and BAC state the values of the angles. The teacher would have responses from students such as:

	BOC	BAC
(1)	120°	60°
(2)	140°	70°
(3)	130°	65°
(4)	100°	50° etc.

Sept IV. Guide the students to determine the relationship between BOC and BAC. Of course, students would discover that  $BOC = 2BAC$  (Azuka, 2012)

With these, the students would have actively participated in the discovery of the circle theorem. When students discover for themselves, they internalize the concepts deeper and derive pleasure from the lessons. As quoted by Max (1988), Rene-Descartes (1595-1650) concluded in his book *La geometric* with this comment; "I hope that posterity will judge me kindly not only as to things which I have explained but also as to those things which I have intentionally omitted so as to leave to others the pleasure of discovery".

Some obstacles associated with the use of active learning include Limited class time; long preparation time; the potential difficulty of using active learning in large class; lack of materials, equipments or resources; and perhaps the single greatest barrier is the risk that students will not participate (Wikipedia,2008). However, with proper planning these problems can be overcome. Also, when a teacher uses the activity- based method over time most of these problems will be minimized.

#### 5. Conclusion

Students understand mathematics concepts and have higher retention when they actively participate in the lesson. Teachers should move away from the "telling method" and select strategies promoting active learning in the classroom. It is important to involve the students while developing mathematical concepts as students need to participate actively in the learning process.

As Dienes cited in Briggs (1968) indicated, there is need for us to "shift the emphasis from teaching to learning from our world to the children's word". Above all, we should provide opportunities for the children to think for themselves, so that learning for them is an active and creative process. Our main objective in the teaching of mathematics at all levels should be to give our students the opportunity to think for themselves, the opportunity to appreciate the order and pattern which is the essence of mathematics, not only in manmade world but in natural world as well, and the needed skills.

Generally, teachers should provide our students with an environment containing the best materials for learning. In such environment, teachers will observe and plan while the students will experience and discover. This is what makes mathematics alive instead being dull and abstract. Active learning strategies if employed in our mathematics lessons would bring about higher achievement of students in mathematics and ensure the realization of the objectives of mathematics in our schools.

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