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TEACHING THE KNOWLEDGE OF DIFFERENTIATION FROM THE FIRST PRINCIPLE TO SENIOR SECONDARY SCHOOL STUDENTS USING ACTIVITY BASED INSTRUCTION

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Abstract
The problem of students' poor performance in mathematics is always attributed to teachers' poor teaching method. One of the problems mathematics teachers encounter in teaching and learning of mathematics is the problem of proper planning for instruction. This paper therefore centres on teaching the knowledge of differentiation from first principle to senior secondary school students using activity based instruction. A model lesson plan was developed on how to actively engage students throughout the lesson. The idea behind is that when mathematics teachers adopt this method in teaching in the class, students interests, attention, participation and concentration in the lesson may be enhanced thus resulting to increase in their mathematical achievement.

Key words: differentiation, first principle, students, activity based instruction.

Introduction

Mathematics is an inevitable subject in the realisation of scientific and technological advancement in Nigeria. Koko (2008), pointed out that mathematics is the backbone of all scientific and technological investigations and activities of human development. Mathematics is really the gateway to the success of science and technology in any nation. Awofala (2012), sees mathematics as the backbone of technological breakthrough. The growing increase of students' poor performance in mathematics is not helping matters towards the realisation of scientific and technological development in the country, Nigeria. West African Examination Council Chief Examiners (2014), reported that candidates performance in those areas of the mathematics syllabus where their performance has been repeatedly poor has not changed. The importance of mathematics in the economic development of Nigeria has given rise to the recent reform in mathematics curriculum. Uka & Iji (2011), posit that mathematics curricula have had changes which were to meet the societal demand and technological needs. Awofala (2012), emphasizes that the reform brought about by different social problems was in recognition of new technological developments which called for a complete restructuring of mathematics curriculum to meet the growing need of mathematics as a touchstone of intelligent and whetstone of scientific and technological innovations. Chinweoke (2015a), points out that the importance of mathematics in connection with technological development and the need for globalization necessitated the reform in secondary school mathematics curriculum which saw the inclusion of modular arithmetic, logical reasoning, matrices and calculus into secondary school mathematics curriculum. The question at this point is: Since new curriculum has been put in place, how far have the mathematics teachers been prepared to meet with challenges that might accompany the change? Mathematics teachers need to trained and re-trained as regards pedagogical content knowledge of the new concepts introduced into the curriculum. Mari (2008), points out that however well a curriculum is conceived, it can only be fruitful where teachers are adequately trained and motivated to translate its goal into actual practices in the classrooms. Chinweoke (2014), posits that due to poor performance of students in mathematics, classroom teaching and learning need to undergo some reforms in order to improve on the quality of productions in the classrooms. Thus reforms obviously, should start by empowering teachers with conceptual knowledge of the subject matter and the teaching methods/strategies. Hassan (2014), states that some mathematics teachers mystify the teaching of mathematics which makes it boring, monotonous and consequently forced students to develop apathy towards mathematics. Chinweoke (2015b), emphasizes that some concepts in mathematics require adequate attention to be paid to their teaching and learning due to their abstract nature to enhance proper understanding by the students.

In this regard, mathematics teachers need to undergo some training in the knowledge of the new concepts and methods of teaching them as the major concern of the NERDC in revising the mathematics curriculum is that mathematics teaching should be based on constructivist approach to learning which is student centred. Constructivist approach to learning is one in which the learners are actively involved in construction of their own knowledge to achieve meaningful learning. Constructivist's pedagogies involve active learning, use of manipulative, cooperative learning, and the use of realistic and genuine tasks. Through active learning, teachers create opportunities for students to engage new materials serving as guides to help them understand and apply information (Awofala, 2012). One of the ways mathematics teachers can make students to be actively involved in the lesson is by use of activity based instruction in teaching in the classrooms.

Activity based instruction is a teaching approach in which students are physically and mentally engaged in problem-solving. Learning by doing is imperative in successful learning since it is well proved that more the senses are stimulated, more person learns and longer he/she retains (Limb, 2012; Dorjiss, 2013). Based on the above facts, this paper tries to show how to teach a mathematical concept- Differentiation from the first principle to senior secondary school students using activity based instruction. Differentiation is a concept in a branch of mathematics called calculus. Thus a model lesson plan is drawn on how to teach this concept from first principle using activity based instruction.

Subject: Mathematics

Class: SS3

Average Age: 17years

Time: 40 minutes

Topic: Differentiation from first Principle

Specific Objectives: At the end of the lesson the students should be able to:

1. Give idea of limit
2. Find derivate of functions from first principle

Entry Behaviour: Students have already had the knowledge of binomial expansion, how to find gradient.

Instructional Materials: Charts, note of lesson, white board, marker, etc.

Instructional Techniques: Questioning, illustration, examples, etc.

Set Induction: Teacher asks students to work on the following problems:

1. Expand the following binomials:

a. $(x + y)^2$ b. $(a + b)^4$

b. Looking at this chart, find the gradient of the straight line (Teacher shows the chart to the students).

Students' activities: Students work on the problems for about 4 minutes.

Instructional Procedure: Step 1: Introduction: In order to understand the new topic, it is necessary to reflect back on the students' previous knowledge which is considered important for the understanding of the topic at hand. So, teacher reworks the problem given to the students with them to refresh their minds on the knowledge whose understanding will enhance the understanding of the new concept.

Corrections:

1a $(x + y)^2 = (x+ y)(x + y) = x^2 + 2xy + y^2$

b $(a + b)^4 =(a + b)^3(a + b) = a^3 + 3a^2b +3ab^2 + b^3(a + b)$

$=a^4 +3a^3b + 3a^2b^2 + ab^3 + a^3b + 3a^2b^2 + 3ab^3 + B^4$

$=a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$

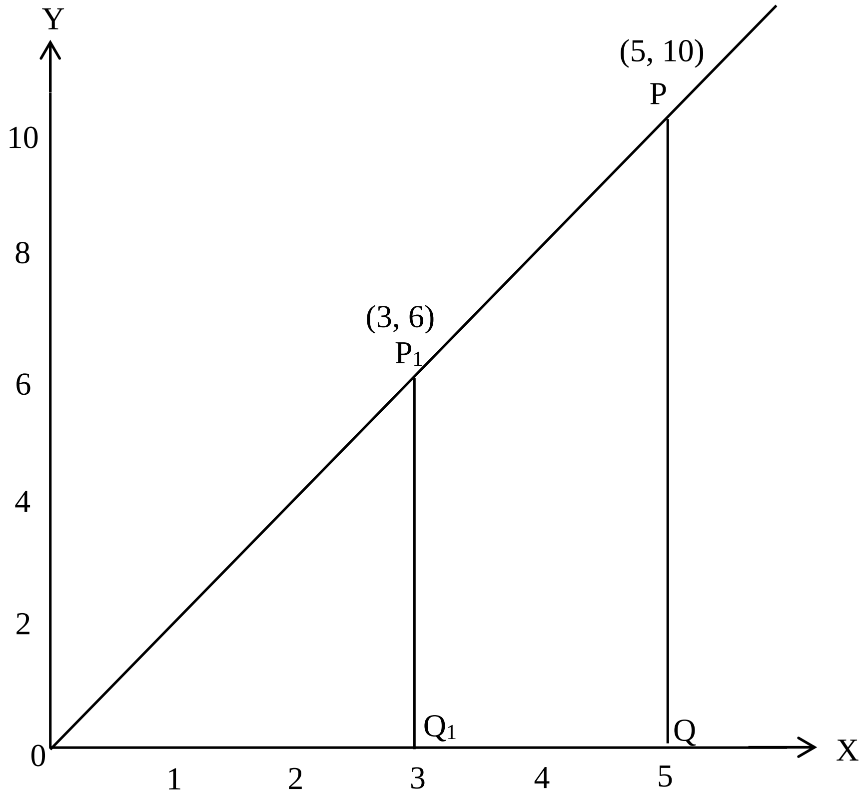

Figure 1: The chart

2. The gradient of the straight line is
   $= P_1Q_1/Q_1O = PQ/QO$
   $= 6/3 \quad = 10/5 \quad = 2$

Step 11: Lesson Development

Notice that the gradient of the line Y = 2x is 2 which is rate at which y decreases from P to P_1 to P_2 and x changes from Q to Q_1 to Q_2 (using the chart to illustrate). So the gradient function of curves may be found by considering small increments in x and y denoted by the symbols ∂x and ∂y, respectively, ∂x is a single quantity and not a product of ∂ as well as ∂y is not a product of ∂ and so their squares are written as ∂x^2 and ∂y^2 and not $(\partial x)^2$ and $(\partial y)^2$, respectively. The process of finding dy/dx or f′(x) is called differentiation and dy/dx is called the derivative of y with respect to x. It can as well be called the differential coefficient of y (Macrae, Kalejaiye, Chima, Garba, Ademosu, Channon, Smith, & Head; 2011). The process of finding the derivative is called differentiation because it involves manipulating differences in coordinate values (Stroud & Booth; 2007)

Now look up, teacher draws the diagram on board for more explanations.

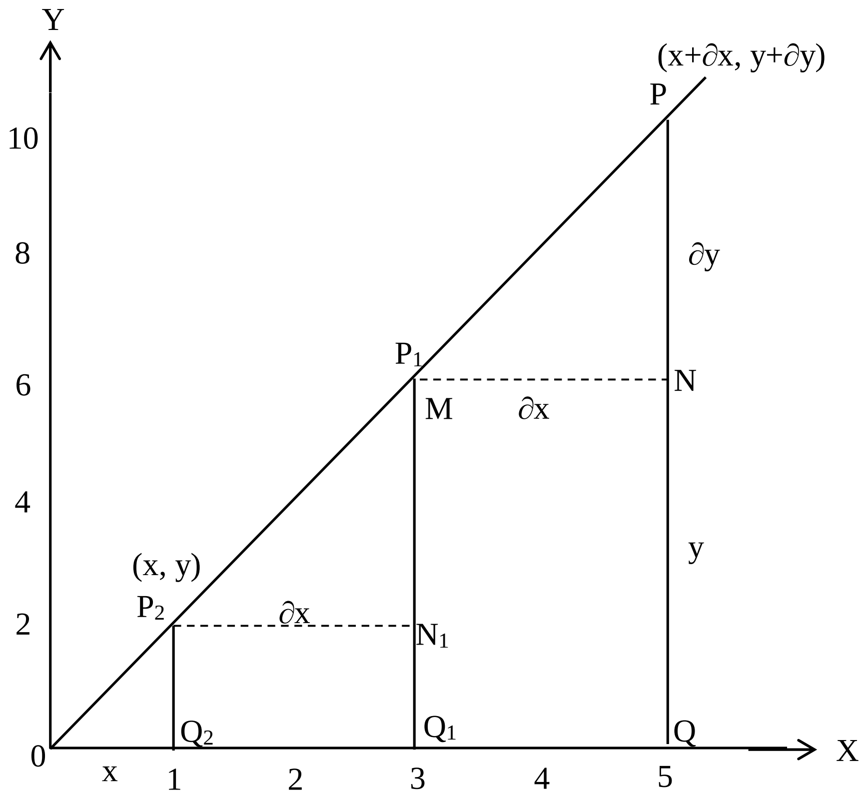

Figure 2: The graph of Y = 2x.

Looking at the gradient at a point on the chord given by Y = 2x, notice that dy/dx gives the gradient function and the value of dy/dx at that point gives the gradient. What can you say about the value of y as x increases from Q_2 to Q_1?

Students' activities: Students are expected to answer that the value of y also increases from P_2 to P_1. Also as the value of x decreases from Q to Q_1, the value of y also decreases from P to P_1.

Good!

Now, you should also notice that as x increases from Q_2 to Q_1, y increases from P_2 to P_1 with small increment ∂x and ∂y, respectively. So, P_2, P_2, P are points on the line y = 2x. P_2M and P_1N are the small increase in x denoted be ∂x while MP_1 and NP are small increase in y denoted by ∂y. Then, OQ = x + ∂x and QP = y + ∂y. What is the coordinates of the point P?

Students activities: Students are expected to give the coordinates of the point P as $(x + \partial x, y + \partial y)$.

The gradient of the PP_1 is what?

Students' activities: Students are supposed to answer NP/PN = $\partial y/\partial x$

Good!

This measure the average rate of change in y compared with x betwee P_1 and P.

Teacher gives the following problems to the students to solve.

Calculate the gradients of the straight line joining a. P(4,0) and Q(7,3)

c. P(5,6) and Q(9,2)

Students' activities: Students work on the problems.

Teacher reworks the problems with the students after students have finished.Thus,

a. $\partial y = 3 – 0 = 3$
   $\partial x = 7 – 4 = 3$
   $\therefore \partial y/\partial x = 3/3 = 1$
b. $\partial y = 2 – 6 = -4$

$\partial x = 9 - 5 = 4$

$\therefore\ \partial y/\partial x = -4/4 = -1$

Step111: Differentiation from first principle

Differentiation from first principle takes into cognisance the idea of limit. Teacher gives students activity to perform that will help thee students understand what limit is. Now draw a circle and inscribe in it a regular polygon of 4sides, 5sides and 10sides. As the students finished the drawing, teacher will ask them what they have observed.

Students' activities: Students make the diagrams as shown below and make theie observations.

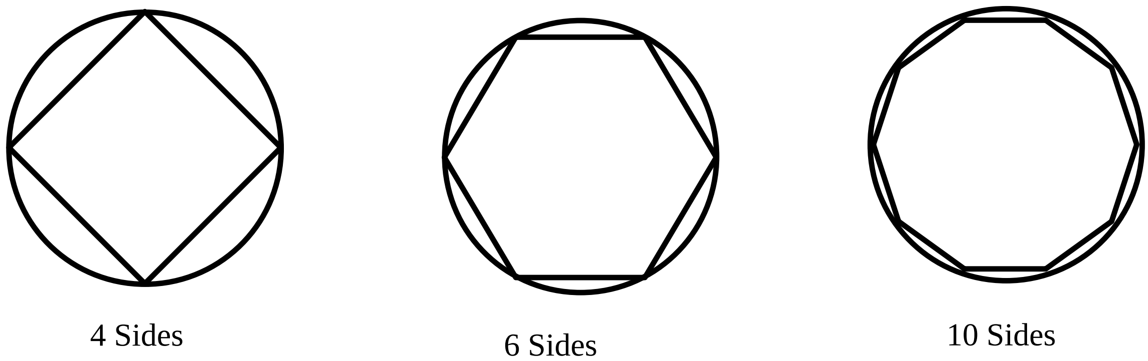

Figure 3: Diagrams of circle with n-sided regular polygons

Teacher then explains as follows: As the number of sides of a regular polygon increases from 4 to 10, the polygon assumes to be a circle. So, if n represents the number of sides of polygon and the symbol ∞ represents the countless number of sides (infinity), we say that as $n \to \infty$, the polygon$\to$a circle. So, the limit of a polygon as n tends to infinity is a circle. That is, the highest shape a regular polygon inside the circle will assume as its number of sides increases is to assume the shape of the circle in which it was inscribed.

Now having learnt what limit means let go into differentiation from the first principle.

Example 1: Find the derivative of $y = x^3$ from the first principle.

Teacher illustrates this showing the chart of the graph of the function to the students.

Students' activities: students look at the graph and answer any question that might follow.

Solution

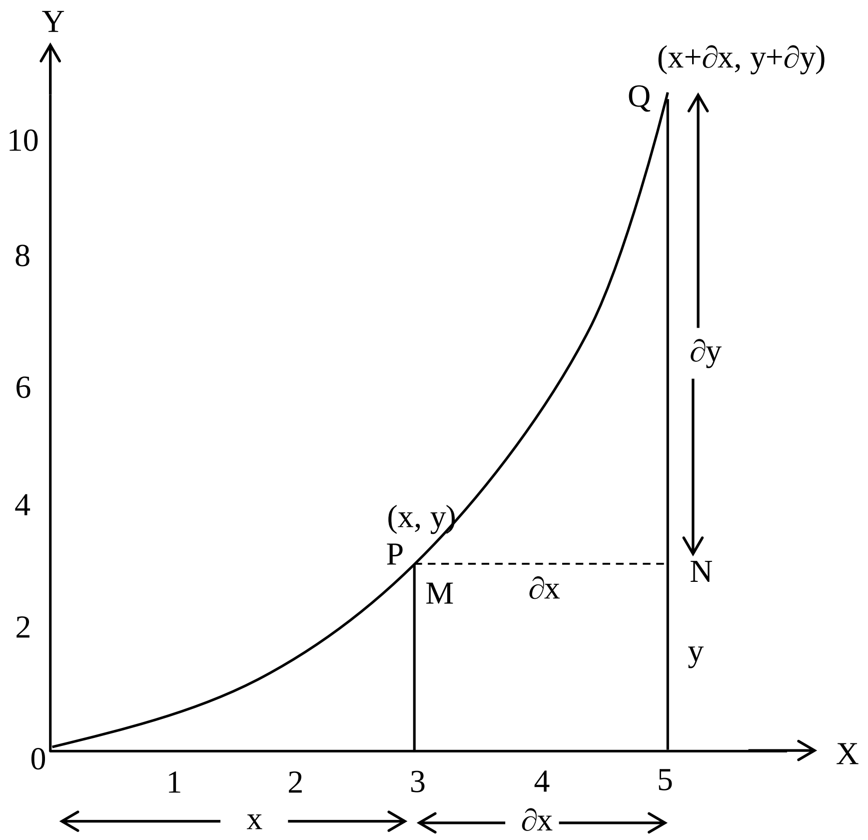

Figure 4: Graph of $Y = x^3$

Now, let x increase to $x + \partial x$, and y correspondingly increase to $y + \partial y$ where ∂x and ∂y are small. Now what are the coordinates of the point where x and y meet after the increase?

Students' activities: Students are expected to giv the coordinates as $(x + \partial x, y + \partial y)$
Then,
At P,
$Y = x^3$……………………………………………(1)
At Q,
$Y + \partial y = (x + \partial x)^3$ ……………………(ii)
Subtracting I from ii
$\partial y = (x + \partial x)^3 – x^3$
Expanding the binomial $(x + \partial x)^3$
$\partial y = x^3 + 3x^2\partial x + 3x\partial x^2 + \partial x^3 – x^3$
$\partial y = 3x^3\partial x + 3x\partial x^2 + \partial x^3$
Dividing through by ∂x
$\partial y/\partial x = 3x^2 + 3x\partial x + \partial x^2$
Taking the limits
$\lim_{\partial x\to 0} \partial y/\partial x = \lim_{\partial x\to 0} 3x^2 + 3x\partial x + \partial x^2$
$\therefore\ dy/dx = 3x^2$
Students' activities: Students ask questions if any.
Example 2: Differentiate from the first principle $y = 5x^2 -3x +2$
Students' activities: Students are to set up the equations as

$Y = 5x^2 - 3x + 2$……………..i
$Y + \partial y = 5(x + \partial x)^2 - 3(x + \partial x) + 2$……..ii
Subtracting I from ii
$Y = 5(x + \partial x)^2 - 3(x + \partial x) + 2 - 5x^2 - 3x + 2$
$Y = 5x^2 + 10x\partial x + 5\partial x^2 - 3x - 3\partial x + 2 - 5x^2 + 3x - 2$
$= 10x\partial x + 5\partial x^2 - 3\partial x$
Dividing through by ∂x
$\partial y/\partial x = 10x + 5\partial x - 3$
$\therefore \lim_{\partial x \to o} \partial y/\partial x = \lim_{\partial x \to o} 10x + 5\partial x - 3$
$\therefore dy/dx = 10x - 3.$

Students' activities: Students are to work on the problem below
Find the derivative of $y = x^2$ from the first principle
Expected answer is:
$Y = x^2$…………….i
$Y + \partial y = (x + \partial x)^2$………ii
$\partial y = (x + \partial x)^2 - x^2$
$= x^2 + 2x\partial x + \partial x^2 - x^2$
$= 2x\partial x + \partial x^2$
$\partial y/\partial x = 2x + \partial x$
$\lim_{\partial x \to 0} \partial y/\partial x = \lim_{\partial x \to 0} 2x + \partial x$
$\therefore dy/dx = 2x$

Step iv: Summary:
In general, if $y = f(t)$, then $f'(t) = dy/dx$ is the limiting value of $(f(t) + \partial y/\partial t) - f(t)$ when $\partial t \to 0$
That is, $dy/dt = \lim_{\partial x \to o} (f(t) + \partial y/\partial t) - f(t)$ where lim means the limiting value of $\partial(t) \to o$

Students' activities: Students copy the evaluation problems below as their take home assignment.
Step v: Evaluation:
1. Find from the first principle the gradient of the graph of $y = 5x^2 + 2$
2. Determine the derivates of y from the first principle
   a. $Y = cx^4$ b. $y = 3x^2 - 5x$ c. $y = x^2 - 4x$.

Conclusion/Recommendation
The greatest problem teachers encounter in classroom teaching and learning is how to plan for an instruction. Some teachers find it difficult to plan and develop a good lesson plan with appropriate instructional method that may enhance students' involvement and understanding of the lesson. This paper tries to develop a lesson plan on how to teach the knowledge of differentiation from the first principle to senior secondary school students using activity based instruction The implication is that any teacher who has been finding it difficult to develop a good lesson plan after going through this paper will find it helpful to develop one. Thus, applying constructivist approach to learning which is highly advocated as a good approach to learning that can help to engage students into learning activities during classroom instructions will help teachers to debunk the habit of frequent use of lecture method in the classroom.
In order to achieve all these, mathematics teachers should be encouraged by their employers and the principals to attend conferences and workshops so as to keep abreast of the new teaching method and techniques in teaching. Governments should also inject more money into education sector to enable administrators sponsor teachers by giving them money to buy text books and journals to develop themselves. Mathematics teachers should also be giving grants to attend conferences abroad to cross fertilize ideas with their colleagues over there. Mathematics teachers on their own should show dedication and commitment on their teaching professions by self- developing themselves by attending conferences, workshops and seminars even when they are not sponsored.

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