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CRISES IN MATHEMATICS AMONG THE NIGERIAN LEARNERS

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Abstract

The paper examines various crises in Mathematics among the Nigerian learners in primary, secondary and higher school systems. The crises are the inability of many learners to understand the idea of numbers at elementary stage, and improper application of Mathematics formula. It explores empirical design with some fundamental issues in the content and pedagogical areas of Mathematics to the manner through which they constitute crises for the understanding of Mathematics by Nigerian learners. The population of the study included learners in primary, secondary and higher levels. A sample of 75 learners were chosen at different levels with different Mathematics instruments ($r_1 = 0.60$, $r_2 = 0.65$ & $r_3 = 0.69$) based on the chronological and mental ages of learners, and in line with the scope and contents of Mathematics. One research question was raised with data analyses through simple descriptive statistics of mean and standard deviation for the categories of learners used. However, the findings were based on mathematical language problems of content and pedagogy. The study concluded with recommendation on the possible way out of these crises in order to attain qualitative academic achievement among the Nigerian learners of Mathematics.

Introduction

The school curriculum depends on the nature of the society which it is expected to serve; and it consists of different subjects such as English, Mathematics, and Social studies. Each of these subjects has considerable crisis among learners. In Mathematics crises are inability of many learners to understand the idea of numbers at elementary stage, and the improper application of mathematics formula. Mathematics as one of the compulsory subjects for the Nigerian learners was evolved to solve societal problems, and according to Omaze (1985), it occupies a central place in the school curriculum. Apart from this, the importance of Mathematics is often noticeable in all spheres of human endeavours to an extent that no meaningful development can be achieved except when Mathematics is employed. The present Global System of Telecommunication (GSM) is possible via the use of numbers, an integral part of Mathematics. Evidence of the crises abound in different studies conducted in Mathematics to have included factors such as the nature of the subject, students and teachers related factors among others. Adesoji, (1999); Akinsola, (1999); Oyedeji, (1996). However, the present researcher is of the opinion that the developmental stages of the crisis deserve to be mentioned in order to proffer a concrete solution to the subsequent crisis in the subject. The crisis in Mathematics is divided into two major factors such as content and pedagogy. As in other subjects language plays an important role in the dissemination of knowledge to its recipient, and that is why every learner is expected to understand Mathematical languages such as positive(+),minus/negative(-),multiplication(x),division(÷),greater than(>),less than(<),greater than or equal to(=), less than or equal to (<),equal to(=),not equal to(=),similar to(Ξ) and various formulae for specific problems in Mathematics.

Statement of the problem

The study was designed to examine the growing crisis in Mathematics among Nigerian learners, having taken into consideration the inherent mathematical languages.

Research question

What are the dimensions of crisis in Mathematics for the Nigerian learners?

Methodology

Design

The study was an empirical research which made use of Nigerian learners in the primary to the higher school levels in Ibadan, Oyo state.

Population

Population to the study included learners at primary, secondary and higher school levels in Ibadan, Oyo State.

Sample and sampling technique

75 learners constituted the subjects to the study, and they were stratifiedly sampled as 35 primary three, 23 Senior Secondary (SS) one and 17 National Diploma (NDI) learners.

Instruments

Major instruments employed in all cases were the Mathematics evaluative questions in Mathematics in three categories and relative to learner's chronological and mental ages.

Validation

The questions measured the content validity of the instrument as attested-to by two experts, who happened to be senior colleagues in Mathematics.

Reliability

All the items of the instrument were trial tested on similar groups of learners in the main study within an interval of two weeks, and correlation coefficients of 0.60, 0.65 and 0.69 were obtained for the primary, secondary and higher levels respectively.

Procedures

Each category of learners was personally taught the concept rose in the instrument and later asked to solve similar questions. Each phase of exercise lasted for six weeks with eighteen weeks for the entire exercises. It was their responses coupled with the aforementioned language problems in Mathematics that allowed the researcher to understand various identified crisis in Mathematics.

Findings

Study revealed that the language of Mathematics plays a dominant crisis in Mathematics for learners, and could be seen in the content and pedagogy.

Contents of Mathematics

In Mathematics, the major languages are signs/symbols and formulae/theories just to mention a few. One of the major crises of the Nigerian learner in Mathematics is the translation of signs/symbols to an acceptable norm. A learner is acquainted with the signs like minus (-), positive (+), multiplication (x) and division (÷) but left in the dark of the meaning of these signs to his immediate environment. Apart from that the manipulation of these signs is a great problem for the learner especially when encountered with the related problems. Take for instance a learner might know that end result of positive (+) and positive (+) is positive (+) but what about the case of negative (-) and negative (-) that do not conform to the earlier assumption. This is an initial crisis for the learner in Mathematics.

With a total weakness in the translation, manipulation, recalling of signs/symbols the next crisis which faces the Nigerian learners lies in the application and recalling of formulae/theories towards an accurate standard. In most cases, the learner feels that these formulae/theories in Mathematics are used to resolve particular problems in Mathematics without its application any longer to the societal values; and as soon as these formulae/theories are applied to definite classroom work, that marks their end. For instance, a learner taught the principle of Simultaneous Equation $x + y = 4$ and $3x-2y = 6$ might not ascribe it to the meaningful buying and appropriation of scarce resources to satisfy one's needs, but only solve for the value of $(x, y) = (14/5, 6/5)$ as the final. The analysis made here is that the principle of Simultaneous Equation has not made the learner to realize that the issue goes beyond the classroom situation, but to the solving of the problems in the society.

Apart from these, the inability of many learners to understand the idea of numbers at the elementary stage constitutes a crisis in Mathematics. It might be true that learner can count from one to hundred off-handedly but, the problem lies with the identification of the numbers. This is because the learner has developed the vocabulary of these concepts as against the meaningful interpretation of the numbers. In the same vein, the improper application of the formula is a problem in Mathematics and sometimes, it constitutes a crisis for the learners. This assertion was based on the personal encounter of the researcher with three separate groups of learners in different a where the following discussions were held. In the discussion T represents teacher, S_o, S_1 and S_2 represent the three groups of learners in Primary three, SS one and ND one respectively.

T: Goodmorning students! S_0: Goodmorning Uncle, God bless you sir.

T : Last week we discussed the manipulation of signs like (+) x (+) , (+) x (-), (-) x (+) and (-) x (-). Can someone remind us of the answers to those questions?

S_0: Yes uncle, the answers are +, -, - and - respectively

T : It is true of questions (1-3) and not true of the last question whose answer should be (+)

S_0: But, uncle, the answer to (+) x (+) = +, and so the answer to (-) x () = - because the sign was repeated in the first one and so, it should be for the second one as well.

T : No, it does not hold like that. What the first one stipulates was that the friend of your friend could be referred to as your friend, okay. The second one could as well be termed as the enemy of your enemy could be your friend, since that one is against your second enemy. The signs (+) and (-) could be termed as friend and enemy, respectively, in ordinary language through symbol in Mathematics.

S_0: Uncle, does it change the cases of the second and third ones where their answers remained the same?

T : No, it doesn't as the rules of friends and enemies still hold in two cases. Do we understand?

S_0: Yes!

T: Now let us see how competent we are in Linear measurements: 10mm = 1cm, 10cm = 1dm, 10dm = 1m and 100m = 1km. Mass and weight measures – 10mg = 1cg, 10cg = 1dg, 10dg = 1g, 1000g = 1kg and 1000kg = 1tons while in cubic measures – 1000 cubic mm = 1 cubic cm, 1000 cubic cm = 1 cubic dm, 1000 cubic dm = 1 cubic m and 1 cubic dm = 1m/litre. Now everybody should recite these after me.

S_0: 10mm = 1cm, 10cm = 1dm, 10dm = 1m and 100m = 1km. Mass and weight measures – 10mg = 1cg, 10cg = 1dg, 10dg = 1g, 1000g = 1kg and 1000kg = 1tons while in cubic measures – 1000 cubic mm = 1 cubic cm, 1000 cubic cm = 1 cubic dm, 1000 cubic dm = 1 cubic m and 1 cubic dm = 1m/litre.

T: Yes, clap for yourselves. Now, I want R to tell me the value of 10dm = ? At this juncture there was a perfect silence in the class to an extent that if a needle was dropped it would be easy to hear its sound due to the non-understanding of the question on the one hand, and the starting of the question half-way. Learners could provide answer to the problem only if they are asked to start recitation.
S_0: Uncle, the answer is possible when we start counting from the beginning. Otherwise there is no solution to the problem.
T: Yes, the question of this 10dm = ? is a crisis for learners to understand except they are taught how to associate values to these linear measurements with the appropriate teaching aids and well structured strategy from the teacher.

At this point many examples with different measuring tapes were shown to learners to see and copy in order to apply these in arriving at appropriate answer. The most surprising thing which T noticed was that these learners (S_0) had to recite the whole linear measurement before answering the question, and the same was applicable to other topics taught by the researcher. They have been used to rote learning style.

Table 1: Mathematics achievement test scores for primary school learners

Num	Pre-test scores		Post-test scores		Difference of variance
	Mean	Std. Dev.	Mean	Std. Dev.	
35	41.3	1.46	43.0	1.88	1.40

Meanwhile teachers are enjoined to make the appropriateness of rules clear to the students rather than dogmatism in solving Mathematical problems in order to avert further crisis, as corroborated in pupils' performance in table 1 of the pre- and post-test scores.

In another forum which involved the researcher with learners of secondary schools where the concept of quadratic equation through the formula was to be used, the first sight of the formula $x = \{-b \pm\sqrt{(b^2 - 4ac)}\}/2a$ was taken as $x = -b \pm\{\sqrt{(b^2 - 4ac)}\}/2a$. Based on the following interaction the session between the researcher and learners went as follows:

T: Let us treat quadratic equation $ax^2 +bx + c = 0$ with the formula $x = \{-b \pm\sqrt{(b^2 - 4ac)}\}/2a$, where a = coefficient of x^2, b = coefficient of x and c as constant in $ax^2 +bx + c = 0$.

S_1: Sir, can't we write the equation's formula as $x = -b \pm\{\sqrt{(b^2 - 4ac)}\}/2a$?

T : No, it does not obey the rules of the quadratic formula. Along the line the equation $x^2 + 3x- 4 = 0$ was written and solved via the formula so that x = -4 or 1.

T : Suppose we want to solve the equation $k^2 + 4k + 3 = 0$ with the same formula, what do we do?

S_1: We cannot solve the equation since x is not given, and that formula to be used is meant for x only.

T : No, the formula still holds for all types of quadratic equations though the answer will be in terms of variables stated in the question.

S_1: Sir, ever since we have come across quadratic equations they are often in x and some in y; and most of the text materials that we have come in contact with have not stipulated otherwise.

T : Suppose the equation is of the form $x^2 + 4x + 3 = 0$, can we use the formula?

S_1: Yes, so that a = 1, b = 4 and c = 3 in the formula $x = \{-4 \pm \sqrt{(4^2 - 4(1)(3)}\}/2(1) = \{-4 \pm\sqrt{(16 - 12}\}/2(1) = \{-4 \pm\sqrt{(4)}\}/2(1) = \{-4 \pm 2\}/2 = -3$ or -1.

T: Now let us use 'k' where we have 'x' and see what we would get. $k= \{-4 \pm\sqrt{(4^2 - 4(1)(3)}\}/2(1)=-3$ or -1.

S_1: Does it mean that we can use any letter and get the same answer?

T: Yes, the main goal of quadratic equation is to have two-value(s) answer irrespective of the letters used.

S_1: But in most of our Mathematics classes we were often taught with x and on some rare occasions we come across y. This has given us the impression that no other alphabet could be used especially as the formula to be used is coded in x.

At this point many examples were given with different letters for the students to copy and solve to see if the same answers would be obtained when presented. To the surprise of the T these students (S_1) had to write the equation in a form of x and get solution before replacing later with the appropriate alphabet, for they have been used to x only.

Table 2: Mathematics achievement test scores for secondary school learners

Number	Pre-test scores		Post-test scores		Difference of variance
	Mean	Std. Dev.	Mean	Std. Dev.	1.72
23	45.0	1.55	55.4	2.03	

There is therefore the need for teachers to make clear to learners the appropriate use of the formula in solving Mathematical problems in order to avert further crisis, based on learners' performance in Table 2 of pre-and post-test scores.

In another forum which involved the researcher with learners of higher learning the formula for the correlation of ordinal variables in form of Spearman rank was to be computed, it should be maintained here that the first sight of the formula to the students was $\{1 - 6\sum d^2\}/n(n^2 - 1)$ as against the appropriate write-up of $1 - \{6\sum d^2\}/n(n^2 - 1)$. When the data in terms of x and y were given to students (S_2) to compute the correlation, S_2 did the preliminary working as the rule stipulated but got confused when applying the formula. The discussion below is better used to illustrate.

T: Let us compute correlation coefficient using the Spearman rank formula of $1 - \{6\sum d^2\}/n(n^2 - 1)$ using the given data. Data and other necessary steps were used, and at the end 0.324 was obtained with the interpretation of weak relationship. Now use another set of data to compute the same correlation coefficient?
S_2: As stated by T, the Spearman rank formula(r) = $\{1 - 6\sum d^2\}/n(n^2 - 1)$, and using the same procedures of the teacher, the answer obtained was far lower than 1, and this contradict the assumption of $-1 \leq r \leq 1$.
T: You have applied the formula wrongly even though your tabulation was in order, and that was why you had a wrong answer. Remember I told you that the formula was $1 - \{6\sum d^2\}/n(n^2 - 1)$ and not $\{1 - 6\sum d^2\}/n(n^2 - 1)$ which you had used.

S_2: Are they not the same notation or formula, sir?
T: No, they are not if you observe them carefully. $1 - \{6\sum d^2\}/n(n^2 - (1)$ and $\{1 - 6\sum d^2\}/n(n^2 - 1)$ states that minus every operation from 1 and minus 6times sum of squares of difference from 1 and divide the solution by $n(n^2 - 1)$, respectively.
S_2: O.K. That was how we missed the answer to the problem.
It is interesting to observe that what happened to learners did occur to generality of learners in Mathematics. It is not only the answer that examiners are after rather the steps constitute parts of awarding marks

Table 3: Mathematics achievement test scores for higher school learners

Number	Pre-test scores		Post-test scores		Difference of variance
	Mean	Std. Dev.	Mean	Std. Dev.	2.20
17	41.5	1.43	49.1	2.06	

Learners might understand the rudiment of problem in Mathematics but most of the times do experience crisis in the application of the required formula. Some other Mathematical problems where formula abound like this constitute crises to Nigerian learners in Mathematics. This and some others are critical crises in Mathematics content-wise for learner to overcome, as shown in the pre-and-post-test scores in Table three above.

Pedagogy in Mathematics

Education stakeholders should be mindful of the language used in teaching. Meanwhile, the process of teaching learner the concept of numbers via the language of the learner should be used with care so that the learner does not equate the learning of language with the learning of 'numbers'. If learner is taught concept of numbers in Yoruba, such as one – *okan, two - eeji, three – eeta* etc. without much association to concrete objects for mastering, the language skill in learner is increased to the detriment of 'number' concept formation. Many learners master the counting from one to hundred off – handedly without meaningful representation.

In contrast, efforts should be made on the real life situation of presenting concrete and non – harmful objects such as one sweet, two balls, and three caps to the learner. With these processes, the idea of numbers would have been registered in the mind of the learner as against the mastery of vocabulary and language. After this process the teacher should combine different objects in order to explain the concepts of numbers as earlier gained in the previous process. Here the teacher can take one mango and one pencil, and ask the learner how many objects are available? This would further register the idea of numbers into the mind of the learner rather than mastery of vocabulary alone. The teaching of numbers at the early stage of the learner should be accompanied by the concrete objects so that the learner will not confuse the concept of learning numbers with that of language expertise.

The poor introduction of four basic operations in Mathematics constitutes great risk to the learner. Mathematics has four elementary operations: addition, subtraction, multiplication and division as earlier mentioned constituting languages of the subject. The method of introducing these operations to a learner goes a long way in the mastery and understanding of Mathematics. In the introduction of the concept of number, the basic operation like 'addition' should be introduced to the child through an activity – oriented system instead of in abstract form. Whenever a foundation concept has not been fully understood the learning of subsequent concepts is problematic, and leads the learner to frustration and aversion for Mathematics. For instance, a teacher might want to teach the concept of addition to learner without accomplishing success, if he approaches it through a wrong step. It is true that the learner has understood the concept of numbers but the operation that exists between two or more numbers has to be clarified through close association and not through abstraction. The learner could be confused if given a simple problem of 8 + 5 =? as a result of his mental and chronological ages. What he understands are concepts of 8 and 5, and nothing more except clearer environmental indices are used. In this case the learner could be asked the addition (+) of 8 sweets and another 5 sweets which generates the correct answer of 13 sweets.

Similarly, the teaching of subtraction (-) needs to be associated with objects familiar to the child or else he loses focus. It is imperative for teachers to associate problem solving skill with the immediate activity surrounding the child, unlike merely writing on the chalkboard 8 – 5 =? which confuses the learner? Alternatively, learner could be taught that 8 sweets less 5 sweets (i.e. 8 sweets – 5 sweets) gives 3 sweets. This approach makes the learner develop a keen interest in Mathematics, which enhances and affects the education of the learner positively.

In multiplication it is wrong to sit the learner down to chant multiplication table off – handedly; rather the concept could be introduced through mild and soft method that enhances the learning operation. Take for instance the problem of 8 x

3 =? could make learner develop cold feet at a start. A good teacher could bail the learner out of the predicament in the same manner as that of addition and subtraction. The approach could be from the right to the left or vice – versa. Here the teacher could get bottle-tops or stones or use matches to be arranged in bundle of eights into three places and ask the learner to count altogether. Alternatively, the learner could be asked to count three bottle tops in eight places, thereafter combine altogether and be asked about the total instead of 8 x 3 = ? Through this method, a viable result is obtained in the practical approach rather than elaborate assignments given to the learner.

The last arithmetic operation (division) seems to be complex for the understanding of the learner through abstraction, except through a practical approach used in multiplication. It is erroneous and time consuming for the teacher to write different exercises on the division of numbers without close association. Learners could be confused with the problem 8 ÷ 4 = ? Instead, the practical approach of sharing 8 sweets among four people could be used, so that the question of how many sweets each person gets would be understood by the learner. A Slow learner would distribute the sweets one by one to the four people until he exhausts the whole sweets while the fast learner gives each person two sweets so that all the four people shared 8 sweets.

Meanwhile, the reversibility of these concepts should be taught with care so that the erroneous impression of 'impossibilities' is ruled – out as the case of 5 – 8 =? Learner should be made to see transactional situation in a classroom like if John owes Janet 8 kobo but gives 5 kobo to Janet, then how much does John owe Janet. The learner knows that it remains negative three kobo. This approach makes it clear to learner that nothing is 'impossible' rather than carrying it to the higher level. The reversibility of operation and discussion of numbers should take cognizance of the mental and chronological age of the learner or else the foundation of mathematics is destroyed.

At times sole dependence on memory work of the arithmetic system constitutes a crisis to the learner. The Learner is often at the cross roads of the application of some concepts of metric arithmetic tables which he could chant from the beginning to the end, but a slight asymptotic situation creates a problem thereafter increasing a fear in the learner to learn mathematics. For instance, a learner could recite as follows: Linear measures – 10mm = 1cm, 10cm = 1dm, 10dm = 1m and 100m = 1km. Mass and weight measures – 10mg = 1cg, 10cg = 1dg, 10dg = 1g, 1000g = 1kg and 1000kg = 1tons while in cubic measures – 1000 cubic mm = 1 cubic cm, 1000 cubic cm = 1 cubic dm, 1000 cubic dm = 1 cubic m and 1 cubic dm = 1m/litre. These concepts are often taught via memory work without any close association to the objects in order to make meaning to the learner. The irony of the teaching and learning arises whenever the learner is faced with a related problem in those areas, but found that he could not make any headway. This creates a negative attitude that affects the learner in life. In some cases, whereby the learner is asked to start from midway, say 10dm = ? but due to starting point already omitted as a result of heavy memory work, learner the develops cold feet. This constitutes a crisis to the learner in Mathematics. In this case, the teacher should make use of appropriate teaching aids like meter rule, measuring tapes to specify the equivalence of these quantities for the learner instead making them commit to memory.

The extent of practice of the learner in Mathematics determines the number of text materials and the different problems encountered, thus enriching his knowledge and diversifing his approaches, to tackle future problems. The learner's lack of rehearsal principle in Mathematics reduces problem-solving skill, which constitutes crisis in Mathematics. What determines the learner's practice of Mathematics varies from one learner to the other, but in general, some of these include gender and attitude (internal and external) towards mathematics.

Meanwhile the teacher should explore the use of different teaching methods to facilitate learning. According to Olaoye (2005) there seems to be no specific method of teaching that is superior to the other, rather, the amalgamation of these methods constitute a better strategy to enhance learning. Teachers should diversify their methodology to suite the learner, topic, time and the environment under which learning takes place. Once a learner declares hatred towards Mathematics, it might take a professionally trained counselor donkey years to disabuse his mind.

As an activity-oriented subject, the quantities and qualities of textbooks in Mathematics affect the learner, and at times constitute crisis. At the pre and primary levels of education, Mathematics' learning is often taught through the play-way method and as such should feature the available text books at these levels in order to fascinate the learner's interest. It is recommended that the use of colours, shapes and familiar teaching aids which are not harmful to the learner, should be explored by the teachers. The arrangement of the topics should take cognizance of the learner's ability to comprehend and not based on assumption. A contextual arrangement should follow from the known to the unknown with different examples and explanations. When a learner is acquainted with known / simple concepts, then an extrapolative study can be built on the known concept, otherwise it would be difficult to lay solid Mathematics foundation for the learner.

In summary crisis in Mathematics among Nigerian learners are multi-dimensional though classified into content and pedagogical aspects with language of Mathematics playing an important role. Concerted efforts must be made to help learners overcome the crises that arise, if the tempo of developing science and technology is to be sustained.

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