CLARIFICATIONS ON PERCEIVED DIFFICULT TOPICS IN MATHEMATICS IN SENIOR SECONDARY SCHOOLS IN NIGERIA: THE CASE OF INEQUALITIES

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Abstract
Mathematics education curriculum at the Senior Secondary School level in Nigeria is loaded with concepts and topics perceived by both Mathematics teachers and learners as difficult. It behoves the mathematics teacher to teach effectively in order to change this narrative. One such perceived difficult topic is inequalities. This paper clarified the concept of inequalities, highlighted and explained areas that would make the topic simple by applying it to real life situations while teaching it. The underlining principles and laws are discussed. Furthermore, examples are solved using the laws and illustrating with graphical diagrams as a model approach in teaching the topic effectively. It is recommended among others, that the perceived difficult topics in Mathematics should be taught exposing their real life applications in order to generate and stimulate the interest of the learner. Also all necessary resource materials needed for effective teaching of the concept should be adequately made available and above all, a learner centred method of teaching should be employed in teaching these topics and concepts.

Keywords*: Inequalities, clarify, difficult concepts, linear, variable.*

INTRODUCTION

Teaching is goal directed and the goals are in line with the aspirations and desires of the society for development. The needs and aspirations of the Nigerian society are encapsulated in her national policy on education (NPE) using education as an instrument for achieving these goals. The education system is structured towards the realization of her scientific and technological development. Mathematics, an instrumental subject in actualizing of the desired development must therefore, be taught effectively. However, the teaching and learning of the subject in our schools have never met the desired standard. For many, the Nigerian Mathematics Education curriculum is loaded with many topics that are perceived to be difficult by both teachers and learners and so cannot be taught and learnt effectively. Such topics include trigonometry, mensuration, inequalities, probability, sequences and series, combination and permutation, word problems among others (Akanni, 2015).

The perceived difficulties on the part of teachers in teaching and learning on the part of students are attributed to ineffective method of teaching on the part of the teacher and abstract nature of the topics on the part of the learners. For many learners, such topics are considered abstract and difficult (Ado, Rahinatu, and Fatima, 2018; Adeniyi and Akinoso, 2023). It behoves the mathematics teacher to effectively teach the perceived difficult topics so that learners can learn easily. In doing this, the Mathematics teacher must therefore, adopt teaching methods and approaches that are practical and learner centred in order to achieve the desired goals of teaching. In this work a conceptual clarification of linear inequalities as well as a practical and learner centred approach has been adopted in teaching linear inequalities in the Senior Secondary Schools, highlighting areas of application of the concept in real life

situations thereby, denouncing the abstract and difficult nature of the concept. Finally suggestions are made for teaching perceived difficult concepts in mathematics

CONCEPT EXPLANATON

In this section of the paper the clarification of the concept of inequalities and its application in real life situation and other areas of human endavour are exposed. Furthermore, axioms, principles and laws of inequalities are clarified towards enhancing effective teaching and learning in order to reduce the difficulty level as perceived by both teachers and learners.

In Mathematics, the relationship between two values that are not equal is defined by inequalities. JEE (2024) define inequalities conditionally that if two real numbers or algebraic expressions are related by the symbols >, <, ≥ or ≤ then the relation is called an inequality. Inequality, by this definition refers a mathematical statement that shows the relationship between two quantities or expressions using the inequality symbol. The term is used to compare the magnitude, number and intensity of two values or expressions. We use '=' when two quantities are equal and when they are not equal we use '≠'. When two things are not equal then the first value can either be greater than (>) or less than (<) or greater than or equal to (≥) or less than or equal to (≤) the second value.

The concept of inequality, taught at the senior secondary school level in Nigeria finds applications in real life situations, in the field of business and economics for modeling and analysis of financial scenarios such as sales, forecasting, budgeting and pricing. Imtiaz (2023), in real life application of linear equations and simple inequalities posits that a business owner might us a linear inequality to model the relationship between the number of unit sold and the total revenue generated. The inequality $y > mx + b$ where y is the number of units that can be sold, x is the price of the product and m is the demand while b is the minimum selling price can be used to model the price fixtures in a business concern. Inequalities also find application in linear programming and domestic affairs such as in the purchase of household provisions like gas and electricity token. For instance, Terna got a new job with a monthly income of N52, 650. To qualify to rent an apartment, his monthly income most be at least three times as much as the rent.

What is the highest rent Terna will qualify for? This problem can be modeled using inequality, where r is the rent. That is $3r \geq 52{,}650$ and solving $r \geq 17{,}550$. So the maximum rent most be N17, 550.

The fundamental principle of inequality is all about comparison between quantities utilizing any of the symbols below:

'>' = Greater than e.g. $5 > 3$.

'<' = Less than e.g. $2 < 7$.

'≥' = Greater than or equal to

'≤' = Less than or equal to

'≠' = Not equal to.

Inequalities involving one variable are known as linear inequalities e.g. $x > 5$ or $-2 < x < 3$. While those involving two variables may be referred to as nonlinear inequalities or inequalities in two variables such as $x + y > 2$,

The >, <, ≠ are strong or strict inequalities while ≥ and ≤ are weak inequalities. Most times, solutions of inequality problems are graphed and the solution set tested from the graph to find the

region representing the inequalities. In representing inequalities on the graph the strict inequalities (> and <) are represented with small circle (o) or broken line indicating that the point or line is not included in the solution set. The weak inequalities (≥ and ≤) are plotted with a dot (.) or continuous line to show that the point or line is included in the solution set.

BASIC LAWS OF INEQUALITIES

For every inequality, there is a corresponding equation meaning inequalities are manipulated the same way as equations employing similar axioms of solving equations. However, the sense or direction of an inequality is flipped or reversed when dividing by a negative number. Sterling (2018) posited the following laws for solving linear inequalities.

1. If $x < y$, then $x \pm k < y \pm k$ for some positive number k

2. If $x < y$, and k is positive then $x\,k < y\,k$ and if k is negative then $x\,k > y\,k$

3. If $x < y$, and k is positive then $x/k < y/k$ and if k is negative then $x/k > y/k$

The fundamental laws above hold for ≥ and ≤ as well as exponential inequalities.

COMMON ERRORS COMMITTED BY STUDENTS IN LEARNING INEQUALITIES

Student's inability to comprehend the learning of inequalities is attributed to misconceptions of operations in solution procedure. Third Space Learning (2024) enumerated these misconceptions or errors to include dropping the inequality sign using the wrong operations and performing the operation to the wrong side. These misconceptions can lead to errors in the solution process that can lead to not only wrong solutions or answers but also frustration to the students. The Mathematics teacher most therefore watch out for these errors and effect correction where they are committed. This calls for the teacher to be innovative and progressive in the teaching of the concept. Mabonga (2021) proposed a guided discovery approache in teaching inequalities while Bot (2018) suggested the open inquiry methods of teaching inequalities.

SOLUTIONS OF LINEAR INEQUALITIES IN ONE VARIABLE

Solutions of linear inequalities in one variable are solved the same way that their corresponding linear equations are solved bearing in mind the basic laws of inequalities.

Example 1: Solve the inequalities (a) $7x - 8 < 5x + 2$ (b) $x/2 - 2 > 4x/3 + 3$.

Solution (a) $7x - 8 < 5x + 2$

$7x - 5x < 2 + 8$

$2x < 10$

$x < 5$

(See graphical representation on fig. 1a)

Solution (b) $x/2 - 2 > 4x/3 + 3$

$3x - 12 < 8x + 18$

$3x - 8x < 18 + 12$

$-5x < 30$

Dividing both sides by - 5 gives $x > -6$.

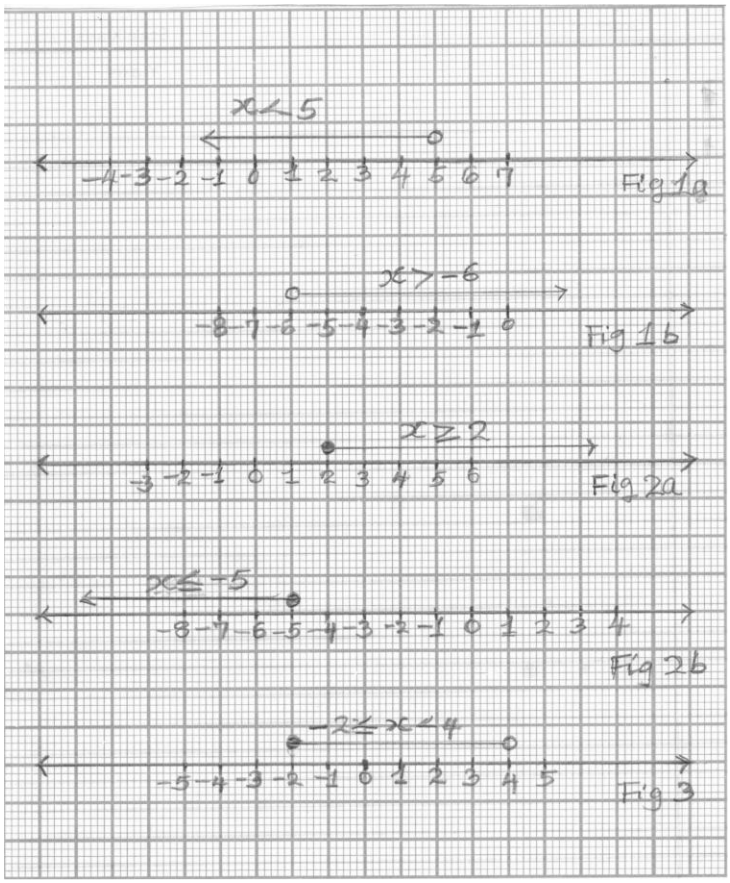
Note the change in the sense of the inequality when divided by -5. (see graphical representation on fig 1b).

Example 2: Solve the inequalities (a) $x + 4 \geq 6$ (b) $3x + 4 \leq 2x - 1$

The solutions are given by (a) $x \geq 2$ and (b) $x \leq -5$

See graphical representation on fig. 2a and 2b respectively

Example 3: Show the inequality $-2 \leq x < 4$ on a line graph. (See graph on fig. 3)



INEQUALITIES IN TWO VARIABLES

Note: every linear inequality has a corresponding linear equation. The line or graph of the corresponding equation divides the x-y plane in two parts. Each part is called a half-plane. To solve linear inequalities in two variables using this method, a point is chosen each from the half-plane and tested in the inequality. If this point satisfy the inequality, then all points lying on this half plane satisfy the inequality are from the solution set.

Example 1 Draw the line whose equation is $x - y = 2$. Show the part of the plane satisfying the inequality $x - y \leq 2$.

Solution Note: a straight line can be drawn if two or three points are known.

If $x = 0$ then $-y = 2$ and $y = -2$

If $y = 0$ then $x = 2$ from the given equation. Plotting this point on the x-y plan

Given $x - y = 2$, whose graph is plotted, chose a point say (- 1, 2) on the x - y plane using the inequality $x - y \leq 2$ to test we have.

$- 1 - 2 \leq 2$

- $3 \leq 2$ which is true.

The point (– 1, 2) is contained in the upper half-plane of the graph. This shows that any point in the upper half-plane satisfies the inequality $x – y \leq 2$ and so form the solution of the inequality and is shaded to form the solution region. Note the continuous line AB represented by the equation $x – y = 2$ shows that the points on the line are included in the solution set.

Example 2: Solve the inequality $2x + 3y > 6$ and shade the region satisfying the inequality on the graph.

Solution: Given $2x +3y > 6$. The corresponding equation is $2x +3y = 6$

Let $x = o , y = 0$

$2x + 3y = 6 , 2x + 3y = 6$

$3y = 6$ ‘ $2x = 6$

$y = 2 , x = 3$

(See the graph in fig. 4b)

Now chose $(x, y) = (2, 1)$ on the lower half-plane of line PQ and testing gives.

$2 (2) + 3 (1) > 6$

$4 + 3 > 6$

$7 > 6$ which is true.

Thus the half-plane below the line PQ satisfy the inequality$2x +3y > 6$ and so all points in the lower half-plane form the solution set of the inequality. Note that the line PQ is broken implying that the points on the line PQ do not form part of the solution.

CONCLUSION

The basic aim of teaching is for learning to take place and learning can take place only if the teaching is effective. Effective teaching/learning process in Mathematics is affected by the perceived difficult level of the concept or topic by both learners and teachers. Akanni (2015) found that, as perceived by both teachers and learners, almost half of the topics in Mathematics curriculum in Nigeria are perceived difficult by both teachers and learners.

Hence, there is the need to improve on the teaching of the topics if learning must effectively take place. Students need to be able to read inequality statements interpret them correctly and transform the statements using appropriate symbols.

This is where the role of the Mathematics teacher in guiding and assisting the learner to perform the required operation correctly becomes necessary. The Mathematics teacher must clarify fundamental terms associated with the topic using leaner centred approach of teaching. In this way effective teaching/learning can take place.

SUGGESTIONS

Based on the above discussions it is recommended that:

a. The fundamental laws and principles that can enhance effective learning of the perceived difficult concept in Mathematics should be stated and explained in the course of teaching the concept.

b. The Mathematics teacher must therefore, expose the real life application of the concept while teaching in order to stimulate and generate interest of the learner for effective teaching/learning to take place.

c. Learner-centred pedagogy, involving the learner at all stages of teaching the perceived difficult topics should be employed.

d. All necessary resources and materials, in this case, graph books, board, be adequately made available in the course of teaching the concepts.

e. The stakeholders in education should always involve Mathematics teachers in in-service training on the new approaches of teaching perceived difficult topics in Mathematics.

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