Competency-based Learning in Mathematics

What Changes in an Actual Classroom?

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The Current Classroom Reality

- You finish the chapter.
- A significant fraction of students did not understand.
- You move on anyway.

Quick Poll

How many of you have experienced this regularly?

What is Actually Fixed?

Traditional System

- Time is fixed
- Learning is variable

CBL Claim

- Learning is fixed
- Time becomes flexible

Consider

We are not short of teaching time.

We are short of **feedback loops** before moving on.

5.2 Inequalities

Let us consider the following situations:

(i) Ravi goes to market with ₹200 to buy rice, which is available in packets of 1kg. The price of one packet of rice is ₹30. If x denotes the number of packets of rice, which he buys, then the total amount spent by him is ₹30x. Since, he has to buy rice in packets only, he may not be able to spend the entire amount of ₹200. (Why?) Hence

$$30x < 200 \qquad \dots (1)$$

Clearly the statement (i) is not an equation as it does not involve the sign of equality.

Real-life situations introducing inequalities

Consider

What is good about this start?

- What is the student thinking about?
- What kind of mathematics is being used?

CBL is familiar

NCERT already begins with modeling and context.

This is competency-oriented mathematics.

But What Happens Next?

Definition 1 Two real numbers or two algebraic expressions related by the symbol ‘<’, ‘>’, ‘≤’ or ‘≥’ form an *inequality*.

Statements such as (1), (2) and (3) above are inequalities.

$3 < 5$; $7 > 5$ are the examples of *numerical inequalities* while

$x < 5$; $y > 2$; $x \geq 3$, $y \leq 4$ are some examples of *literal inequalities*.

$3 < 5 < 7$ (read as 5 is greater than 3 and less than 7), $3 \leq x < 5$ (read as x is greater than or equal to 3 and less than 5) and $2 < y \leq 4$ are the examples of *double inequalities*.

Some more examples of inequalities are:

$$ax + b < 0 \quad \text{... (5)}$$

$$ax + b > 0 \quad \text{... (6)}$$

$$ax + b \leq 0 \quad \text{... (7)}$$

$$ax + b \geq 0 \quad \text{... (8)}$$

$$ax + by < c \quad \text{... (9)}$$

$$ax + by > c \quad \text{... (10)}$$

$$ax + by \leq c \quad \text{... (11)}$$

$$ax + by \geq c \quad \text{... (12)}$$

$$ax^2 + bx + c \leq 0 \quad \text{... (13)}$$

$$ax^2 + bx + c > 0 \quad \text{... (14)}$$

Consider

At what point does the student stop thinking about the situation and start focusing only on symbols?

Key Point

The shift from context to symbols happens **too quickly**.

Students lose the meaning of what they are doing.

Exercise Pattern

1. Solve $24x < 100$, when
   (i) x is a natural number. (ii) x is an integer.
2. Solve $-12x > 30$, when
   (i) x is a natural number. (ii) x is an integer.
3. Solve $5x - 3 < 7$, when
   (i) x is an integer. (ii) x is a real number.
4. Solve $3x + 8 > 2$, when
   (i) x is an integer. (ii) x is a real number.

Solve the inequalities in Exercises 5 to 16 for real x.

5. $4x + 3 < 5x + 7$
6. $3x - 7 > 5x - 1$
7. $3(x - 1) \le 2(x - 3)$
8. $3(2 - x) \ge 2(1 - x)$
9. $x + \frac{x}{2} + \frac{x}{3} < 11$
10. $\frac{x}{3} > \frac{x}{2} + 1$
11. $\frac{3(x-2)}{5} \le \frac{5(2-x)}{3}$
12. $\frac{1}{2}\left(\frac{3x}{5} + 4\right) \ge \frac{1}{3}(x - 6)$
13. $2(2x + 3) - 10 < 6(x - 2)$
14. $37 - (3x + 5) \ge 9x - 8(x - 3)$
15. $\frac{x}{4} < \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$
16. $\frac{(2x-1)}{3} \ge \frac{(3x-2)}{4} - \frac{(2-x)}{5}$

Solve the inequalities in Exercises 17 to 20 and show the graph of the solution in each case on number line

17. $3x - 2 < 2x + 1$
18. $5x - 3 \ge 3x - 5$
19. $3(1 - x) < 2(x + 4)$
20. $\frac{x}{2} \ge \frac{(5x-2)}{3} - \frac{(7x-3)}{5}$
21. Ravi obtained 70 and 75 marks in first two unit test. Find the minimum marks he should get in the third test to have an average of at least 60 marks.
22. To receive Grade 'A' in a course, one must obtain an average of 90 marks or more in five examinations (each of 100 marks). If Sunita's marks in first four examinations are 87, 92, 94 and 95, find minimum marks that Sunita must obtain in fifth examination to get grade 'A' in the course.
23. Find all pairs of consecutive odd positive integers both of which are smaller than 10 such that their sum is more than 11.
24. Find all pairs of consecutive even positive integers, both of which are larger than 5 such that their sum is less than 23.

Consider

If a student completes all these:

- What have they mastered?
- What have they not practiced?

Key Point

Practice builds fluency.

But fluency without meaning is fragile.

What Is the Real Issue?

- The chapter starts with context.
- Then quickly becomes procedural.

Changing the Entry Point

Example 13 A manufacturer has 600 litres of a 12% solution of acid. How many litres of a 30% acid solution must be added to it so that acid content in the resulting mixture will be more than 15% but less than 18%?

A problem that requires forming inequalities

Consider

Before teaching any rules:

- What will students try?
- Where will they get stuck?

Key Point

If students feel the need for a concept, they learn it more meaningfully.

Start at least one chapter with a problem, not with a definition.

Checking Understanding

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Consider

If a student can solve all of these:

- Can they explain what they are doing?
- Can they interpret the answer?

A Simple Way to Check Understanding

Pick one concept.

Ask students to show understanding in **more than one way**.

Example

A concept can be expressed in different ways:

- Algebraic (solve an equation)
- Graphical (draw or visualize)
- Verbal (explain reasoning)
- Numerical (test with values)

Even asking for two of these is enough.

Key Point

Understanding is not one-dimensional.

If students can only solve, they may not understand.

What Our Feedback Often Looks Like

- -3 for sign error
- -2 for calculation mistake
- Final answer wrong

Student sees: A score

Student does not see:

- Where the mistake happened
- Why it happened
- What to do next

Consider

When a student sees this:

- What do they actually learn?
- What do they do next?

Key Point

Feedback should lead to an action, not just a judgement.

What Can You Try Next Week?

- Start one chapter with a contextual problem
- Ask one question that requires explanation
- Write one piece of actionable feedback

That is enough.

Final Thought

The textbook is not the problem.

Where we choose to begin, and what we choose to emphasize, makes the difference.