Grade 10 Mathematics Lesson Plan

Translating Vectors

Strand:	Measurement and Geometry
Sub-Strand:	Vectors I
Specific Learning Outcome:	Determine translation vector as a transformation
Duration:	40 minutes
Key Inquiry Question:	How is Vectors I applied in day-to-day life?
Learning Resources:	CBC Grade 10 textbooks, graph paper, rulers, pencils, colored markers

Lesson Structure Overview

Phase	Duration	Focus
Problem-Solving and Discovery	15 minutes	Anchor activity: Discovering translation
Structured Instruction	10 minutes	Formalizing translation vectors
Practice and Application	10 minutes	Worked examples and translation problems
Assessment	5 minutes	Exit ticket to check understanding

Phase 1: Problem-Solving and Discovery (15 minutes)

Anchor Activity: Discovering Translation

Objective: Students will plot a triangle on graph paper, translate it by moving each point the same distance and direction, and discover the properties of translation as a transformation.

Materials Needed:

- Graph paper (one sheet per student)
- Rulers
- Pencils and colored markers
- Coordinate plane drawn on board or chart paper

Activity Steps (Activity 2.9.10 from textbook):

1. Step 1: Draw the x axis and y axis on the graph paper.
2. Step 2: Plot the triangle with vertices A(negative 3, 1), B(negative 1, 1), and C(negative 2, 3).
3. Step 3: Translate each point by moving 2 units to the right parallel to the x axis and 3 units up in the y axis. Label the new points as A prime, B prime, and C prime.
4. Step 4: Draw the new triangle A prime B prime C prime on the graph.
5. Step 5: Use dotted lines to connect each original point to its corresponding translated point (A to A prime, B to B prime, C to C prime), add arrows to indicate the direction.
6. Step 6: Observe and describe any similarities between triangle ABC and triangle A prime B prime C prime.
7. Step 7: Analyze the distance each point moved.
8. Step 8: Discuss and share your findings with your classmates in the class.

Expected Discovery:

Students should discover that:

- All points moved the same distance (2 units right, 3 units up)
- All points moved in the same direction
- The shape and size of the triangle did not change
- The translated triangle is congruent to the original
- The translation vector is (2, 3)
- Translation is a transformation that slides a shape without changing its size or orientation

Guiding Questions:

9. What are the coordinates of A prime, B prime, and C prime?
10. How far did each point move horizontally? Vertically?
11. Did all points move the same distance?
12. Did the shape or size of the triangle change?
13. What vector describes this movement?
14. Can you predict where a point D(0, 0) would move under the same translation?
15. What happens if we translate by (negative 2, negative 3)? Would we get back to the original triangle?

Teacher Role During Discovery:

- Circulate among students, ensuring they plot points correctly.
- Ask probing questions: Did all points move the same distance? In the same direction?

- For struggling students: Let us count together. A moved from (negative 3, 1) to where? Count 2 right and 3 up.
- For early finishers: What if we translate by (5, negative 2)? Try it!
- Guide students to articulate: Translation moves every point the same distance and direction.
- Identify 2-3 students with clear findings to share with the class.

Phase 2: Structured Instruction (10 minutes)

Formalizing Translation Vectors

After students have completed the anchor activity and shared their findings, the teacher formalizes the concept of translation vectors.

Key Takeaway 2.9.54:

A square ABCD undergoes a translation when each of its vertices (A, B, C and D) is moved the same distance and in the same direction. A translation vector, denoted by T, describes this movement.

Using T to represent a translation, the notation T(P) indicates the application of the translation T on P. The image A prime B prime C prime D prime is the result of ABCD under a translation.

Properties of Translation:

- Shape and size remain unchanged (congruent)
- All points move the same distance
- All points move in the same direction
- The image is congruent to the original
- Orientation remains the same

Finding Translated Coordinates:

If point P(x, y) is translated by vector (a, b), then P prime equals (x plus a, y plus b).

Example: If A(1, 3) is translated by (4, 3), then A prime equals (1 plus 4, 3 plus 3) equals (5, 6).

Finding Translation Vector:

If P(x1, y1) is translated to P prime(x2, y2), then translation vector equals (x2 minus x1, y2 minus y1).

Example: If P(5, negative 3) is translated to P prime(9, 1), then translation vector equals (9 minus 5, 1 minus (negative 3)) equals (4, 4).

Scaffolding Strategies to Address Misconceptions:

- Misconception: Translation changes the shape or size. Clarification: No, translation preserves shape and size.
- Misconception: Points can move different distances. Clarification: No, all points move the same distance and direction.
- Misconception: Translation rotates or flips the shape. Clarification: No, translation only slides the shape.
- Misconception: Translation vector is the same as position vector. Clarification: No, translation vector describes movement, not position.

Phase 3: Practice and Application (10 minutes)

Worked Example from Textbook:

Example 2.9.56: Triangle ABC has vertices A(1, 3), B(3, 0) and C(4, 4). The triangle undergoes a translation T defined by the vector (4, 3). Determine the coordinates of the translated vertices A prime, B prime, and C prime.

Solution:

To find the translated coordinates, add the translation vector to each vertex:

A prime equals (1 plus 4, 3 plus 3) equals (5, 6)

B prime equals (3 plus 4, 0 plus 3) equals (7, 3)

C prime equals (4 plus 4, 4 plus 3) equals (8, 7)

Additional Practice Problems:

Problem 1: A point P(5, negative 3) is mapped to a new position after a translation. If the new coordinates are (9, 1), determine the translation vector used.

Solution: Translation vector equals (9 minus 5, 1 minus (negative 3)) equals (4, 4)

Problem 2: A point M(1, negative 4) undergoes a translation by (3, 5). Determine the coordinates of M prime.

Solution: M prime equals (1 plus 3, negative 4 plus 5) equals (4, 1)

Problem 3: The point (4, negative 1) was translated using the vector (2, 3). Determine the original position.

Solution: Original position equals (4 minus 2, negative 1 minus 3) equals (2, negative 4)

Phase 4: Assessment (5 minutes)

Exit Ticket:

Students complete the following questions individually.

1. Draw triangle XYZ with vertices X(1, 4), Y(6, 2), and Z(5, 3). Plot X prime Y prime Z prime, the image of triangle XYZ under a translation given by (4, 9).

2. The point (0, negative 3) was translated using the vector (1, 3). Determine the original position.

3. A point P(5, negative 3) is mapped to (9, 1). Determine the translation vector.

4. A point M(1, negative 4) undergoes a translation by (3, 5). If M prime is then translated by (negative 4, 2), find the final position M double prime. What is the single translation vector that maps M to M double prime directly?

Answer Key:

1. X prime(5, 13), Y prime(10, 11), Z prime(9, 12)

2. Original position: (negative 1, negative 6)

3. Translation vector: (4, 4)

4. M prime equals (4, 1), M double prime equals (0, 3), Single translation vector: (negative 1, 7)

Differentiation Strategies

For Struggling Learners:

- Provide pre-drawn shapes with labeled vertices.
- Use color coding: one color for original, another for translated.
- Provide step-by-step calculation templates.
- Start with simple translations (positive integers only).
- Use physical manipulatives (cut-out shapes) to show sliding.
- Pair struggling students with confident problem solvers.

For On-Level Learners:

- Encourage students to create their own translation problems.
- Ask students to explain why translation preserves congruence.
- Provide mixed practice with positive and negative translations.
- Challenge students to find inverse translations.

For Advanced Learners:

- Explore composition of translations (two translations in sequence).
- Investigate translations in three dimensions.
- Apply translations to coordinate geometry proofs.
- Challenge: Prove that translation preserves distance and angle.
- Explore applications in computer graphics (sprite movement in games).

Extension Activity

Real-World Application: Animation and Computer Graphics

Work in pairs or small groups

Situation: You are creating a simple animation where a character moves across the screen.

Tasks:

16. Draw a simple character (stick figure or shape) at position (2, 3).
17. The character moves 5 units right and 2 units up. What is the translation vector? (Answer: (5, 2))
18. What is the new position of the character? (Answer: (7, 5))
19. The character then moves 3 units left and 4 units down. What is the translation vector? (Answer: (negative 3, negative 4))
20. What is the final position? (Answer: (4, 1))
21. What single translation vector would move the character from (2, 3) to (4, 1) directly? (Answer: (2, negative 2))
22. Draw the character at all three positions and show the translation vectors.
23. Present your animation sequence to the class.

Real-World Applications of Translation:

- Computer Graphics: Moving sprites in video games.
- Animation: Creating smooth movement sequences.
- Robotics: Programming robot movement.
- Navigation: Describing displacement from one location to another.
- Architecture: Positioning repeated elements in designs.

Teacher Reflection Prompts

- Did students successfully discover the properties of translation?
- Were students able to apply translation correctly?
- What misconceptions emerged during the lesson, and how were they addressed?
- Did students understand how to find translation vectors?
- What adjustments would improve this lesson for future classes?