Step by Step Guide: Apply Similarity and Enlargement to Real-Life Situations

Pre-Class Preparation Checklist

- Prepare printed handouts with the park design scenario and instructions (steps a–j).
- Ensure each pair has rulers, calculators, graph paper, and coloured pencils.
- Write on the board or prepare a slide: "Blueprint: 10 ft × 15 ft → Actual Park: 200 ft × 300 ft."
- Prepare the scale factor summary: LSF = k, ASF = k², VSF = k³.
- Have a simple diagram of the park blueprint showing: the rectangular boundary, a swimming pool, a pathway, a fountain, and a garden bed.
- Prepare the sustainability discussion prompt: "How do scale factors affect materials, water, and cost?"
- Have the digital textbook section open: Section 2.1.4 Similarity and Enlargement in Real-Life.

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

Opening and Real-World Connection (3 minutes)

[SAY] "Over the past few lessons, we have learned about similarity, enlargement, and scale factors — linear, area, and volume. Today, we are going to use ALL of these concepts together in a real-world design project."

[SAY] "Imagine you are part of a team of architects. Your community has a vacant lot, and they want you to design a park. You have a small blueprint, and you need to enlarge it to fit the actual lot."

[ASK] "Has anyone ever seen a blueprint or a floor plan? What is it?"

[WAIT] Expected: "A scaled-down drawing of a building or space."

[SAY] "Exactly! A blueprint is a SIMILAR figure — it has the same proportions as the real thing, just smaller. Today, we'll figure out exactly HOW MUCH bigger the real park will be."

[ASK] "If the blueprint is 20 times smaller in length, do you think the area is also 20 times smaller? What about the volume?"

[WAIT] Allow students to predict. Some may say yes, some may remember from previous lessons.

[SAY] "Let's find out! Here's our scenario."

Anchor Activity Launch (2 minutes)

[DO] Distribute handouts and display the scenario on the board.

[SAY] "A local community is planning to design a new park. The architects have created a small blueprint that measures 10 feet by 15 feet. The actual vacant lot is 200 feet by 300 feet."

[SAY] "Work in pairs. Follow the steps on your handout."

[SAY] "Steps (a) and (b): Find the linear scale factor from both the length and the width. Are they the same?"

[SAY] "Steps (c), (d), and (e): Calculate both areas, find the area scale factor, and compare it to the LSF squared."

[SAY] "Steps (f) through (i): The blueprint shows a swimming pool measuring 1 foot by 2 feet by 0.5 feet deep. Find the actual pool dimensions, both volumes, and the volume scale factor. Compare it to LSF cubed."

[SAY] "Step (j): Discuss how these scale factors affect materials, water, and cost. You have 8 minutes. Go!"

Student Work Time (8 minutes)

[DO] Circulate among pairs. Check that students find LSF = 20 from both dimensions.

[ASK] To pairs calculating: "What is 200 divided by 10? And 300 divided by 15? Are they the same?"

[ASK] "Why must both ratios be equal? What would it mean if they were different?"

[WAIT] Expected: "If they were different, the shape would be distorted, not similar."

[ASK] To pairs finding the area: "What is 10 times 15? What is 200 times 300? Now divide the big area by the small area."

[ASK] "You got 400 for the ASF. What is 20 squared? Are they the same?"

[DO] For struggling pairs: "Let's do the pool step by step. Each dimension is multiplied by 20. So 1 foot becomes... 2 feet becomes... 0.5 feet becomes..."

[ASK] To pairs who found the VSF: "You got 8,000. What is 20 cubed? Does it match?"

[ASK] To early finishers: "If a circular fountain on the blueprint has diameter 0.5 feet, what is the actual diameter? What about the actual area of the fountain?"

[DO] Note which pairs have clear explanations for the sharing phase.

Class Sharing (2 minutes)

[SAY] "Let's hear from a few pairs. What linear scale factor did you find?"

[WAIT] Call on 2–3 pairs.

[SAY] "The LSF is 20 — from both length and width. This confirms the blueprint and the park are SIMILAR."

[SAY] "Blueprint area: 150 square feet. Actual area: 60,000 square feet. ASF = 400 = 20 squared."

[SAY] "Blueprint pool volume: 1 cubic foot. Actual pool: 20 by 40 by 10 feet = 8,000 cubic feet. VSF = 8,000 = 20 cubed."

[ASK] "So when the linear scale factor is 20, the area is how many times bigger?"

[WAIT] Expected: "400 times."

[ASK] "And the volume?"

[WAIT] Expected: "8,000 times!"

[SAY] "Exactly! This is why large-scale construction projects are so expensive. The volume of materials increases MUCH faster than the area."

Phase 2: Structured Instruction (10 minutes)
Formalising the Scale Factor Relationships (4 minutes)

[SAY] "Let's formalise what you discovered using the park design."

[WRITE] On the board: "Park Blueprint: 10 ft × 15 ft → Actual Park: 200 ft × 300 ft"

[WRITE] "Linear Scale Factor (LSF) = k = 20"

[WRITE] "Area Scale Factor (ASF) = $k^2 = 20^2 = 400$"

[WRITE] "Volume Scale Factor (VSF) = $k^3 = 20^3 = 8,000$"

[SAY] "The linear scale factor tells us how much each LENGTH is multiplied. The area scale factor tells us how much each AREA is multiplied. The volume scale factor tells us how much each VOLUME is multiplied."

[SAY] "In our park: every length is 20 times bigger, every area is 400 times bigger, and every volume is 8,000 times bigger."

Real-World Impact Table (3 minutes)

[WRITE] Draw this table on the board:

[WRITE] "Feature | Blueprint | Actual | Scale Factor Used"

[WRITE] "Path length | 2 ft | 40 ft | LSF = 20"

[WRITE] "Garden area | 0.375 sq ft | 150 sq ft | ASF = 400"

[WRITE] "Pool volume | 1 cu ft | 8,000 cu ft | VSF = 8,000"

[SAY] "Notice: for lengths (1D), we multiply by k. For areas (2D), we multiply by k squared. For volumes (3D), we multiply by k cubed."

[SAY] "This means that if you double the size of a park (k = 2), the area quadruples (2^2 = 4) and the volume increases 8 times (2^3 = 8)."

[ASK] "If a park is 10 times bigger in each dimension, how many times more soil would you need for the garden beds?"

[WAIT] Expected: "1,000 times, because 10 cubed is 1,000."

[SAY] "Correct! This is why understanding scale factors is critical for budgeting and planning."

Addressing Misconceptions (3 minutes)

[SAY] "Common mistake number one: thinking that if the length is 20 times bigger, the area is also 20 times bigger. It's NOT. The area is 20 SQUARED = 400 times bigger."

[SAY] "Common mistake number two: thinking that if the length is 20 times bigger, the volume is 20 times bigger. It's NOT. The volume is 20 CUBED = 8,000 times bigger."

[SAY] "Common mistake number three: forgetting that ALL three dimensions must be scaled. The pool is not just longer — it's also wider AND deeper."

[SAY] "Here's a real-world consequence. On the blueprint, the pool holds 1 cubic foot of water. The actual pool holds 8,000 cubic feet. If water costs Ksh 5 per cubic foot, the blueprint pool costs Ksh 5, but the actual pool costs Ksh 40,000!"

[ASK] "If the community only budgeted for 20 times the blueprint cost, would that be enough?"

[WAIT] Expected: "No! They need 8,000 times the cost for volume-based features."

[SAY] "Exactly. This is why architects must understand scale factors — to give accurate cost estimates."

Phase 3: Practice and Application (10 minutes)
Worked Example 1: Park Pathways (2 minutes)

[SAY] "Problem 1. On the blueprint, a winding pathway covers 8 square feet. What is the actual pathway area?"

[ASK] "Which scale factor do we use for area?"

[WAIT] Expected: "ASF = k squared = 400."

[WRITE] "Actual pathway area = 8 × 400 = 3,200 square feet"

[SAY] "The actual pathway covers 3,200 square feet. If paving costs Ksh 100 per square foot, that's Ksh 320,000 for the pathway alone."

Worked Example 2: Fountain Volume (2 minutes)

[SAY] "Problem 2. The blueprint shows a fountain basin with volume 0.25 cubic feet. What is the actual volume?"

[ASK] "Which scale factor for volume?"

[WAIT] Expected: "VSF = k cubed = 8,000."

[WRITE] "Actual volume = 0.25 × 8,000 = 2,000 cubic feet"

[SAY] "The fountain will hold 2,000 cubic feet of water. That's a LOT of water — about 56,600 litres!"

Worked Example 3: Garden Bed — Combined Calculation (3 minutes)

[SAY] "Problem 3. A garden bed on the blueprint is 0.75 ft long, 0.5 ft wide, and 0.15 ft deep."

[SAY] "Part (a): Actual dimensions. Each dimension times 20."

[WRITE] "Length: 0.75 × 20 = 15 ft"

[WRITE] "Width: 0.5 × 20 = 10 ft"

[WRITE] "Depth: 0.15 × 20 = 3 ft"

[SAY] "Part (b): Actual area for planting."

[WRITE] "Area = 15 × 10 = 150 sq ft"

[SAY] "Let's verify: Blueprint area = 0.75 × 0.5 = 0.375 sq ft. Times ASF: 0.375 × 400 = 150. Same answer!"

[SAY] "Part (c): Volume of soil needed."

[WRITE] "Volume = 15 × 10 × 3 = 450 cu ft"

[SAY] "Verify: Blueprint volume = 0.75 × 0.5 × 0.15 = 0.05625 cu ft. Times VSF: 0.05625 × 8,000 = 450. Same answer!"

[SAY] "Both methods give the same result. This confirms our scale factors are correct."

Worked Example 4: Sustainability Analysis (3 minutes)

[SAY] "Problem 4. A sandpit on the blueprint has volume 0.4 cubic feet. Sand costs Ksh 200 per cubic foot. The budget is Ksh 500,000."

[SAY] "Part (a): Actual volume."

[WRITE] "Actual volume = 0.4 × 8,000 = 3,200 cubic feet"

[SAY] "Part (b): Total cost."

[WRITE] "Cost = 3,200 × 200 = Ksh 640,000"

[SAY] "Part (c): Is the budget sufficient?"

[WRITE] "Ksh 640,000 > Ksh 500,000. Budget is NOT sufficient."

[SAY] "The community needs an extra Ksh 140,000. What could they do?"

[WAIT] Expected: "Reduce the sandpit size, find cheaper sand, or increase the budget."

[SAY] "This is exactly the kind of decision architects and planners face every day. Mathematics helps them make informed choices."

Phase 4: Assessment — Exit Ticket (5 minutes)

[SAY] "For our exit ticket, answer these four questions on a separate piece of paper. You have 5 minutes."

[SAY] "Question 1: A blueprint of a community garden measures 5 feet by 8 feet. The actual garden is 100 feet by 160 feet. (a) What is the linear scale factor? (b) What is the area scale factor? (c) If a flower bed on the blueprint has area 2 square feet, what is the actual area?"

[SAY] "Question 2: On the park blueprint with LSF = 20, a storage shed is 0.3 ft long, 0.2 ft wide, and 0.15 ft tall. What is the actual volume of the shed?"

[SAY] "Question 3: A landscape architect creates a model at scale 1:50. A pond in the model has volume 0.064 cubic metres. What is the actual volume of the pond?"

[SAY] "Question 4: Two similar park designs have an area scale factor of 25. The smaller park covers 1,200 square feet. What is the area of the larger park? What is the linear scale factor?"

[DO] Collect exit tickets as students finish.

Answer Key:

- 1(a) LSF = 100 ÷ 5 = 20 (or 160 ÷ 8 = 20).
- 1(b) ASF = 20^2 = 400.
- 1(c) Actual area = 2 × 400 = 800 sq ft.
- 2. Actual: 6 × 4 × 3 = 72 cu ft (or 0.009 × 8,000 = 72 cu ft).
- 3. VSF = 50^3 = 125,000. Actual = 0.064 × 125,000 = 8,000 cu m.
- 4. Larger area = 1,200 × 25 = 30,000 sq ft. LSF = $\sqrt{25}$ = 5.

Differentiation Notes

Struggling Learners:

Provide a formula card: LSF = k, ASF = k^2, VSF = k^3. Use grid paper to draw the blueprint (10×15 squares) and count squares to find area visually. Start with the linear scale factor only before introducing area and volume. Walk through Problem 1 step-by-step. Use concrete language: "If each side is 20 times bigger, the area is 20 times 20 = 400 times bigger."

On-Level Learners:

Complete all problems independently. Verify answers using both the scale factor method and direct calculation. Work through the sustainability analysis (Problem 4) to connect mathematics to real-world budgeting. Attempt the extension activity on jogging tracks, rainwater tanks, and solar panels.

Advanced Learners:

Challenge: Calculate the actual surface area and volume of a hemispherical dome over the fountain (blueprint radius 0.25 ft). Investigate total park construction costs using area-based costs (paving, grass) and volume-based costs (soil, water, concrete). Design their own park blueprint with at least 5 features, calculating all actual dimensions, areas, volumes, and estimated costs.

Post-Lesson Reflection

1. Did students discover that the linear scale factor is the same for both length and width, confirming similarity?

2. Were students able to connect ASF = (LSF)^2 and VSF = (LSF)^3 through their own calculations?

3. How effectively did the park design scenario engage students in seeing mathematics as relevant to real-world design?

4. Did students grasp the practical implications — that volume scales much faster than area?

5. Were students able to use both methods (scale factor and direct calculation) and verify their answers?

6. Did the sustainability discussion deepen understanding of why scale factors matter in planning?

7. What common misconceptions arose (e.g., thinking area scales by k instead of k^2)?

8. What adjustments would improve the lesson for future delivery?