Step by step guide: Perfect Squares

Grade 10 Mathematics | 40-Minute Lesson

Before Class Begins

Preparation Checklist:

- Write the two perfect square identities on the board (covered until Phase 2)
- Prepare group discussion prompts
- Prepare exit tickets for distribution
- Set timer for phase transitions
- Have worked examples ready

PHASE 1: Problem-Solving and Discovery (15 Minutes)

Opening (2 minutes)

[SAY]:

"Good morning/afternoon, class! Today we're going to learn about PERFECT SQUARES. These are special patterns in algebra that will help you factor and expand expressions much faster!"

[SAY]:

"Here's our key question: How do we apply the concept of quadratic equations? Perfect squares are everywhere in quadratic equations!"

Anchor Activity Introduction (3 minutes)

[SAY]:

"In your groups, I want you to define, discuss, and work on:

1. Perfect square identities
2. Expanding perfect squares
3. Recognizing perfect square trinomials
4. Factoring perfect square trinomials

Copy these two identities and observe them:

(i) $(a + b)^2 = a^2 + 2ab + b^2$
(ii) $(a - b)^2 = a^2 - 2ab + b^2$"

[EMPHASIZE]:

"Pay special attention to the MIDDLE TERM. What do you notice about it?"

Group Work (7 minutes)

[SAY]:

"Discuss in your groups:
• How can you verify these identities by expanding?
• How do perfect square identities make factoring easier?
• What happens if you don't recognize the pattern?
• Can you think of real-world applications?

You have 6 minutes. Begin!"

[DO]: Walk around the room, observing group discussions.

[ASK probing questions as you circulate]:

- "Can you expand $(a + b)^2$ to verify the identity?"
- "What do you notice about the middle term?"
- "How is 2ab related to a and b?"
- "What's the difference between $(a + b)^2$ and $(a - b)^2$?"
- "How would you check if $x^2 + 6x + 9$ is a perfect square?"

[TIME CHECK]: At 5 minutes, announce: "One more minute!"

Class Discussion (3 minutes)

[SAY]:

"Let's share what you discovered. What did you notice about the middle term?"

[Expected answer]: "The middle term is TWICE the product of a and b!"

[ASK]:

"What's the difference between the two identities?"

[Expected answer]: "One has a positive middle term, one has a negative middle term!"

[TRANSITION]:

"Excellent! Let me formalize these perfect square identities."

PHASE 2: Structured Instruction (10 Minutes)

The Two Perfect Square Identities (5 minutes)

[REVEAL identities on board]:

[SAY]:

"A PERFECT SQUARE is a special trinomial that can be factored into the square of a binomial.

There are TWO perfect square identities:"

[WRITE Identity 1]:

"Identity 1 (Positive middle term):
$a^2 + 2ab + b^2 = (a + b)^2$

Use this when the middle term is POSITIVE."

[WRITE Identity 2]:

"Identity 2 (Negative middle term):
$a^2 - 2ab + b^2 = (a - b)^2$

Use this when the middle term is NEGATIVE."

How to Recognize a Perfect Square (3 minutes)

[SAY]:

"How do you know if a trinomial is a perfect square? Check THREE things:

1. Is the FIRST term a perfect square? (Can you take its square root?)
2. Is the LAST term a perfect square? (Can you take its square root?)
3. Is the MIDDLE term equal to $2 \times \sqrt{(first)} \times \sqrt{(last)}$?

If all three are YES, it's a perfect square!"

Addressing Misconceptions (2 minutes)

[SAY - IMPORTANT]:

"COMMON MISTAKE: Not every trinomial is a perfect square!

For example: $x^2 + 5x + 6$ is NOT a perfect square.

• *First term x^2 ✓*
• *Last term 6 is NOT a perfect square ✗*

You MUST check all three conditions!"

[TRANSITION]:

"Now let's practice factoring perfect squares!"

PHASE 3: Practice and Application (15 Minutes)

Worked Example (4 minutes)

[SAY]:

"Let's factor $x^2 + 6x + 9$."

[WRITE step by step]:

"Step 1: Check if it's a perfect square
• *First term: x^2 is a perfect square ($\sqrt{x^2} = x$) ✓*
• *Last term: 9 is a perfect square ($\sqrt{9} = 3$) ✓*
• *Middle term: $6x = 2 \times x \times 3 = 2ab$ ✓*

Step 2: Identify a and b
• *$a = x$*
• *$b = 3$*

Step 3: Apply the identity
Since the middle term is positive:
$x^2 + 6x + 9 = (x + 3)^2$"

Guided Practice (5 minutes)

[SAY]:

"Try these with your partner:
a) Factor: $x^2 - 10x + 25$
b) Expand: $(2x + 5)^2$"

[GIVE 4 minutes, then review]:

"a) $x^2 - 10x + 25$
• *$a = x$, $b = 5$*

• *Middle term: −10x = −2(x)(5) ✓*
• *Since negative: (x − 5)²*

b) (2x + 5)²
= (2x)² + 2(2x)(5) + 5²
= 4x² + 20x + 25"

Independent Practice (6 minutes)

[SAY]:

"Now try these on your own:
a) Factor: x² + 8x + 16
b) Factor: 4y² + 12y + 9
c) Is x² + 5x + 6 a perfect square?"

[GIVE 5 minutes, then quickly check]:

"a) (x + 4)²
b) (2y + 3)²
c) NO! 6 is not a perfect square. It factors as (x + 2)(x + 3)."

[TRANSITION]:

"Now I want to see what each of you has learned."

PHASE 4: Assessment / Checkpoint (8 Minutes)

Checkpoint exploration (5 minutes)

[DO] Project the digital textbook on the screen. Navigate to the "Checkpoint" section.

[SAY] "This is our digital mathematics textbook. It has something special called checkpoints. Watch what happens when I click this button..."

[DO] Click "Show new example question" on Checkpoint

[SAY] "See? A new number appeared! And if I click again..."

[DO] Click the button again to show randomization

[SAY] "A different number! This means you can practice with hundreds of different examples. The computer never runs out of problems to give you."

[SAY] "Now it's your turn. With your partner, open the digital textbook and find the checkpoint.

[SAY] Click “Show new example question” to load the problem

[SAY] Solve the displayed question

[SAY] Click “submit” to check your answer

[SAY] If incorrect, carefully read the feedback and analyse the error before trying a new question. The immediate feedback from checkpoint submissions allows students to identify and correct errors in real-time.

[SAY] Complete at least 5 questions

[DO] Circulate among pairs. Ask probing questions, for example, what patterns do you notice?

Independent Work (5 minutes)

[DISPLAY questions]:

"1. Factor: $x^2 - 14x + 49$

2. Expand: $(3y - 2)^2$

3. Complete the square: $x^2 + 10x + \_\_\_ = (x + \_\_\_)^2$"

[SAY]:

"You have 5 minutes. Begin."

Collection and Closure (2 minutes)

[SAY]:

"Time's up. Please pass your exit tickets forward."

[COLLECT all tickets]

[SAY]:

"Today you learned the TWO perfect square identities:
- *$a^2 + 2ab + b^2 = (a + b)^2$*
- *$a^2 - 2ab + b^2 = (a - b)^2$*

Remember: The middle term is ALWAYS twice the product of a and b!"

[SAY]:

"Great work today! For homework, practice more factoring problems."

Differentiation Notes

For Struggling Learners:

- Provide identity reference cards
- Use color coding to highlight a^2, $2ab$, and b^2
- Start with numerical examples (e.g., $4 + 4 + 1 = 9 = 3^2$)
- Allow peer support during practice

For Advanced Learners:

[GIVE these extensions]:

- Factor: $x^4 + 4x^2 + 4$
- If $(x + k)^2 = x^2 + 12x + c$, find k and c
- Use completing the square to solve: $x^2 + 6x + 5 = 0$

Answer Key

Exit Ticket Answers:

1. $x^2 - 14x + 49$: $(x - 7)^2$

2. $(3y - 2)^2$: $9y^2 - 12y + 4$

3. Complete the square: $x^2 + 10x + 25 = (x + 5)^2$

Extension Answers:

1. $x^4 + 4x^2 + 4 = (x^2 + 2)^2$

2. $k = 6$, $c = 36$

3. $x^2 + 6x + 5 = 0 \longrightarrow (x + 3)^2 = 4 \longrightarrow x = -1$ or $x = -5$

Post-Lesson Reflection Prompts

1. What went well? Did students recognize the pattern in the middle term?

2. What would I change? Was the three-step check clear enough?

3. Student Understanding: Could students distinguish perfect squares from non-perfect squares?

4. Next Steps: Which students need more practice with expanding?