SUPPORTING ADULT GUIDANCE

Growing patterns

Quadratics. For any supporting adult — teacher, practitioner, parent or carer. **You do not need to be a mathematics specialist to support this lesson.**

What this lesson does

The learner meets a **quadratic** for the first time — through its **number face**, a growing sequence. The lesson's whole job is to build one perception: that in some patterns the **gap between terms is not constant but grows steadily**, and that this speeding-up is what marks a quadratic and sets it apart from the linear (constant-gap) sequences met with straight lines. Learners generate growing patterns from dots, work out the **first differences** (the gaps), use them to predict the next term, and classify sequences as steady (linear) or growing (quadratic). The **constant second difference** — the deeper fingerprint of a quadratic — is deliberately held back for the next lesson; here the goal is only to notice that the gaps grow.

Driving Question: *When a pattern grows faster and faster, what stays steady underneath it?*

The mathematics, in plain terms

A sequence is just a list of numbers made by a rule. In a **linear** sequence the step from one term to the next never changes: 3, 5, 7, 9 goes up by 2 every time. In a **quadratic** sequence the step itself grows: the square numbers 1, 4, 9, 16, 25 go up by 3, then 5, then 7, then 9. Those steps — the differences between neighbouring terms — are called the **first differences**, and the single most useful habit in this whole topic is to write them underneath the sequence and look at them. If the first differences are all equal, the pattern is **linear**. If they grow (and, as the learner will discover next lesson, grow by a constant amount), the pattern is **quadratic**. The dot pictures make the idea concrete: a growing square gains an extra row *and* an extra column each time, so it grows in two directions at once — which is exactly why its total speeds up. Two gentle points are worth holding. First, a pattern can **decrease** and still be linear: 10, 7, 4, 1 falls by 3 each time, so its gap is constant. 'Steady' means the gap never changes, not that the numbers rise. Second, the aim today is **perception, not a formula**: the learner does not need an nth-term rule, only to see that the gaps grow and to use that to predict the next term. The move to praise above all others is simply 'I wrote the gaps underneath.'

The worked method the learner sees

These are the two worked examples the learner meets on screen, with the lesson's exact method and notation. They are here for consistency, not because the mathematics is demanding — whether you teach mathematics or are meeting it afresh alongside the learner, working from the same steps and the same language keeps your support aligned with what is on the screen, and lets you point back to a line the learner has already seen. Skip them freely if the method is already familiar.

Example 1 — predict the next term

This pattern is growing — the gaps get bigger. Write the gaps underneath, then use them to find the next term.



1. write the gaps underneath	4, 6, 8
2. the gaps grow by 2, so the next gap is	+10
3. add it to the last term	20 + 10

the next term is 30

Example 2 — steady or growing?

Always check the gaps first. If they are all equal, the pattern is steady (linear) — and the next term is just one more gap.



1. write the gaps underneath	4, 4, 4
2. the gaps are all equal, so this is	steady (linear)
3. add one more gap of 4	17 + 4

steady (linear) — the next term is 21

Write the gaps underneath

The organising habit of this lesson — and of the whole quadratics topic — is to **write the first differences underneath a sequence and read them**. It sounds trivial, but it is the move that turns 'these numbers are just getting bigger' into 'ah, I can see the rule'. Encourage it every time: the sequence on one line, the gaps on the line below. From there, two questions do almost all the work — *are the gaps equal?* (linear) and *are they growing?* (quadratic) — and the very same gaps let the learner predict the next term by continuing their pattern. Keep the dot pictures alongside the numbers for as long as they help: seeing the square gain a row and a column at once is what makes 'grows in two directions, so it speeds up' land. Resist any rush to the second difference or to n^2 notation; both come later in the unit. The quiet success of this lesson is a learner who reaches for the gaps without being asked.

The shape of the lesson

Timings are invitations, not deadlines. A learner may need much longer on one phase and skim another — that is expected. Each Cornerstone is given an honest mathematical role here:

Cornerstone	Its role here	Invitational timing
Connection	Growing dots: build a growing pattern stage by stage and watch the gaps between the terms grow.	~12 min
Movement	The Difference Machine: use the growing gaps to predict the hidden next term of a sequence.	~12 min
Reflection	Steady or growing?: decide from the gaps whether a sequence is linear (steady) or quadratic (growing).	~12 min
Creativity	Invent a growing pattern: sketch your own on the Scratchpad and check that its gaps grow.	~5 min
Rest	A pause after meeting a new kind of pattern — one that speeds up.	~2 min
Nutrition	Mode B (intellectual): what the learning feeds — the habit of looking for what stays steady amid change.	~2 min

Common misconceptions, and gentle repairs

These are the sticking points to expect. In every case, the aim is a question that returns the thinking to the learner — never to supply the answer.

Thinking any increasing sequence is quadratic

Repair: “Write the gaps underneath. If the gaps are all equal it is still linear — quadratic means the gaps themselves grow.”

Thinking a decreasing sequence cannot be steady/linear

Repair: “10, 7, 4, 1 falls by 3 each time — the gap is constant, so it is linear. Steady means the gap never changes, not that the numbers rise.”

Adding the same gap again instead of the growing gap

Repair: “Look at how the gaps grow: 3, 5, 7 — the next gap is 9, not another 7. Continue the pattern of the gaps.”

Reading the picture but not the numbers, or the other way round

Repair: “Line them up — the dot picture with the number underneath it. Watch the square gain a row and a column; that is why the total speeds up.”

Reaching for an nth-term formula too early

Repair: “You do not need a formula today. Write the gaps and continue their pattern — that is enough to find the next term.”

Protecting the support pathway

The lesson offers support in a deliberate order: **Socratic prompt** → **first try** → **hint** → **second try** → **worked solution**. The worked solution for each question stays locked until the learner has used the prompt, used the hint, and checked two answers. This is by design: the steps *are* the learning.

Please hold this line

Do not read the worked solution aloud, or talk a learner straight to the answer, while it is still locked. If they are stuck, use the Reconnection Routes, the prompt and the hint, or ask one of the repair questions above. Arriving at a correct line of reasoning — even slowly — is worth far more than being handed the result.

Reconnection Routes

If an earlier idea is blocking progress, the lesson’s Reconnection Routes offer short recaps of exactly the prerequisites this lesson needs: reading and continuing simple sequences, substituting a value into a rule (such as n^2), and squaring a number. A learner can choose one independently, or you can invite one without requiring it. Using a route is part of learning, not evidence of falling behind, and it always returns the learner to their place.

Supporting through questions: an example

Keep the learner writing and reading the gaps:

- “Write the gaps between the terms underneath. Are they equal, or growing?”
- “The gaps are 3, 5, 7 — what will the next gap be? So what is the next term?”
- “Is this pattern speeding up, or going up by the same amount each time?”
- “Show me on the dots — what does the square gain when it grows by one stage?”

If they stall, that is the moment for a Reconnection Route or the lesson’s prompt and hint — not for the answer.

Questions you might have

“What actually makes a sequence ‘quadratic’?”

For now: the gaps between the terms grow, rather than staying the same as they do in a linear sequence. Next lesson the learner will discover the exact fingerprint — that those gaps grow by a *constant* amount, called the second difference.

“Do they need to know the nth-term rule, or n^2?”

Not in this lesson. The goal is to notice that the gaps grow and to use them to predict the next term. The x^2 expression and the rules come later in the unit.

“My learner says a falling sequence like 10, 7, 4 is quadratic because it keeps changing. Is it?”

No — it falls by 3 every time, so the gap is constant and it is linear. ‘Steady’ refers to the gap, not to whether the numbers rise or fall.

Keeping things regulated and calm

- Keep to one clear step at a time; there is no time pressure and no benefit to speed.
- Treat a wrong or unfinished answer as information for the next step, never as failure.
- Let the learner choose how to record — typed, written, drawn, spoken or annotated.
- If frustration rises, it is fine to pause and return later; the lesson holds their place.
- Avoid any language about age, school year or pace as a judgement of ability.

Recognising progress

Progress is described as Approaching Proficiency → Developing Proficiency → Proficiency → Refining Proficiency across understanding, application, communication and reflection. These describe where a learner is right now, not labels of what they are. Real understanding shown in part is still real understanding, even while other pieces are still settling.

Where they are	What it can look like
Approaching Proficiency	Beginning to engage; names some features and makes a start with support.

Developing Proficiency	Carries out the method with prompts; can explain part of the reasoning.
Proficiency	Works through independently and explains why each step is true.
Refining Proficiency	Applies the idea confidently to a new or unfamiliar case, and could teach it to someone else.

A note on evidence

Evidence can be captured in whatever form suits the learner — a photo of working, a short spoken explanation, an annotated Scratchpad image, or a written solution. There is no single required format. Incomplete work is information for the next connection, never a failure: it tells you exactly where to begin next time. The aim is a true record of the learner's thinking, not a tidy performance.

If a learner is stuck or distressed

Slow the pace and reduce the load: return to one concrete, familiar case and a single small question. Offer a Reconnection Route. Remind them they can pause and come back. A short, successful, low-stakes step rebuilds confidence more reliably than pushing through. Connection before curriculum — always.

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