

BEYOND ALGORITHMS

Our Journey Toward Building Mathematical Thinkers

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When artificial intelligence began solving math problems in seconds — showing steps, explaining reasoning, and performing with perfect accuracy — it forced those of us in Nanaimo Ladysmith Public Schools (NLPS) to confront a quiet truth we could no longer ignore:

*If mathematics education is defined by procedural answer getting,
AI can now do much of it better than humans.*

What AI exposed wasn't a crisis. It was an invitation — an opportunity to rethink what we want math learning to be.

For decades, many of our classrooms mirrored the way we ourselves learned: carefully following steps, memorizing procedures, identifying the right formula for the right type of problem. But as AI grew more capable, we could no longer pretend that procedural fluency alone would prepare students for a world where machines execute algorithms effortlessly.

And so, we found ourselves asking a new — and fundamental — question:

*If AI can perform the calculations,
what does it truly mean to think mathematically?*

That question became the starting point of an exploration that continues to reshape our classrooms, our professional learning, and even our identities as educators.

A Turning Point: When “Which Formula Do I Use?” Reveals More Than We Realized

The earliest signs that something needed to change weren't dramatic — they were subtle, repetitive moments. A problem would appear on the board, and before thinking about the numbers or the situation, students asked:

“Which formula do I use?”
“What’s the rule for this one again?”

Their impulse wasn’t to make sense of the problem. Instead, they tried to recall the matching steps.

It wasn’t their fault. We had conditioned them to search for the right procedure.

Phil Daro’s well known distinction echoed in our minds: math class cannot be about answer getting. Answer getting may produce correct results, but it rarely produces thinkers. And in a world where technology answers faster and more accurately than we ever could, our mission needed to be deeper.

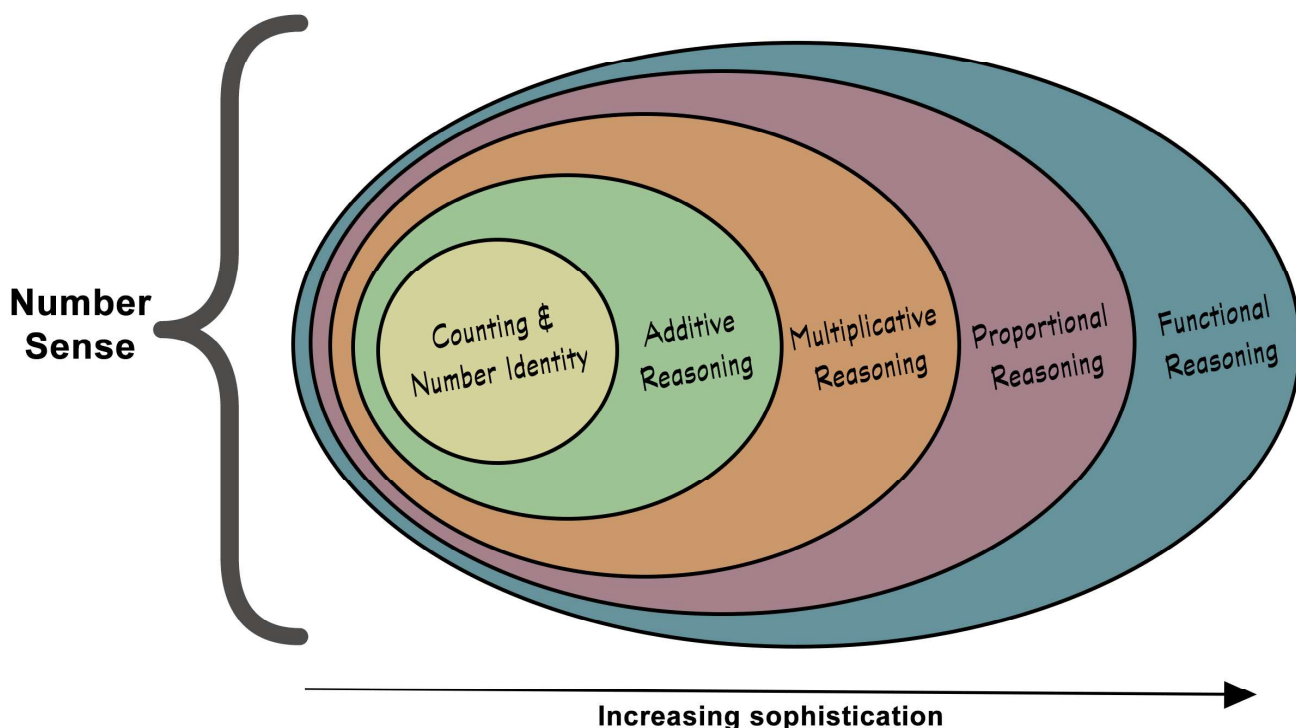
When we embraced this truth, something shifted. Instead of asking how to teach students to compute faster or follow steps more efficiently, we began asking:

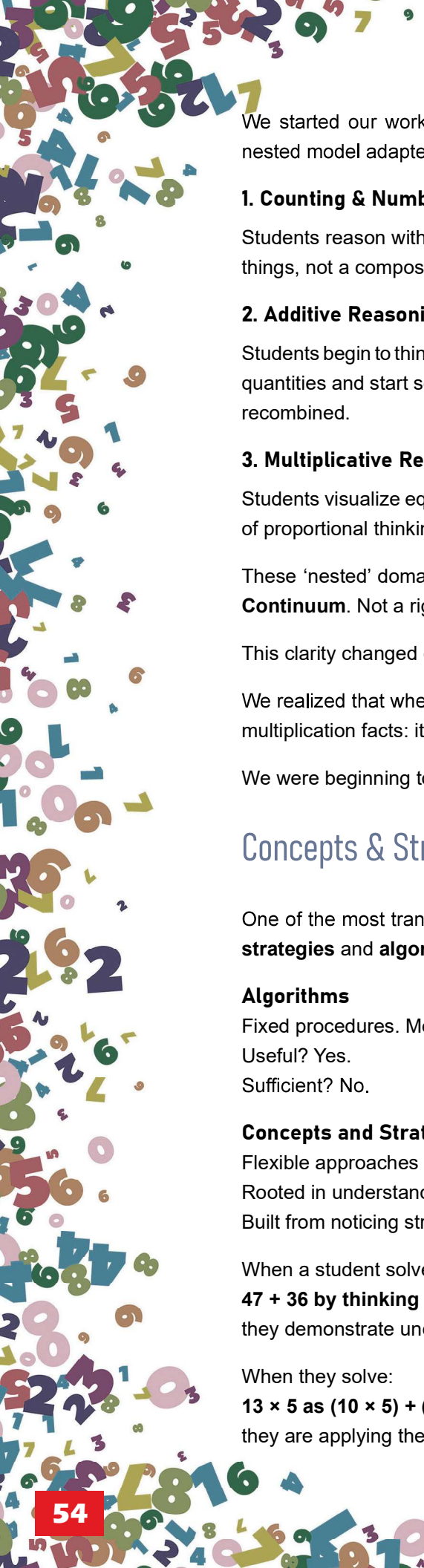
How do we help them think? Reason? Notice patterns? See structure? Understand?

Seeing Mathematics Through New Eyes

Our search for clarity led us to the work of Pam Harris and Peter Liljedahl. Their research didn’t simply provide new ideas — it offered a new way of seeing students’ mathematical development.

Domains of Mathematical Reasoning





We started our work in NLPS focused on the first three domains of mathematical reasoning in this nested model adapted from the work of Pam Harris:

1. Counting & Number Identity

Students reason with individual items. Their thinking moves in ones. Ten is understood as ten separate things, not a composed unit.

2. Additive Reasoning

Students begin to think in sets. They make jumps larger than one. They understand numbers as composed quantities and start seeing relationships: how far apart numbers are, how they can be decomposed and recombined.

3. Multiplicative Reasoning

Students visualize equal groups and arrays. They begin attending to two dimensions at once. The seeds of proportional thinking — and eventually functional reasoning — take root here.

These ‘nested’ domains became the backbone of what would eventually become our **K–5 Numeracy Continuum**. Not a rigid checklist. Not a remedial tool. But a way of making students’ thinking visible.

This clarity changed everything.

We realized that when a student solves 13×5 by counting by fives on their fingers, the issue isn’t their multiplication facts: it’s that they are still reasoning additively.

We were beginning to see what students understood, rather than what they remembered.

Concepts & Strategies Over Steps: The Heart of Mathematical Thinking

One of the most transformative shifts for us was understanding the difference between **concepts and strategies** and **algorithms**.

Algorithms

Fixed procedures. Memorized steps. Little thinking required.

Useful? Yes.

Sufficient? No.

Concepts and Strategies

Flexible approaches grounded in relationships.

Rooted in understanding.

Built from noticing structure, not remembering steps.

When a student solves:

$47 + 36$ by thinking “ $50 + 33$ ”

they demonstrate understanding of number relationships, not a memorized trick.

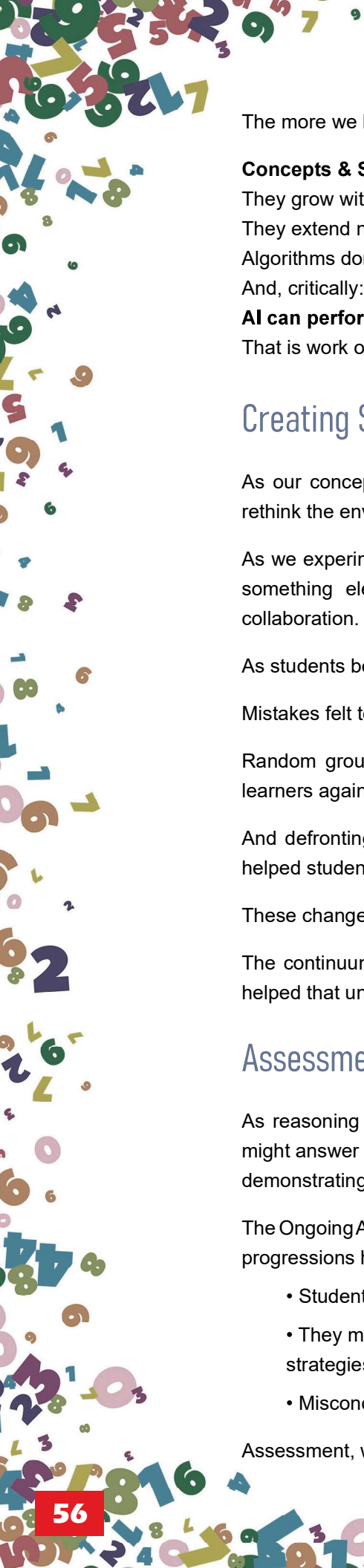
When they solve:

13×5 as $(10 \times 5) + (3 \times 5)$

they are applying the distributive property, often without knowing its formal name.

“Students visualize equal groups and arrays. They begin attending to two dimensions at once. The seeds of proportional thinking — and eventually functional reasoning — take root here.”





The more we leaned into concepts and strategies, the more we realized something important:

Concepts & Strategies scale.

They grow with the learner.

They extend naturally into decimals, fractions, functional reasoning, and beyond.

Algorithms don't.

And, critically:

AI can perform algorithms effortlessly, but it cannot build understanding.

That is work only humans can do.

Creating Spaces Where Thinking Can Emerge

As our conceptual understanding grew, Liljedahl's "Thinking Classroom" practices helped us rethink the environment where reasoning develops.

As we experimented with students standing at vertical whiteboards instead of sitting at desks, something electric happened. The classroom shifted, from silent compliance to buzzing collaboration.

As students became more comfortable: They leaned in. They shared ideas. They took risks.

Mistakes felt temporary when they could be erased with a swipe of a hand.

Random grouping reshaped identities. Students who were used to being "helpers" became learners again. Those who had long been quiet found their voice in a small group of peers.

And defronting — the teacher moving away from demonstrating procedures at the board — helped students see that math isn't something shown to you. It's something you do.

These changes didn't just create engagement. They created **conditions for thinking**.

The continuum helped us know what understanding to look for; thinking classroom practices helped that understanding take root.

Assessment as a Window Into Thought

As reasoning took center stage, traditional assessments began to feel too narrow. A student might answer correctly while relying on fragile counting strategies, or answer incorrectly despite demonstrating strong reasoning blurred by a small error.

The Ongoing Assessment Project (OGAP) became a powerful guide here. OGAP's developmental progressions helped us recognize:

- Students don't develop reasoning linearly.
- They may show multiplicative thinking with small numbers but revert to additive strategies with larger ones.
- Misconceptions are not failures: they're roadmaps.

Assessment, we realized, should not sort students.

It should reveal their thinking.

This shift has influenced how we are looking to design assessments in NLPS:

- More open tasks
- More justification
- More analysis of student work
- More focus on evidence rather than correctness

The goal has become simple:

Make students' reasoning visible so we know how to support their next step.

Professional Learning as a Journey, Not a Workshop

If we are asking students to rethink math, teachers have to as well.

Many educators carry their own math stories — some marked by success, others by anxiety or even trauma. We cannot simply hand them new strategies and expect transformation.

The Responsive Math Teaching (RMT) model has guided us to what we think of as a more humane approach:

Phase 1 — EXPERIENCE

Teachers first experience math as thinkers themselves.

They grapple with reasoning tasks.

They feel what students feel.

They rediscover mathematics as sense making.

Phase 2 — TEACH

Teachers bring these practices to their classrooms: experimenting, observing, adjusting.

They share student work with colleagues, reflect together, and refine their instruction.

Phase 3 — LEAD

Some teachers begin facilitating learning with peers, not as experts, but as co-learners guiding the journey.

This model allows us to acknowledge a truth:

Instructional change is emotional long before it is technical.

Leadership in the Midst of Transformation

Leading this work required a deep shift in how we see our own roles.

We are not here to dictate change.

We are here to walk through it with teachers.

Drawing on Dr. Becky Kennedy's concept of **The Learning Space**, we recognize that people grow best when:

- struggle is normalized
- support is present

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- uncertainty is safe, and
 - identity is honoured

We are learning to say things like:

“I’m still figuring out the difference between additive and multiplicative reasoning myself.”

And, magically, teachers are beginning to lean in.
Because if leaders can learn out loud, they can too.

We are also learning to honor the emotions tied to this transformation. For some teachers, letting go of familiar practices feels like loss. Their expertise had been built on traditional methods, and the shift toward reasoning challenges their sense of competence.

Our role is not to push harder.

It is to accompany.

To notice.

To listen.

To celebrate.

To ask:

“What are you wondering about right now?”

Making Space for Coherence and Momentum

As this work unfolds across our district, we have noticed some patterns in what has supported our push forward:

- Targeted collaboration time
- Shared language around reasoning
- Common developmental frameworks
- Co-teaching opportunities
- Focus on a few high leverage concepts

And, perhaps most importantly:

Positioning ourselves as lead learners — not lead knowers.

Redefining What Fluency Means

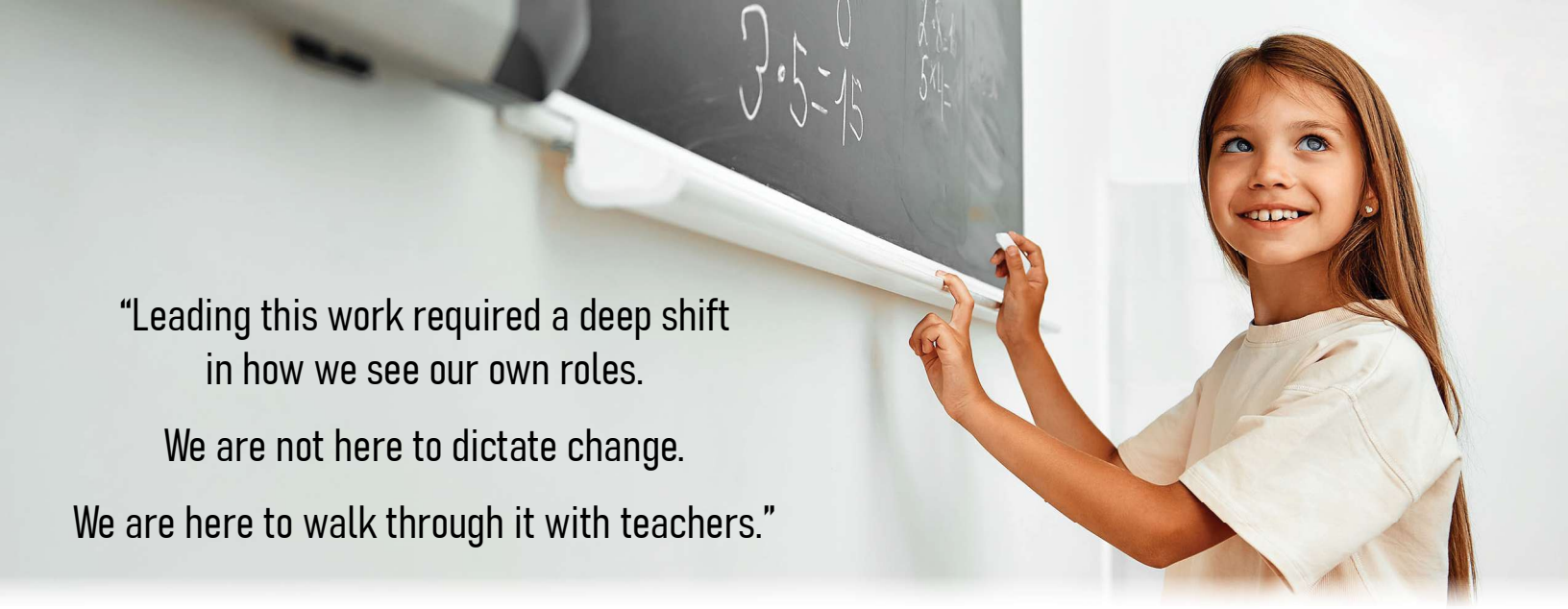
As our Numeracy Continuum matures, it is reshaping our beliefs about fluency.

Fluency has become **flexibility, efficiency, and reasoning** — working together, grounded in understanding.

Students don’t reach fluency by memorizing facts.

They reach it by:

- recognizing relationships
- decomposing and recomposing numbers
- choosing strategies that fit numbers



“Leading this work required a deep shift
in how we see our own roles.

We are not here to dictate change.

We are here to walk through it with teachers.”

- reasoning with models
- understanding structure

Fluency has become something **grown**, not *assigned*.

And, we fully acknowledge, it grows at different rates for all of our learners.

An Invitation to Continue the Exploration

One of the reasons we started this journey was because AI forces us to ask difficult questions about the purpose of mathematics education.

We continue it because we have glimpsed what is possible when classrooms become places of reasoning rather than answer getting:

- Students take intellectual risks.
- Teachers rediscover joy in mathematical thinking.
- Collaboration replaces compliance.
- Understanding replaces memorization.
- Mathematics becomes a living, human pursuit.

We don't have a blueprint.

We don't claim to know the “right” way.

We are learning: imperfectly, openly, together.

And now we extend an invitation:

If you are asking similar questions in your district, let's learn with one another.

Let's examine what reasoning looks like across contexts.

Let's build a community committed to developing mathematical thinkers, not answer getters.

Because in a world where algorithms are executed instantly by machines, perhaps the most important work we can do is help students become the kind of thinkers who can understand, evaluate, and extend what those machines produce.

*This work would not have been possible without the contributions of **Tannis Reis, NLPS Learning Coordinator – Numeracy**. Tannis' collaborative spirit and her expertise in numeracy development were pivotal in guiding the creation of our Numeracy Continuum.*