Important findings from Scholastic: aligning cognitive science with PR1ME Maths

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EDUCATION

Maths teaching fails pupils by ignoring cognitive science findings

We have to prioritise the science of learning over political expediency, to revitalise the mathematics curriculum and its teaching

by **Dr Tanya Evans** 10/04/2024 Share

'A well-crafted explanation of a mathematical concept or procedure by a proficient educator serves to channel learners' attention towards incoming information, fostering active cognitive engagement crucial for selecting pertinent information for further processing in the working memory,' writes Tanya Evans. Photo: Getty Images

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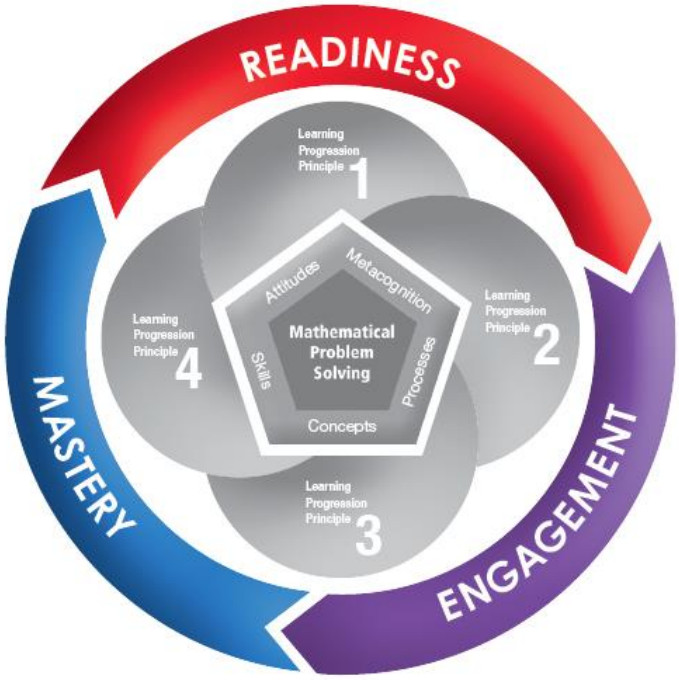
In a recent article titled "Maths teaching fails pupils by ignoring cognitive science findings," Dr. Evans offers an insightful analysis of the landscape of mathematics education in New Zealand ([Evans, 2024]). As the head of the mathematics education unit at the University of Auckland, Dr. Evans provides a comprehensive critique of prevailing educational approaches in New Zealand, encompassing project-based learning, inquiry-based learning, and traditional teacher-led instruction. Her article lays the groundwork for examining how the principles of PR1ME Math Pedagogy, emphasizing deep conceptual understanding, the concrete-pictorial-abstract approach, and the integration of critical insights, can potentially revolutionize teaching and learning practices.

PR1ME's Readiness Engagement Mastery (REM) Model

Every student is a successful mathematics learner.

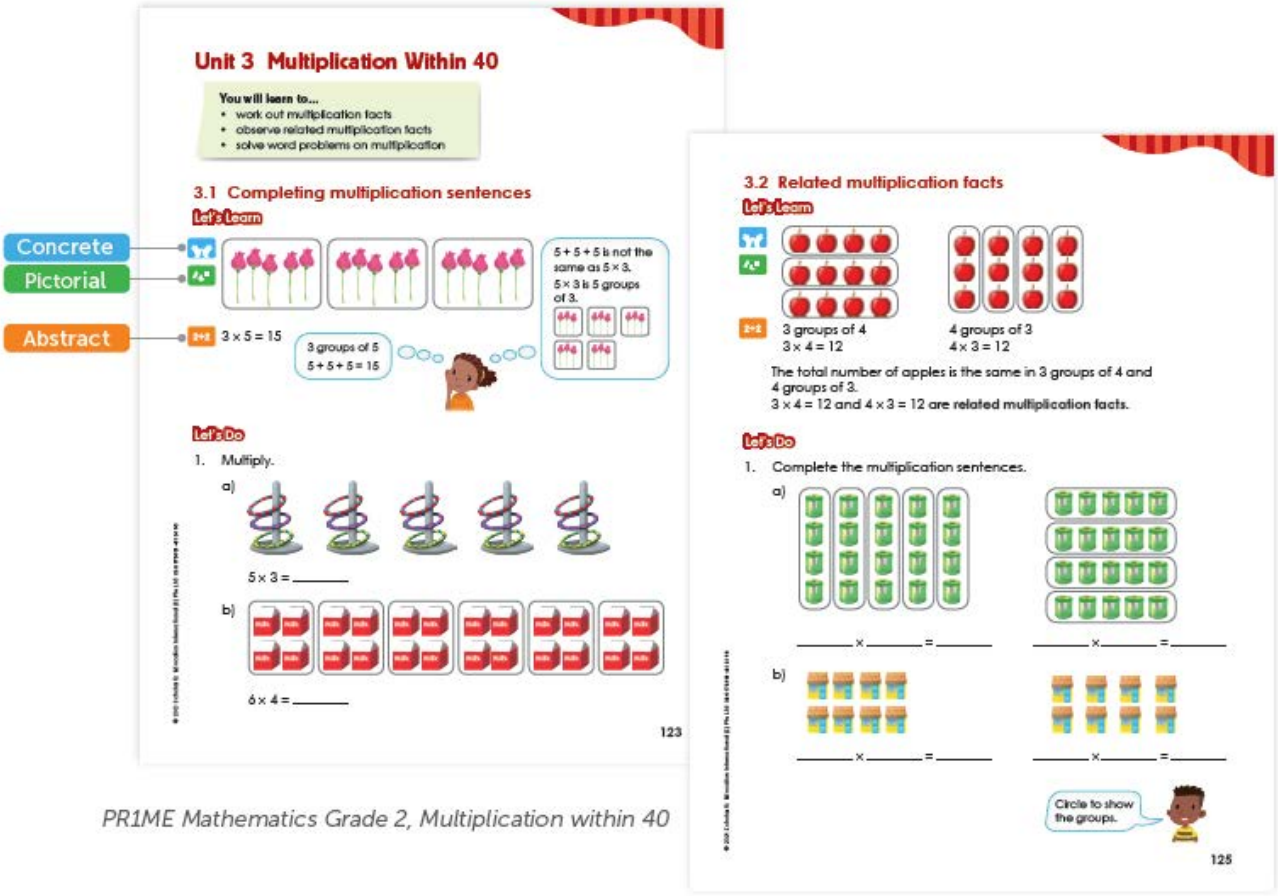
The instructional design of each chapter comprises learning experiences that consistently involve three phases of learning: Readiness, Engagement, and Mastery so that teaching and learning mathematics is effective, measurable and diagnostic.



Dr. Evans emphasized the importance of transitioning to a phase of extensive practice once students reached a satisfactory level of proficiency. This phase emphasized repetition and reinforcement to achieve the necessary speed of execution and develop automaticity in mathematical skills. REM model underscores the essential role of practice and repetition in guiding student learning.

Beginning with the readiness phase, teachers ensure that students have a solid grasp of prior knowledge before transitioning to the engagement phase. Here, active participation and repetition are emphasized, facilitating the profound internalization of skills and concepts. Through diligent and meticulous practice, students' progress towards mastery, attaining the necessary speed and accuracy for task execution, leading to the development of automaticity. This automaticity, akin to the mastery phase in PR1ME's model, empowers students to perform tasks effortlessly, showcasing a heightened level of proficiency and adept skill application.

Concrete-Pictorial-Abstract Approach

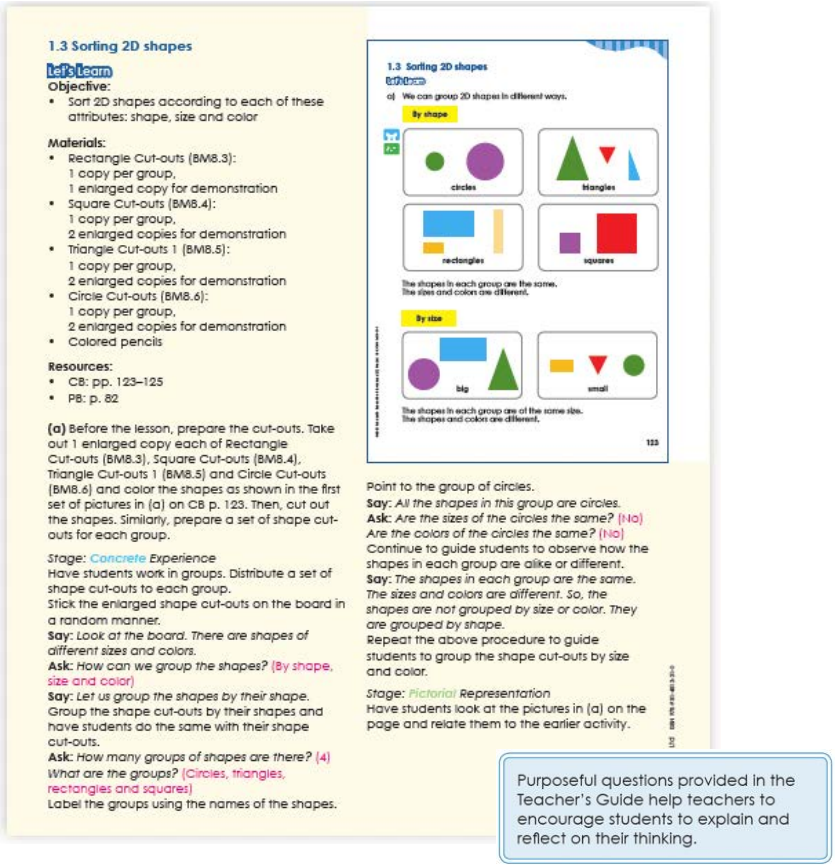


PR1ME Mathematics Grade 2, Multiplication within 40

A central theme in Dr. Evans' article is the gap between traditional educational philosophies and the evidence-based Concrete-Pictorial-Abstract (CPA) approach advocated by PR1ME Math.

The analysis presents a nuanced perspective on the limitations of certain methodologies in fostering mathematical proficiency. By comparing experiences with various educational approaches, the efficacy of the CPA approach is subtly highlighted, emphasizing the sequential progression from hands-on experiences to pictorial representations and finally to abstract symbolic representations. This emphasis on explicit instruction involves clear explanations, immediate corrective feedback, and extensive practice, all of which are endorsed by PR1ME as essential components for fostering mathematical fluency and thinking skills.

Deep Conceptual Understanding



1.3 Sorting 2D shapes

Let's Learn

Objective:
- Sort 2D shapes according to each of these attributes: shape, size and color

Materials:
- Rectangle Cut-outs (BM8.3):
  1 copy per group,
  1 enlarged copy for demonstration
- Square Cut-outs (BM8.4):
  1 copy per group,
  2 enlarged copies for demonstration
- Triangle Cut-outs 1 (BM8.5):
  1 copy per group,
  2 enlarged copies for demonstration
- Circle Cut-outs (BM8.6):
  1 copy per group,
  2 enlarged copies for demonstration
- Colored pencils

Resources:
- CB: pp. 123–125
- PB: p. 82

(a) Before the lesson, prepare the cut-outs. Take out 1 enlarged copy each of Rectangle Cut-outs (BM8.3), Square Cut-outs (BM8.4), Triangle Cut-outs 1 (BM8.5) and Circle Cut-outs (BM8.6) and color the shapes as shown in the first set of pictures in (a) on CB p. 123. Then, cut out the shapes. Similarly, prepare a set of shape cut-outs for each group.

Stage: Concrete Experience
Have students work in groups. Distribute a set of shape cut-outs to each group.
Stick the enlarged shape cut-outs on the board in a random manner.
Say: *Look at the board. There are shapes of different sizes and colors.*
Ask: *How can we group the shapes?* (By shape, size and color)
Say: *Let us group the shapes by their shape.*
Group the shape cut-outs by their shapes and have students do the same with their shape cut-outs.
Ask: *How many groups of shapes are there?* (4)
What are the groups? (Circles, triangles, rectangles and squares)
Label the groups using the names of the shapes.

Point to the group of circles.
Say: *All the shapes in this group are circles.*
Ask: *Are the sizes of the circles the same?* (No)
Are the colors of the circles the same? (No)
Continue to guide students to observe how the shapes in each group are alike or different.
Say: *The shapes in each group are the same. The sizes and colors are different. So, the shapes are not grouped by size or color. They are grouped by shape.*
Repeat the above procedure to guide students to group the shape cut-outs by size and color.

Stage: Pictorial Representation
Have students look at the pictures in (a) on the page and relate them to the earlier activity.

Purposeful questions provided in the Teacher's Guide help teachers to encourage students to explain and reflect on their thinking.

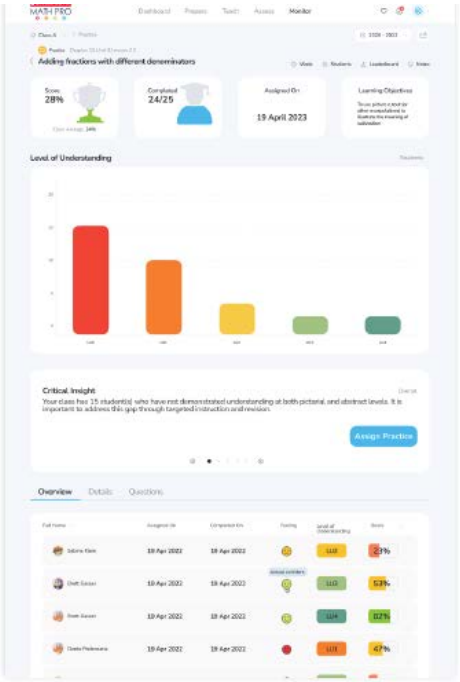
Dr. Evans discussed the false dichotomy between 'rote learning' and 'learning with understanding' in mathematics education, particularly in New Zealand and other English-speaking nations. Dr. Evans stressed the pivotal role of long-term memory in facilitating comprehension and effective learning, while also noting the constraints of working memory in handling new information and proposing that well-structured long-term memory content could mitigate cognitive overload.

As emphasized in PR1ME, a program advocating deep conceptual understanding, this belief overlooks the critical role of long-term memory in fostering comprehension and effective learning. PR1ME's approach, which prioritizes understanding over mere memorization, facilitates the organization of information in students' long-term memory. Through strategies like number bonds, students develop a profound understanding of mathematical concepts and relationships, enabling them to internalize well-structured information. By breaking down numbers into their component parts and comprehending their interconnections, students not only grasp mathematical concepts more deeply but also organize information in a manner that enhances accessibility and retrieval.

This well-organized information, easily accessible from long-term memory, allows the working memory to operate without constraints, fostering effective thinking and learning. Thus, by promoting deep conceptual understanding and employing strategies like number bonds, PR1ME cultivates an environment where well-organized information serves as the cornerstone for enhanced comprehension and enthusiasm for mathematics.

’s Instructional Design with Teacher-Led Explicit Teaching Model and Evidence-Based Instruction

Teachers can see their students’ understanding of topics easily through the assignment cards that show the LUs.



Teachers can also choose to review this information by individual assignment/practice so that they know how many students are struggling based on the LU chart.

Dr. Evans highlighted the detrimental fallout of paradigm wars as the vilification of the teacher-led classroom model, despite scientific evidence supporting its efficacy. Contrary to common criticisms, well-crafted explanations by proficient educators aided in directing students' attention, fostering active cognitive engagement, and enhancing comprehension of new mathematical concepts. Scientific research demonstrated the effectiveness of explicit instruction, which included clear explanations, example demonstrations, and immediate corrective feedback during initial practice.

PR1ME's instructional design resonates with the teacher-led model, countering misconceptions regarding its effectiveness in fostering mathematical comprehension. Emphasizing clarity, PR1ME ensures that teachers provide clear explanations of mathematical concepts and procedures, guiding students through their learning journey. Through demonstration of examples, PR1ME facilitates visual and practical understanding, enabling students to grasp abstract concepts with greater ease. Moreover, PR1ME underscores the significance of immediate corrective feedback, allowing teachers to address students' misconceptions promptly and nurture their mathematical proficiency. By integrating these principles into its approach, PR1ME not only promotes active cognitive engagement but also harnesses the efficacy of teacher-led instruction to enhance students' comprehension of novel mathematical concepts and procedures.

The government's emphasis on implementing evidence-based instruction in early mathematics mirrors PR1ME's commitment to evidence-based teaching strategies. The integration of explicit instruction, as endorsed by PR1ME, aligns with the government's goal of ensuring that students receive clear explanations, immediate corrective feedback, and structured practice to foster mathematical fluency and critical thinking skills. Through the implementation of evidence-based instructional practices, New Zealand can effectively address the gaps identified and enhance students' mathematical proficiency and overall academic achievement.

Empowering Educators: Investing in Teacher Training and Collaboration

The priorities outlined by the government, such as establishing a knowledge-rich curriculum grounded in the science of learning, implementing evidence-based instruction in early mathematics, and developing the workforce of the future through improved teacher training, resonate perfectly with the principles advocated by PR1ME Math. PR1ME Math educational approaches align with the government's aim of providing a clearer curriculum, emphasizing the importance of grounding educational practices in evidence-based methodologies.

Additionally, the government's focus on developing the workforce of the future through improved teacher training resonates with PR1ME's dedication to providing teachers with the necessary support and resources to effectively implement the pedagogical principles advocated by the program. By investing in teacher training and leadership development pathways, New Zealand can empower educators to deliver high-quality mathematics instruction that promotes deep conceptual understanding and mathematical thinking skills among students. This alignment between government priorities and PR1ME's objectives underscores the potential for collaboration between policymakers, educators, and Scholastic to drive positive change in mathematics education in New Zealand.

Reference list:

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