

MATHEMATICS CHAMPION: MATHEMATICS READER

INTRODUCTION

RATIONALE

- The statement "**The problem with mathematics is English**" reflects a powerful insight into one of ***the hidden barriers to learning mathematics - language comprehension***.
- While mathematics is often viewed as a ***universal subject based on numbers and logic, learners must still understand verbal instructions, word problems, and conceptual terms expressed*** in English (or another language of instruction).
- Many **mathematics problems are embedded in linguistically complex sentences**, which require learners to ***unpack meanings before applying mathematical reasoning***.

EXAMPLE

A learner might understand subtraction in a numerical context, but struggle when asked:

“How many more apples does Sam have than Thabo?”

This question demands comprehension of **comparative language** (“more than”), **context interpretation**, and **translation into a mathematical operation**.

If a learner is not proficient in English or is unfamiliar with the phrasing, their cognitive load shifts to decoding language, not solving the math.

LANGUAGE IS A GATEKEEPER

- Language becomes a gatekeeper to mathematical understanding.
- When learners misinterpret terms like “difference,” “altogether,” or “at least,” they are not failing at mathematics - they are struggling with the language of mathematics.
- This is why integrating mathematics language development into teaching is critical, teachers must not assume that knowing numbers equals understanding math.
- Instead, they must help learners build a conceptual vocabulary that connects words to mathematical ideas.

WHAT IS A MATHEMATICS READER

- A Mathematics Reader is not just a fluent reader of text, but an explainer of mathematical language.
- They help learners make sense of mathematical terms, phrases, and symbols.
- They read with a focus on conceptual understanding, not just word recognition.

CENTRAL THEME: MATHEMATICS READERS EMPOWERED TO:

- Identify and understand the nuances and true meanings of mathematical language, symbolism and visual representation
- View a math concept from different perspectives
- Make connections among key concepts which will enhance and leverage the learning of new topics
- Provide instruction focused on building a conceptual understanding of math rather than memorizing rules and procedures

WHY ARE MATHEMATICS READERS IMPORTANT

- Mathematics is a language of precision, and many learners struggle to decode it.
- Misunderstanding terms like “more than”, “difference”, or “product” affects problem-solving.
- A Mathematics Reader bridges this gap by clarifying vocabulary and structure.

CORE FUNCTIONS OF A MATHEMATICS READER

- Break down complex word problems into understandable parts.
- Explain vocabulary using visuals or real-world examples.
- Help learners link words to operations (e.g., “altogether” → addition).
- Emphasize reasoning over rote.

KNOWLEDGE ABOUT TEACHING

It is a complex endeavour involving: (cannot teach what they do not know) - **AWARENESS**

- 1) subject-matter expertise
- 2) Focus was on how teachers teach but overlooked what they teach
- 3) The role of language and symbolism in understanding mathematics conceptually
- 4) Challenge: learning both academic content and a new language at the same time
- 5) Note: language struggles are embedded in mathematics, in many ways is its own language

CONCEPTUAL UNDERSTANDING THROUGH LANGUAGE

- Meaning is made when language is tied to concepts
- “Multiply” is more than a word, it’s repeated groups.
- “Equal” is more than a symbol, it represents balance or equivalence.
- Mathematics Readers help learners visualize and internalize these meanings.

DEFINITIONS

- Need to emphasize definitions as a core element of instruction
- Help to build understanding of important concepts
- Incorrect responses reveal misunderstanding and gaps in knowledge, also provide clues about effectiveness of instruction, the curriculum and the larger maths education system

CHARACTERISTICS OF EFFECTIVE MATHEMATICS READERS

- Strong understanding of math content and terminology
- Use of gestures, diagrams, and analogies to explain terms
- Can identify when a learner's confusion is language-based or concept-based.
- Patient, reflective, and aware of learner misconceptions.

MATHEMATICS READER vs LANGUAGE READER

FEATURE	MATHEMATICS READER	LANGUAGE READER
FOCUS	Mathematical terms, symbols, structures	Grammar, vocabulary, comprehension
GOAL	Conceptual clarity in maths	General reading fluency and understanding
EXAMPLE	Explains "less than" in context of subtraction	Explains "less than" in context of grammar
CORE CONSTRUCT	Builds understanding	Builds reading fluency

WHY A LANGUAGE FOCUS

- Maths and language inextricably intertwined
- Understanding is dependent of both the academic language of maths and the instructional language
- Every lesson, regardless of content, presents terms, symbols and context to grasp new material
- We have complexities of english = landmines;
- Poor practices entrenched in traditional instruction

MORE THAN VOCABULARY

- Foundation for understanding key concepts
- Without understanding language = handicapped in efforts to learn maths
- Vocab is incidental or separate from solution process
- Exposure to definitions not enough
- Need to think about it, discuss vocab terms
- Vocab instruction in isolation through test-like exercises does not lead to conceptual understanding
- Terms rarely used outside of class = if you don't use it you lose it
- Examples: perpendicular, divisor, quotient

FACILITATION OF LEARNING: 5 STRATEGIES & LEARNING STYLES

CHOICE - Not every student is the same kind of learner, give multiple options when assigning projects. This shows that you respect their unique learning style. It also shows that you're more interested in facilitating their learning than exercising your authority.

VARIATION - Vary class activities to give learners the ability to try out different learning styles, and to give each learner their moment to shine. Help them to choose their approach to assigned projects.

CONNECTION - Give context for each lesson and show how it relates to other things your learners might be learning or experiencing. Tie the material in to other lessons, classes, subjects, current events, or real-life examples. Tell them why the lesson is relevant to their lives and why it should matter to them.

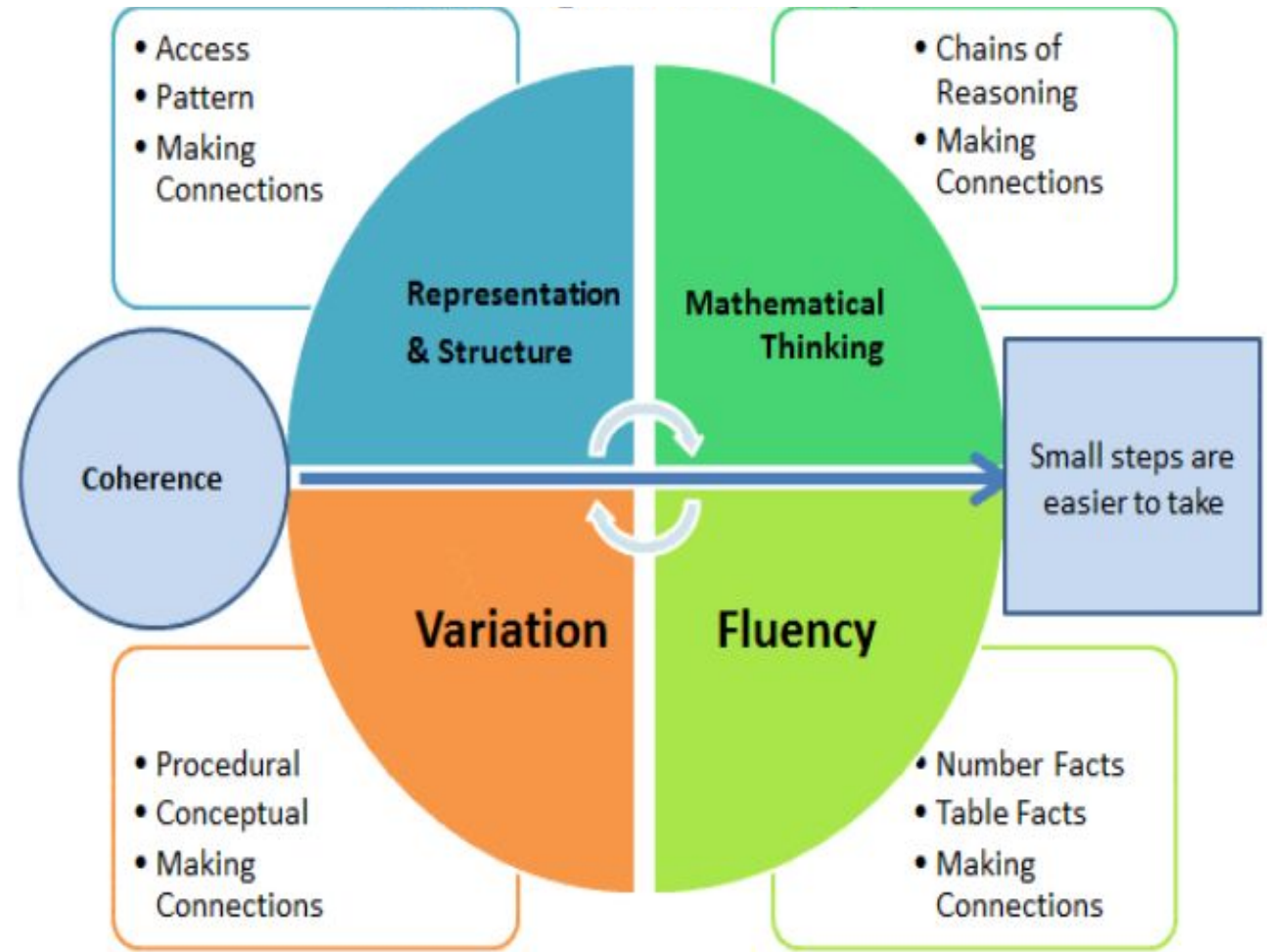
CONVERSATION - Learning how to problem-solve is just as important as knowing the answer, so give learners time to talk through a problem in small groups or as a class. Conversation also promotes communication skills, socialization, and cooperation.

RESOURCES - Today's learners have access to a lot more information than the learners of previous generations. The real challenge is teaching them how to assess the quality and validity of the information they find. Provide learners with resources they can trust, and tools for gauging trustworthiness.



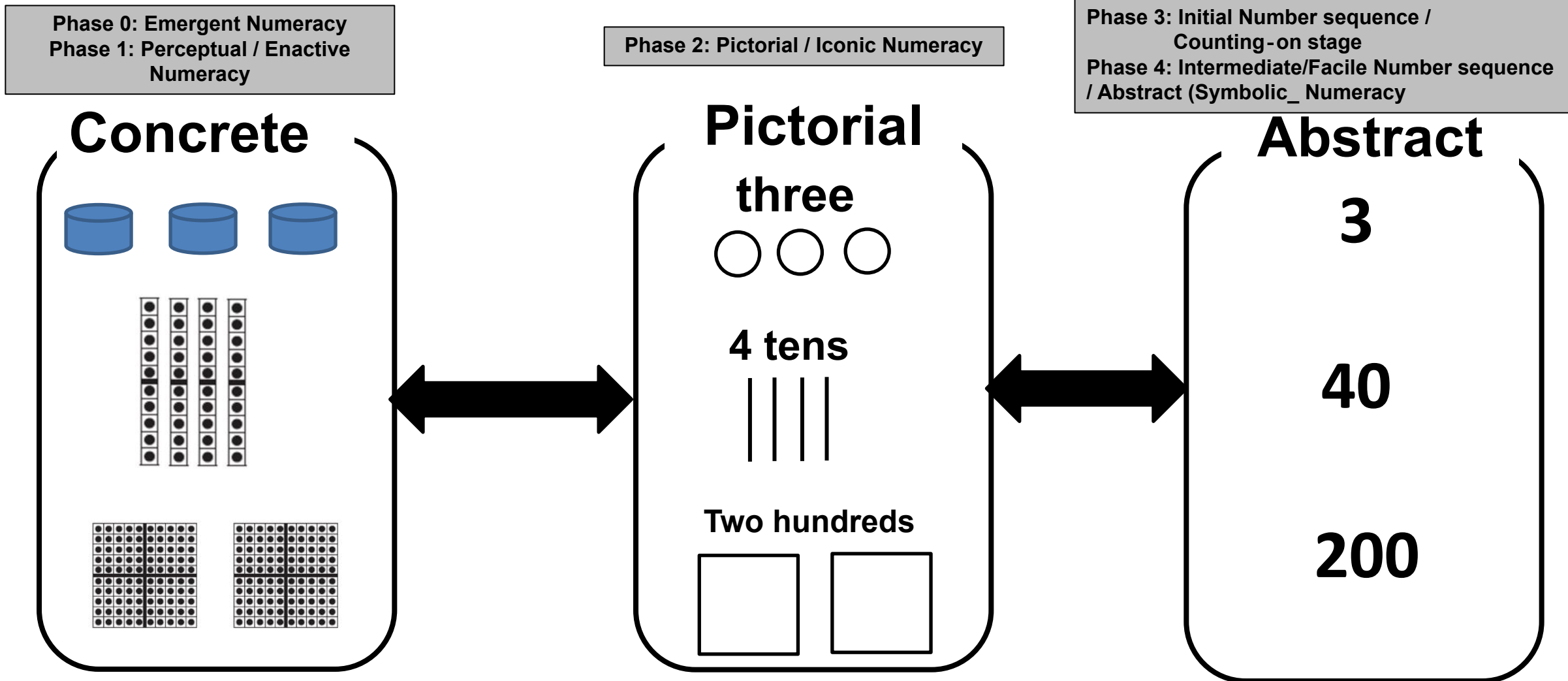
TEACHING FOR MASTERY

- The **belief** that all learners can achieve.
- Keeping the **class working together** so that all can access and master mathematics.
- Develop **deep understanding**
- Develop the **conceptual** and **procedural fluency**
- Provide multiple the **time** on key topics, providing **multiple opportunities** for deep teaching and embed learning



PHASES ON NUMERATE LEARNING

CPA means concrete, pictorial and abstract.



DEPTH OF MATHEMATICAL KNOWLEDGE

LEVEL	MATHEMATICAL KNOWLEDGE	EXAMPLES
1	Recall, recognition, skill, behaviour or sequence of behaviours learned through practice and easily performed	Find the next three terms in the following pattern: 2/7, 4/7, 6/7, 8/7. ...
2	Engagement of some mental processing beyond recalling , the use of information or concept knowledge, requires making some decisions regarding how to approach a question or problem	Draw the next figure in the following pattern:
3	More sophisticated reasoning and analysis, deep understanding; learners are required to solve problems and draw conclusions	 ... in the pattern and determine the rule for the following pattern of numbers: 1, 4, 8, 11, 15, 18, 22, 25, 29, ...
4	Requires integration of knowledge from multiple sources and ability to represent knowledge in a variety of ways , usually work over an extended period of time	Find the next three terms in the pattern, determine the rule for finding the next number in the pattern, and make or find a model for the pattern: 1, 1, 2, 3, 5, 8, 13, 21, 34, ...

Competency: Critical Thinking

Critical thinking is the application of analytical thinking habits. These include gathering data; asking useful questions; making use of the available evidence; assessing the logical sequence of ideas; identifying errors in reasoning; and giving clear reasons for conclusions.

Sub-competency: CRI1 – Applies problem solving strategies

Elements of this sub-competency are witnessed when a learner:

- Seeks solutions (recognising opportunities presented by problems)
- Asks probing questions
- Identifies patterns to make predictions

Early Childhood Development (ages 3 - 5)	Foundation Phase (Grades R-3, ages 6-8)	Intermediate Phase (Grades 4-6, ages 9-11)	Senior Phase (Grades 7-9, ages 12-14)	Further Education and Training Phase (Grades 10-12, ages 15-17)
<i>By the age of 3, a child's knowledge of objects and how they relate to each other are core to the development of their problem solving and reasoning skills. They need opportunities to explore and manipulate objects, putting them into categories, discovering which ones usually go together in a system, and how cause-and-effect relationships work between them. The patterns of the physical world model possible patterns in the mental world of imagination and language.</i>	<i>At this stage, learners' abilities to develop problem-solving strategies are limited by their short-term memories and their ability to write and create abstract diagrams, both of which must be promoted at this age to ensure problem-solving success later on. From a young age, learners must get a taste of facing problems that they have not been told how to solve, thus growing their perseverance and sense of agency over their knowledge. These problems will largely be physical puzzles at this stage.</i>	<i>At this stage, learners are better at constructing and maintaining mental representations of a scenario. This means they can begin to solve more abstract, non-visual puzzles and more complicated, multi-step word sums. They are also getting stronger at conditional 'if-then' reasoning, meaning that they can handle complicated rule-and-exception systems (e.g., in grammar, punctuation and spelling).</i>	<i>At this stage, learners' capacity for abstract thinking is really blooming. They should be building a sense of themselves as capable, adaptive problem solvers who can come up with new ideas and strategies in response to new problems. They can start to rely on themselves to figure out what to do, not requiring to be told what method to apply to solve a problem.</i>	<i>At this stage, learners should be extending their problem-solving experience to ever more complex settings. They should have developed a sense of what strategies work best for them and the types of problems they enjoy solving.</i>

Developmental Pathway Statements for [CRI1: Applies problem-solving strategies](#)

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From the age of 4 can follow multi step commands of at least three steps. From the age of 4 can use their imagination to respond to “What will happen next?” in an open-ended story. Can sort a series of pictures showing a familiar process into the appropriate step-by-step sequence	Understands and follows procedures represented in simple flowcharts that use images and/or icons to represent actions. Remembers the results of previous steps to use them in future steps. Can use a trial-and-error approach to solving physical problems (e.g. opening boxes), learning from mistakes and then not repeating them. Can hold a sequence of instructions in short-term memory and keep track of where they are in the sequence. Is able to learn and follow new instructions and procedures after repeated exposure to the method. Is able to follow unambiguous directions	Can give clear directions around an environment they are familiar with. Is familiar with the notion of efficiency as a measure of how many steps and how much time a procedure takes to complete. Uses a simple process of elimination when choosing between possible strategies. Is able to combine a highly constrained selection of physical materials in order to construct a structure matching certain specifications (e.g. building a bridge of a certain height and length out of a given collection of wooden objects and string). Solves multi-step numerical word sums by converting each step into an arithmetic operation and then chaining the operations together.	Can follow the directions in a decision tree, carefully choosing the options provided at each branching point before continuing along a new branch. Tackles problems involving multiple steps and multiple variables (problems that contain more information than can be held in mind at once). Uses external devices, like checklists and flowcharts, to structure and store relevant information. Carefully keeps track of the known information in a problem as well as the unknowns they are trying to find. Takes time when confronted with a new problem to consider different approaches before diving in. When they can't think of a method in full for problem solving, uses trial and error to	Articulates and acknowledges emerging thought patterns and potential solutions with the confidence to follow through on partially complete ideas (thinking in rough). Recognises when there is not enough information to find a given unknown (the solution is not uniquely determined). Is able to develop new problem-solving procedures to tackle unfamiliar types of problems. When designing algorithms or closed-ended procedures, can clearly talk about what the parameters of the problem are and how changing them will impact the performance of the algorithm/procedure (e.g. in long multiplication, the parameters are the two numbers to multiply and as the parameters are made larger the problem requires

around an unfamiliar environment. Guide a friend through a maze by putting together a chain of given commands, e.g. 'move forward one block', 'turn left', etc. Solves simple word sums involving the four basic arithmetical operations Follows simple 'if-then' rules to decide on what step/procedure to use for a given problem Is able to switch between methods when solving a collection of different problems (e.g. mixed addition and subtraction problems) Lists the possible strategies for solving an unfamiliar problem before diving into one. Uses cognitive trial and error to imagine the outcomes of a step-by-step process and avoid mistakes before making them,	Is able to apply rules and exceptions in order to follow decision trees or perform processes that involve choosing options at branches in the process (e.g. 'If it has capital letter it is a proper noun, unless it is at the beginning of a sentence or it is an acronym') Understands simple diagrams and schematic representations of information and procedures (e.g. flowcharts, mind maps, infographics) Using a map can plan efficient routes and is able to give directions. Is able to articulate the steps clearly and precisely in a problem-solving method they are familiar with (e.g. long multiplication, looking something up in the dictionary). Can take a problem or scenario and succinctly list all the information contained in it.	test different strategy paths and evaluate whether they seem to be making progress or not. Applies closed-ended questions when designing their own decision trees, flow diagrams, and computer programmes. When solving complex closed-ended questions (e.g. difficult maths problems) connects what they already know to what they need to know by asking themselves questions backwards from what they need to know and building a 'strategy chain' that links the unknowns to the knowns in a problem (e.g. 'I need to find this angle. What do I need to know in order to find this? Well, I need to know this length. How will I figure out this length? Well, I will first need to know this other length, etc.') Analyses the constraints (all the things you cannot change) and degrees of freedom (all the ways you are	more individual multiplication steps). When learning a method for solving a class of problems, recognises under what conditions the method works and under what conditions it is not applicable. Develops their own personalised transferable procedures for research, studying and problem-solving (e.g. 'if it is a complex topic, I prefer to scan through it to build a framework of the concepts and then fill in the details on each concept. After that, I look for all the interactions between the subtopics and try to understand the information as a whole within a broader context.')
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