

A Practical Exploration of Cultivating Mathematical Reading Ability in First-Stage Learning from the Core Literacy Perspective

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Abstract: By reviewing domestic and international research on mathematical core literacy, this study identifies three primary perspectives: the "comprehensive competency orientation," the "thinking quality orientation," and the "multidimensional orientation." The Compulsory Education Mathematics Curriculum Standards (2022 Edition) defines core literacy as the "Three Abilities": "using mathematical perspectives to observe the real world, using mathematical thinking to analyze the real world, and using mathematical language to express the real world." Mathematical reading plays a crucial role in cultivating students' mathematical core literacy. For elementary school students, the components of mathematical reading ability include conceptual understanding, language translation and conversion, reading transfer, reading reasoning, spatial imagination, and information integration. From the perspective of core literacy, this paper proposes three recommendations for fostering students' mathematical reading abilities.

Keyword: Mathematical Reading; Core Literacy; First-Stage Learning; Three Abilities; Elementary School Student

1. Introduction

Mathematical literacy has become a key objective in mathematics education globally. The earliest research on mathematical literacy originated in the United Kingdom. In 1959, British economist Geoffrey Crowther coined the term "mathematical literacy," emphasizing its equivalence to linguistic literacy. In 1982, Dr. Wilfred Cockcroft published the Cockcroft Report, which comprehensively summarized British primary and secondary mathematics education. The report highlighted mathematical

literacy as essential mathematics for daily life and work. In 1996, the UK introduced the National Numeracy Strategy, defining mathematical literacy as the ability to understand numerical systems, master computational skills, solve numerical problems in diverse contexts, and present results through charts, tables, and graphs. Following the UK's initiative, other countries incorporated mathematical literacy into their educational frameworks [1]. For instance, Australia (1996) described it as the capacity to apply mathematics in life and work [2], while the OECD (1999) defined it as "an individual's ability to formulate, employ, and interpret mathematics in various contexts, including using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena." [3]

Domestic research on mathematical core literacy can be categorized into three orientations. The first, the comprehensive competency orientation, views mathematical core literacy as an integration of critical abilities and essential qualities. Ma Yunpeng argues that core literacy encompasses discipline-specific competencies and character development [4]. The second, the thinking quality orientation, focuses on cultivating rational thinking and intellectual rigor. Zheng, posits that mathematical core literacy reflects the evolution of students' cognitive processes [5], while Zhang, defines it as the cultivation of "precise intellectual thinking and behavior," emphasizing the analytical nature of mathematical reasoning [6]. The third, the multidimensional orientation, emphasizes the integration of knowledge, skills, contexts, problem-solving, thinking, expression, communication, and reflection. Lü Shihu and colleagues describe mathematical core literacy as the comprehensive ability to solve real-world problems using mathematical knowledge and methods, alongside the development of related

attitudes and values [7].

International research underscores that mathematical literacy is inclusive, lifelong, and contextually adaptive, prioritizing the application of mathematical skills, attitudes, and emotional engagement. Similarly, China's three orientations align with global perspectives: the comprehensive competency orientation highlights explicit mathematical abilities, the thinking quality orientation emphasizes implicit cognitive development, and the multidimensional orientation bridges both. The Compulsory Education Mathematics Curriculum Standards (2022 Edition) consolidates these ideas into the "Three Abilities," anchoring core literacy in observational, analytical, and expressive competencies rooted in mathematics [8].

In primary school mathematics education, the cultivation of reading skills has long been overlooked. Traditional views hold that mathematics learning primarily involves problem-solving and calculations, neglecting the critical role of reading in constructing mathematical thinking. However, with the evolution of educational concepts, mathematical reading ability is now regarded as a fundamental cornerstone for students to comprehend mathematical knowledge, master mathematical methods, and enhance mathematical literacy. It not only helps students better tackle various challenges in mathematics learning but also provides strong support for their future studies in other disciplines and problem-solving in daily life.

2. Characteristics and Components of Mathematical Reading Ability

Mathematical reading refers to the psychological process through which students extract meaning from mathematical texts by translating and converting linguistic, symbolic, and graphical information. This process involves autonomous processing of mathematical information, analysis of problem-text relationships, problem-solving, and knowledge construction, all contributing to the development of mathematical reading ability. As the foundational stage of mathematical learning, the first academic phase (Grades 1–3) significantly influences students' future learning habits and core literacy.

Scholars such as Yang, identify six components of mathematical reading ability for elementary

students [9].

1) The Uniqueness of Mathematical Reading: Mathematical reading is fundamentally different from language arts reading. While language arts reading primarily follows linear narratives, focusing on textual comprehension and emotional resonance, mathematical reading is filled with abstract symbols, complex diagrams, and rigorous formulas. It requires students to dissect the logical relationships between symbols and translate them into their own cognitive understanding, demanding exceptional depth and precision of thought. This highlights the critical importance of strong logical reasoning and information-processing skills.

2) Mapping of Core Competencies: In the process of mathematical reading, students cultivate multiple core competencies. By analyzing textual conditions and conclusions, they explore mathematical patterns through deduction, induction, and analogy, honing their logical reasoning skills and developing rigorous thinking. Leveraging real-world problem scenarios encountered in reading, students translate everyday issues into mathematical problems and construct models to solve them. Additionally, when faced with problem information, they apply critical thinking to filter and process data, thereby enhancing their information-processing abilities [10, 11].

2.1 Conceptual Understanding

Mathematical concepts form the basic units of reading materials. Conceptual understanding involves interpreting mathematical text, symbols, and diagrams. For example, a student's grasp of operational symbols (e.g., +, −) directly affects problem-solving accuracy and speed.

2.2 Language Translation and Conversion

This component entails bidirectional translation among textual, symbolic, and graphical representations. For early learners with limited literacy, visual aids (e.g., diagrams) often substitute textual descriptions. Translating images into verbal or symbolic information is a critical skill.

2.3 Spatial Imagination

Spatial imagination refers to the ability to perceive, analyze, and abstract spatial relationships from static two-dimensional materials. For instance, in the "Movement of Shapes" unit (Grade 2), students analyze images

to identify characteristics of translation and rotation through spatial reasoning.

2.4 Reading Reasoning

Reading reasoning involves deciphering logical relationships within mathematical texts. Students must connect problem statements with given information and identify underlying patterns. For example, solving word problems requires understanding how numerical data interrelates to formulate solutions.

2.5 Reading Transfer

Transfer encompasses both knowledge transfer (linking concepts across contexts) and method transfer (applying learned strategies to new tasks). Early learners, for instance, might apply quantifiers from language arts (e.g., "three apples") to grasp mathematical units (e.g., "three meters").

2.6 Information Integration

Information integration involves synthesizing and optimizing data from texts. Even first-graders must learn to filter irrelevant details and focus on pertinent information. For example, in problem-solving tasks, students identify key numerical data while disregarding extraneous content.

3. Recommendations for Cultivating Mathematical Reading Ability from a Core Literacy Perspective

The cultivation of students' mathematical reading ability is not limited to the classroom; it extends beyond formal instruction and permeates their learning and daily lives. Grounded in the principles of mathematical core literacy, the enhancement of students' mathematical reading proficiency can be realized through three key pathways: providing students with intuitively presented reading materials, teaching flexible application of reading strategies, and collaboratively fostering a rich reading culture both within and beyond the school environment.

3.1 Present Materials Intuitively to Develop Mathematical Observation

According to Piaget's cognitive development theory, early learners (ages 6–8) operate in the concrete operational stage, relying on tangible objects to build cognitive structures. Thus, teachers should employ visual aids and real-life

examples to contextualize abstract concepts.

Written Materials: Use diagrams, physical models, or digital tools to clarify textual information. For instance, in "queue problems," students sketch scenarios or act them out to visualize sequential relationships.

Real-World Materials: Connect mathematics to daily life. Measuring objects (e.g., desks, books) helps students abstract concepts like length, while building blocks foster spatial understanding.

3.2 Apply Flexible Reading Strategies to Foster Mathematical Thinking

Effective reading strategies enhance logical reasoning and problem-solving. Three approaches are recommended:

Surface Processing: Train students to highlight keywords, sequence steps, and extract surface-level information. For example, circling terms like "total" or "difference" helps beginners focus on critical data.

Deep Processing: Encourage linking concepts across contexts. When exploring multiplication facts (e.g., "Which facts yield only one multiplication and division equation?"), students connect commutative properties to deduce that identical factors (e.g., 3×3) limit equation variations.

Intermodal Translation: Promote mutual conversion among text, symbols, and visuals. Drawing number lines or bar models helps students visualize abstract relationships.

3.3 Cultivate a Reading-Rich Environment to Encourage Mathematical Expression

A supportive environment nurtures interest and confidence in mathematical communication. Two avenues are essential:

School Initiatives: Create math corners with puzzles, storybooks, and interactive displays. Host "math story hours" where students share interpretations of problems or historical anecdotes.

Home-School Collaboration: Provide parents with reading lists (e.g., *The Number Devil*) and activity kits. Encourage shared reading sessions and showcase student work via digital platforms to reinforce parental engagement.

3.4 Enhancing Guidance: Problem-Driven Reading

To cultivate students' mathematical reading skills in primary school, teachers should adopt a

problem-driven approach to guide active learning. This means that the teaching process should revolve around specific mathematical questions from the very beginning. These questions—drawn from textbooks or real-life situations—should spark students' curiosity and serve as entry points for instruction. Teachers can then guide students to actively seek answers through reading and discussion. Additionally, teachers should encourage students to engage in deep reading and thinking centered around these problems. This involves identifying key information, clarifying the problem's logical structure, and exploring solution strategies—thereby strengthening mathematical logical thinking. Furthermore, teachers should guide students to analyze and summarize their reading experiences based on the problem-solving process. This helps deepen their understanding and mastery of mathematical knowledge and skills while encouraging reflection on their own problem-solving strategies.

3.5 Comparative Teaching: Building a Reading Framework

Comparative teaching enables students to better grasp new knowledge by comparing and connecting it with prior knowledge when solving novel problems. This instructional approach helps students establish internal connections between concepts, fostering a well-structured knowledge system. In the process of learning new material, students can review and reference existing knowledge, identifying similarities and differences to concretize abstract ideas—enhancing comprehension and retention. Teachers can actively involve students in knowledge construction during lessons, boosting engagement and learning efficiency. Additionally, comparative teaching cultivates students' ability to extrapolate principles, allowing them to distill universal mathematical rules from specific problems. This deepens understanding, broadens thinking, and promotes the development of a systematic mathematical knowledge framework. Since young learners' cognition remains tied to concrete objects and phenomena—making abstract concepts challenging—comparative teaching bridges this gap by facilitating cross-domain cognitive training. By designing analogous mathematical problems, teachers guide students to analyze

contrasts and extract generalized problem-solving strategies, thereby strengthening their mathematical reading proficiency [12,13].

4. Conclusion

By aligning pedagogical practices with the "Three Abilities" framework, educators can systematically enhance students' mathematical reading proficiency. This framework serves as a holistic guide to nurturing core literacy. It emphasizes not only the acquisition of knowledge but also the cultivation of transferable skills that bridge classroom learning with real-world applications. To achieve this, educators must adopt a multifaceted approach that integrates intuitive teaching methods, strategic cognitive development, and collaborative learning ecosystems, each contributing uniquely to fostering students' ability to decode, interpret, and apply mathematical texts.

Such strategies not only refine problem-solving efficiency but also align with the "thinking quality orientation" of core literacy, which prioritizes precision, logic, and adaptability in cognitive processes.

In conclusion, the "Three Abilities" framework offers a cohesive road map for transforming mathematical reading from a passive skill into an active, inquiry-driven practice. By prioritizing intuitive engagement, strategic rigor, and collaborative vitality, educators empower students to navigate the evolving landscapes of mathematics and beyond. As the global emphasis on STEM literacy grows, such approaches will remain critical in preparing learners to decode, analyze, and shape the world through mathematics.

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