Comparing Mathematics Education to the Science of Reading

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The Science of Reading is becoming a standard for high-quality instruction in teaching children to read. Many educators want to translate practices established by the Science of Reading to the teaching of mathematics. While there is wide consensus within the research literature around many important principles of teaching and learning reading, this consensus does not mean that the Science of Reading represents the entirety of effective literacy instruction, nor does the same level of consensus yet exist in mathematics education. This document compares and contrasts principles supported by the Science of Reading with evidence-based teaching practices in mathematics education. Understanding both the similarities and differences is important when considering whether, and how, insights from one field can appropriately inform the other.

What Do Educators Call Evidence-Based Teaching Practices?

Reading educators call these evidence-based teaching practices the **Science of Reading**[1].

Mathematics educators do not typically use the phrase "the science of math" to refer to these evidence-based teaching practices. They call these practices **Evidence Based Teaching Practices**[2] or **High-leverage Teaching Practices**[3].

Does Each Field Have a Common Definition of the Discipline?

"The **science of reading** is a vast, interdisciplinary body of scientifically-based research about reading and issues related to reading and writing.

The research has been conducted over the last five decades across the world, and it is derived from thousands of studies conducted in multiple languages. The science of reading has culminated in a preponderance of evidence to inform how proficient reading and writing develop; why some have difficulty; and how we can most effectively assess and teach and, therefore, improve student outcomes through prevention and intervention of reading difficulties."[4]

The science of reading, as described, is generally accepted as best practices to inform the teaching of reading.

AACTE, AMTE, ASSM, NCSM, NCTM, and the Charles A. Dana Center in a recent joint position statement suggest that "**Evidence-based math instruction** focuses on developing students' conceptual understanding, reasoning, and procedural skills and fluency, along with their capacity to solve everyday problems. Student success depends upon opportunities to engage in problem solving, practice, and the discussion of strategies, methods, and solutions. It also depends upon developing a strong sense of oneself as someone who can do math."[5]

Another group of educators has called themselves the "Science of Math" and they disagree with the above.[6]

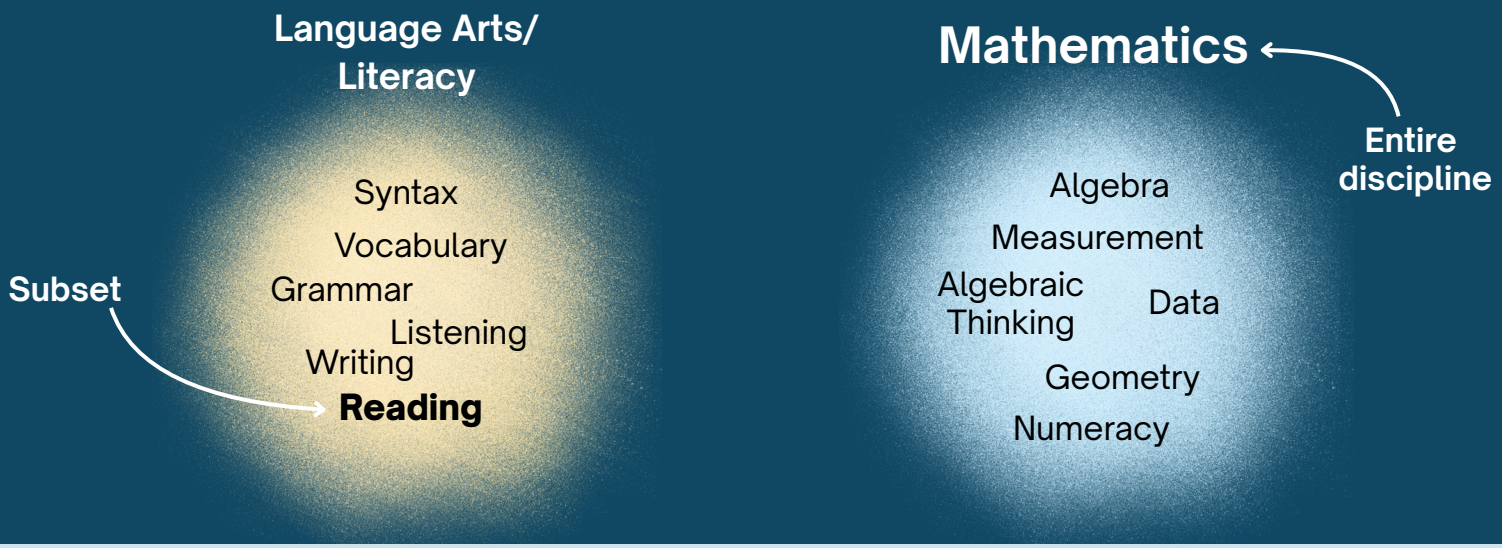
This is one example that there is not the same consensus in mathematics education as in reading.

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What are the Breadth and Depth of Each?

Reading is a part of the larger discipline of Language Arts/Literacy. Literacy is a broad topic which consists of reading, writing, speaking, listening, and language (a grasp of syntax, vocabulary and grammar to structure messages).[7]

The “Science of Reading” refers to a subset of the broad field of Language Arts/Literacy. This subset is not called “The Science of Language Arts/Literacy.” It focuses narrowly on parts of reading—decoding and the foundational skills of learning how to read—how to get students to look at symbols on paper and decipher meaning. These foundational skills are important for the more general Language Arts/ Literacy that develops later.[8]



Mathematics is a broad discipline that includes many varied subsets: numeracy, geometry, algebraic thinking, algebra, data, and measurement.

Unlike literacy, which features a narrow, foundational subset (reading/ decoding), mathematics does not have a single narrow-part analog.

Because of this depth, trying to apply a "science of math" label does not make sense: mathematics is not parallel to reading, we cannot overgeneralize from a narrow subset to the overarching set, and a subset does not equal the entire discipline.

Instead, the field of mathematics education focuses on building mathematical proficiency across all of these varied subsets throughout students’ PK-12 educational experience.

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What is the General Consensus? What do You Test?

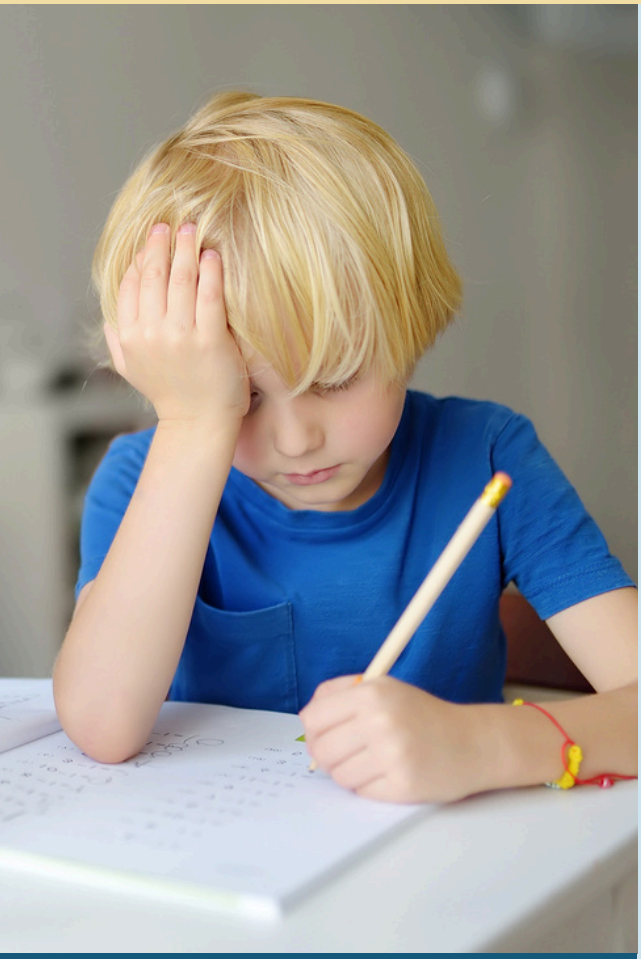
When you say “reading,” people understand and agree as to what it means “to read.”

To read means understanding language in written form.

This consensus means that the public generally grasps the broad arguments about reading proficiency and assessment.

Reading is much more than just saying written words, and the ability to decode words is an essential, fundamental component of reading fluency and comprehension. Reading instruction throughout the grades recognizes this and has reached some consensus regarding methods to assess both decoding and comprehension.





When you say “*math*-ing,” people interpret that to mean different things.

There is no consensus in the general population on what it means to do math.

Some define “doing math” based on their experiences in school—following the steps their teacher showed them to get answers.

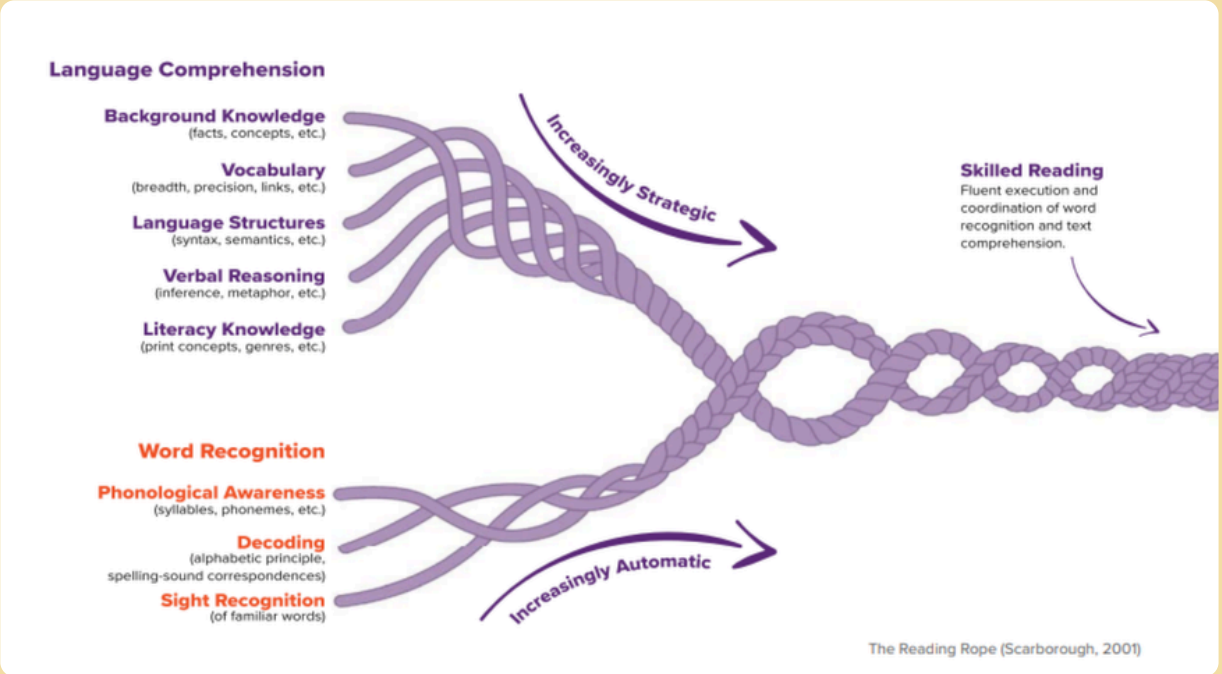
Others define “doing math” as noticing and using patterns, generalizing relationships, and using mathematical connections in flexible, efficient, and creative ways to solve meaningful problems.

Unfortunately, conceptual understanding and procedural fluency are often pitted as competing priorities rather than working together. There is disagreement about whether students simply answering mathematics questions counts as proficiency. Because conceptual understanding can be difficult to measure, students are often assessed solely on reproducing procedures and correct answers.

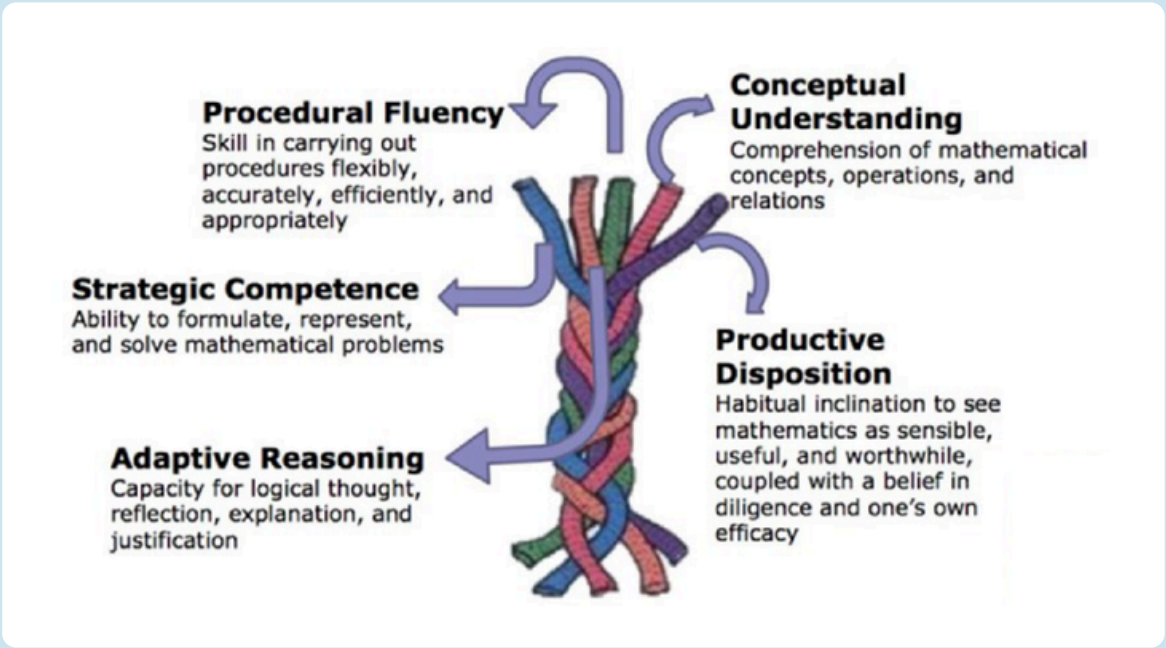
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What are the Components of Learning in Each?

Learning to read is the product of word recognition and language comprehension. The subcomponents of these two components are represented visually in Scarborough's Reading Rope.[9]



One influential framework proposes that learning mathematics involves five different proficiencies: adaptive reasoning, strategic competence, procedural fluency, conceptual understanding, and productive disposition. The "math braid" from Adding it Up[10] provides a visual image of these five proficiencies.



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How does Neuroscience Inform Each Discipline?

Brain researchers have identified areas and networks of the brain involved in processing print, speech sounds, language, and meaning. Learning to read is taught to the human brain through explicit instruction, repetition and practice to build connections between these networks. Learning to read does not come naturally to humans.

Stanislas Dehaene is a pioneer in the Science of Reading and wrote a book called Reading and The Brain: The New Science of How We Read.[11]

Brain researchers have identified areas and networks of the brain that visualize magnitude and connect those visualizations to language and symbolic notation.[12] While the symbolic code of mathematics must be taught to the human brain, humans are born with an intuitive sense of quantity and the ability to visualize and recognize mathematical ideas such as patterns, shapes, comparison and magnitude.

Stanislas Dehaene calls this “the number sense.” He wrote a book about how the brain learns mathematics called The Number Sense.[13]



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What is the Research Tradition on Teaching Practices?

Research on the Science of Reading is robust and also ongoing.[14] Five decades of research inform the Science of Reading, with strong collaboration and consensus between different research genres.

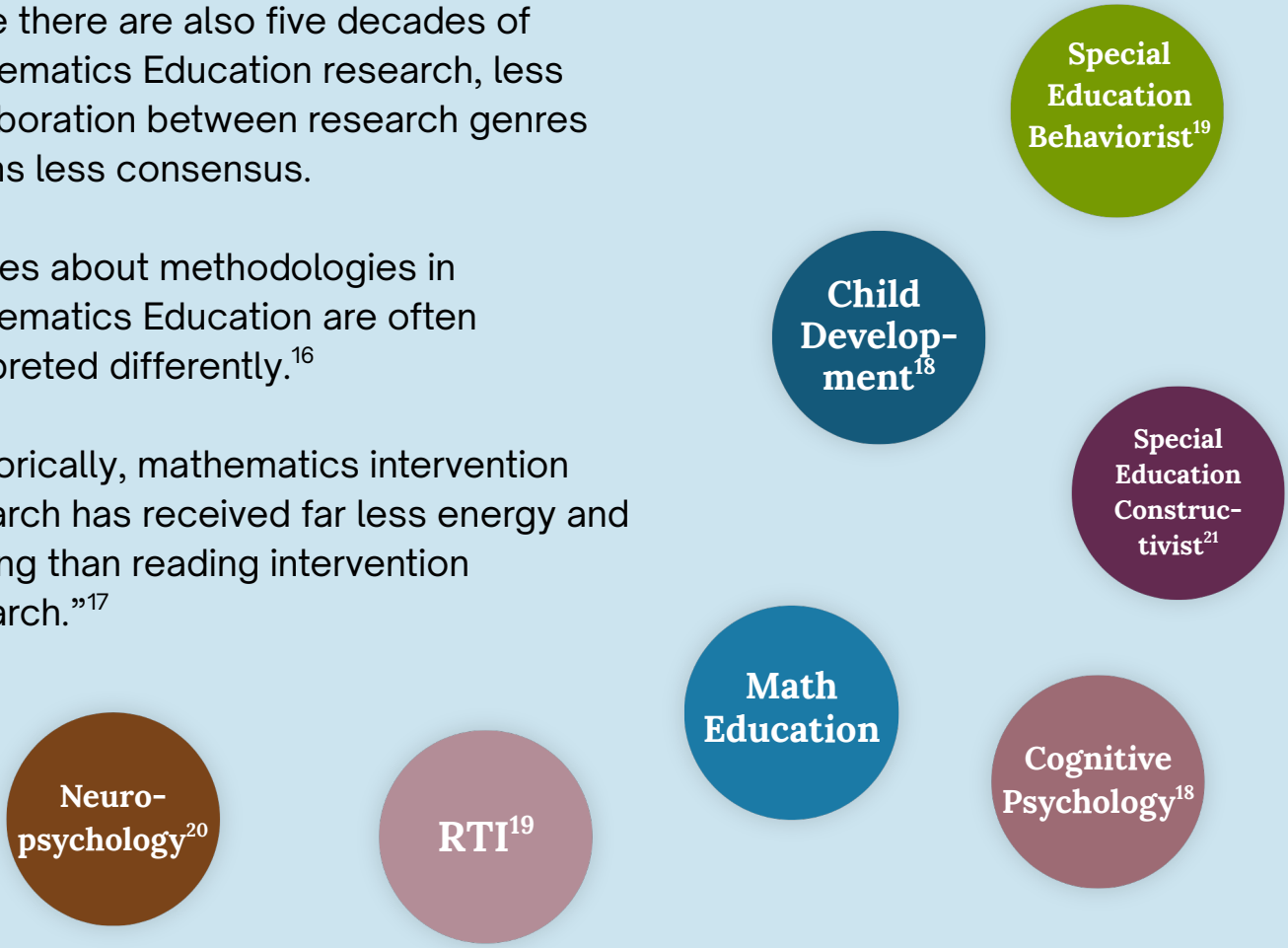
This graphic demonstrates that the Science of Reading is the intersection of the other disciplines.[15]



While there are also five decades of Mathematics Education research, less collaboration between research genres means less consensus.

Studies about methodologies in Mathematics Education are often interpreted differently.[16]

"Historically, mathematics intervention research has received far less energy and funding than reading intervention research."[17]



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Does Universal Screening Work the Same in Both Disciplines?

Learning to read is a combination of word recognition and language comprehension.[22] Early reading screeners that focus on decoding skills have been strongly correlated to future reading achievement. Thus, early reading screeners focused on decoding skills provide some level of confidence about a child's future reading achievement.

Research on predictive indicators in mathematics is not as robust as the research on predictive indicators in reading.[23] Most math screeners do not provide a targeted focus on any one component of mathematics achievement. Because mathematics achievement is multi-faceted, it is difficult to design one assessment that is effective for universal screening.

How does a Multi-Tiered System of Supports Help?



MTSS provides a framework for the early identification of risk and immediate instructional response that improves outcomes through prevention of and intervention for reading difficulties. Many states provide funding for literacy intervention. Practices are guided by a well-established research field.

MTSS can provide a framework for the early identification of risk and immediate instructional response that improves outcomes through prevention of and intervention for mathematics difficulties. Schools often do not have funding for training, additional staff, and resources needed for math intervention. There is much less research to guide intervention in mathematics compared to literacy. This is an emerging research field.

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What is the Role of Explicit Instruction?

Explicit instruction in reading is well-defined and includes demonstration and guided practice. This is an effective teaching practice that helps children enunciate sounds correctly, blend them together into words, and learn to spell.



Math educators disagree on the meaning and role of explicit instruction.

Some interpret explicit instruction as telling students what steps to do when, how to replicate procedures, I do/we do/you do. They believe that drill and practice are essential and timed assessments are necessary to assess student recall.

Other interpretations of explicit instruction focus on creating clear understanding of student and teacher roles, clearly defined mathematical goals, and working toward mental clarity of mathematical relationships and strategies. Practice has a role in building mathematical fluency, but rote replication of procedures does not help students develop mathematical habits of mind.

Does Each Discipline Have A Call to Action?

The Science of Reading says, “literacy success for all is the defining human right of the 21st century, regardless of zip code, ethnic origin, dialect, or language.”[24]

Bob Moses, founder of the Algebra Project, promoted that math is a civil right.[25] "Economic access and full citizenship depend crucially on math and science literacy."[26]

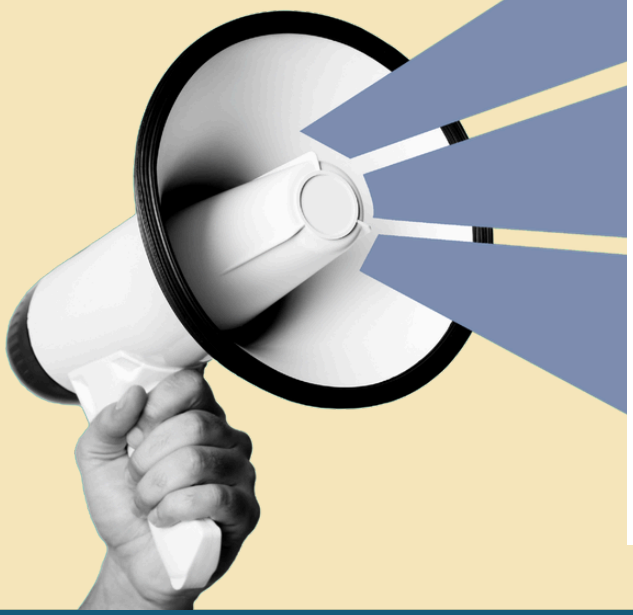


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Take Away Points

- If you hear someone say that the Science of Reading is the same as the Science of Math, realize there is no consensus in mathematics education called the Science of Math.
- If you hear “evidence-based math teaching practices,” know that six professional mathematics education organizations agree what those look like.
- We cannot assume that what we know about reading intervention will work well in math intervention.





Call to Action

- Advocate for high-quality mathematics instruction for all students
- Be informed
- Share what you’ve learned
- Arm yourself with facts to dispute claims that are untrue
- Push for more research

Compiled by Dr. Catherine Beals and Pamela Weber Harris.

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Endnotes

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