Strengthening Research-informed Decision Making for Mathematics Education

A Position Statement from NCSM

Our Position

Mathematics teacher leaders provide guidance and direction for those they serve, be they pre-service teachers, early career teachers, veteran teachers, or those in other leadership roles such as curriculum specialists. Whatever form this guidance might take, it should be grounded in research. However, this statement—"grounded in research"—is not straightforward. Different constituents and mathematics teacher leaders may have varying interpretations of its meaning, and approaching research with a critical lens can be challenging without training and expertise on the topic and the implications it may have for mathematics teacher leaders. Thus, there can be risks of misapplying purported findings, misunderstanding suggestions being made, or implementing pedagogical practices not actually recommended by the research. Mathematics teacher leaders' best intentions for supporting students and teachers may fall subject to misinformation or misleading information that lead to policies and practices that, at best, do not benefit students and, at worst, do academic harm by requiring students to all learn mathematics a particular way.

Our commitments to mathematics education and students are premised on using ethical and independent research that is (a) both well-established and reflective of various fields and subfields of expertise and forms of evidence; (b) promotes the teaching and learning of mathematics as a rich, broad discipline; and (c) views students as having multiple developmental trajectories, competencies, knowledge bases, and accompanying identities that promote positive relationships to mathematics and its use in daily life for their own long-term educational goals. The adoption of mathematics education legislation, policies, curriculum materials, and/or institutional teaching practices should not rely exclusively on practices that are labeled "scientific" without a critical questioning and review of the findings. Over the decades there are many examples of the misuse of research or the misinterpretation of research (Kooli, 2023; Reid, 2016; Zeichner & Conklin, 2016), which can lead teacher leaders and policy makers to make faulty decisions. This misinterpretation and misuse of research cannot persist. NCSM: Leadership in Mathematics Education calls for all mathematics teacher leaders, no matter their role, context, or years of experience to take a stand against the mis-application of research.

Background

For as long as mathematics has been taught in schools, it has focused on students using teacher-demonstrated procedures to produce correct calculations to prescribed problems (Cobb et al., 1992; Hiebert, 2013). And for just as long, many students have been bored and frustrated in mathematics class and many parents have been at a loss for how to support their children's mathematics learning. It is not surprising, then, that a recent survey found that mathematics was the subject in school that most needs an overhaul (Global Strategy Group, 2023). A majority of parents and teachers surveyed want mathematics to be more relevant to the real world, more useful, and more focused on creative problem solving. They want a change from mathematics instruction that narrowly focuses on following procedural steps to correct answers.

In addition to students understanding concepts and developing fluency with procedures, a more expansive vision of school mathematics also focuses on supporting students in:

- developing forms of reasoning that are fundamental to mathematics;
- developing a positive mathematics identity;
- being able to use mathematics in purposeful ways in their lives; and
- appreciating mathematics as an expression of creativity and humanity.

In the 21st century, such a vision has been repeatedly endorsed by mathematics educators, leading mathematics education organizations, and mathematicians nationally (Common Core State Standards Initiative, 2010; National Council of Teachers of Mathematics, 2000; National Research Council, 2001). And yet, there are some who advocate for maintaining the traditional narrow focus of school mathematics.

Again, instances of the misinterpretation or misuse of research continue today, often with the claim that their findings are "research-based" or "evidence-based." Recently, and as just one example, a small group of researchers in special education and school psychology claim to represent what they call the "science of math." In media pieces, a website, and several articles, those scholars, under the banner of "science of math," have advocated for teaching strategies they describe as "evidence-based" (Codding et al. 2023; VanDerHeyden et al., 2021)—that is, "objective evidence about how students learn math" (The Science of Math, 2025). The use of the term "science" holds sway in the general public's understanding of what is valued in mathematics education and research and builds off the recent media attention to the Science of Reading. There is evidence supporting *some* of the "science of math" claims. But to appropriately interpret that evidence in context, it is important to understand a number of aspects of the effort: (a) its origins, which are distinct from the Science of Reading; (b) its practices for engaging with the research base; (c) the nature of the research from which its supporting evidence is cited and the implications for what school mathematics can be; (d) the vision of school mathematics it promotes; and (e) the application of pedagogical recommendations to complex ecosystems of schools.

Summary of Key Points

1. The "science of math" is not equivalent to the Science of Reading as an established body of research with respect to multidisciplinary expertise.
2. The "science of math" has engaged in misleading research citational practice.
3. The "science of math" does not reflect the education research base with respect to relevant forms of evidence and forwards a narrow view of the goals and possibilities for school mathematics.
4. The "science of math" elevates an impoverished pedagogical approach to the exclusion of all other forms of teaching.
5. The "science of math" ignores the full complexity of learning environments and learners faced by teachers and school leaders, providing a one-size-fits-all answer.

The Origins of the "Science of Math"

Those who initiated the "science of math" (SoM) effort took inspiration from the Science of Reading (Codding et al., 2023), which gained media popularity from the podcast *Sold a Story* (American Public Media, 2022), spurring local action among school districts. And SoM arguments have attracted media attention in part because of a perceived parallel with the Science of Reading. However, what is being promoted as the "science of math" is not connected to or equivalent to the Science of Reading.

The Science of Reading is a highly interdisciplinary body of research on the process of learning to read, accumulated over decades (Shanahan, 2020; Snowling et al., 2022). In contrast, SoM began as a website during the COVID-19 pandemic (Otten, 2025), which, as of the date of this statement, lists 13 "founding advocates"—11 university researchers (9 in special education, 2 in school or applied psychology) and 2 education consultants. Like research on reading, mathematics development is studied in a variety of fields, including mathematics education, anthropology, the learning sciences, developmental psychology, cognitive science, neuroscience, and mathematics; yet, SoM founders include scholars from none of these fields.

The Misleading Citational Practices of the "Science of Math"

Given that the SoM website advocates for the use of high-quality research to guide teaching, it is important to call attention to their citational practices to make sense of how they establish their claims for best practices in mathematics teaching and learning. These citational practices include mischaracterizing, misrepresenting, or overgeneralizing prior research on the SoM website and on the handouts designed for teachers. Table 1 provides four examples of claims on the SoM website, the sources cited as supporting those claims, and what was actually reported (or not) in those sources.

Table 1
Examples of misleading or inaccurate citations of SoM website

Claim from the SoM website	From the cited source(s)
"Timed tactics improve math performance" (citing Tsui and Mazzocco, 2006)	*Ignores differences in findings with respect to sample subgroups, in this case, girls:* "girls were less accurate during timed testing relative to their own untimed performance" (Tsui & Mazzocco, 2006, p. 8)
"Explicit instruction is effective for all students and increases creativity" (citing Alfieri et al., 2011; Doabler et al., 2015; Heijltjes et al., 2014; Morgan et al., 2015; Stockard et al., 2018).	*Cites only some findings, omitting others from the full study:* Alfieri et al. (2011) found "outcomes were favorable for enhanced discovery when compared with other forms of instruction" (p. 1). Doabler et al. (2015) "did not find that the frequency of teacher models or demonstrations—that is, teachers showing students what they expected them to be able to do—was associated with achievement gains" (p. 323). Morgan et al. (2015) found that for students without mathematical difficulties, the effects of "student-centered" instruction were equal to or slightly larger than those of "teacher-directed" instruction. *Overgeneralizes from a different discipline, different age group, in this case an adult, undergraduate business education class:* cites Heijltjes et al. (2014), a study of the impact of including an additional 15-min video and practice tasks on critical thinking among economics and business education students at a Dutch university. *Misrepresents a study's focus:* None of the five sources cited reported anything about the impact of explicit instruction on creativity.
"To help students achieve math proficiency, teachers should use multiple approaches to meet the needs of students; explicit instruction should be used regularly" (citing National Mathematics Advisory Panel, 2008).	*Misrepresents a study's findings or recommendations:* The claim by SoM is about all students, but the cited report was discussing students with mathematical difficulties, not all students: "Explicit instruction with students who have mathematical difficulties has shown consistently positive effects on performance with word problems and computation… This finding does not mean that all of a student's mathematics instruction should be delivered in an explicit fashion. However, the Panel recommends that struggling students receive some explicit mathematics instruction regularly" (National Mathematics Advisory Panel, 2008, p. xxiii).
"Productive struggle can lead to frustration and cause students to develop misconceptions" (citing Brown & Campione, 1994).	*Mischaracterizes authors' interpretation, in this case framing misconceptions as a problem as opposed to an asset for learning. Also, overgeneralizes from a different discipline, in this case biology:* "Children 'discovering' in our biology classrooms are quite adept at inventing scientific misconceptions… We encourage teachers to see these common problems as fruitful errors, way stations on the route to mature understanding that they can manipulate and direct in useful ways" (Brown & Campione, 1994, p. 263).

The Nature of the Research Cited as Evidence of the "Science of Math"

The pursuit of a full range of school mathematics goals requires multiple kinds of research methods and forms of evidence. There are many questions to ask about how children are learning and developing in their mathematics classes. We may want to know about students' memorization of multiplication facts, conceptual understanding, student motivation, or student identity development in mathematics, to name just a few. For each question, the research methods would be different. Some aspects of school mathematics are well suited for quantitative research methods, but many aspects can be investigated only qualitatively (e.g, by talking to or observing learners) or through mixed methods, which integrate both quantitative and qualitative methods. However, as of the release of this position paper from NCSM, nearly all of the research cited by SoM is quantitative in nature.

This over-emphasis on quantitative methods stems from SoM's alignment with the long-standing agenda of the Institute of Education Sciences and its *What Works Clearinghouse* (WWC), which promotes only studies that quantitatively "identify the effect of [an] intervention on outcomes" (What Works Clearinghouse, 2022, p. 14). Such a narrow definition of "evidence" distorts what is viewed as "scientific" and ignores most of the research on the learning, teaching, and experiencing of mathematics. For example, positive mathematics identities are not the result of "interventions"; they emerge, evolve, and perhaps solidify over time in relation to one's other identities and one's experiences with and interactions around mathematics. To study such a highly contextualized process requires methods that are beyond what are promoted by the WWC and SoM. Furthermore, the bulk of SoM-endorsed research focuses on testing "interventions" with individual or small groups of students, with almost no studies of whole-classroom environments.

Another consequence of SoM's narrow definition of research and evidence is that it focuses almost exclusively on what "works" at raising scores on standardized measures of achievement. Such tests primarily assess fluency with procedures, with far less emphasis on conceptual understanding and very little, if any, attention to other goals of school mathematics. Focusing only on what is easily measured limits what is possible for children in school mathematics, over-emphasizing knowledge of facts and procedures and failing to honor the richness of what it means to do, use, and benefit from mathematics in one's life. As former Mathematical Association of America president Francis Su argued, "[a] grander, more purposeful vision of mathematics would tap into the desires that can entice us to do mathematics as well as the virtues that mathematics can build" (Su, 2020, p. 11).

A Closer Look at Explicit Instruction Promoted by the "Science of Math"

Accompanying its limiting view of mathematics is SoM's singular pedagogical focus on "explicit instruction," in which a teacher provides a "step-by-step explanation on how to work a math problem" and then opportunity for students to practice what was demonstrated, all supported by the teacher's questions, eliciting of student responses, and corrective feedback (The Science of Math, 2025). Teacher demonstration is well-suited for supporting students' mathematics learning in a number of ways, such as sharing mathematical conventions (e.g., definitions, standard algorithms, representations), offering additional solution strategies, or challenging an incorrect consensus among students (Chazan & Ball, 1999; Hiebert et al., 1997; Lobato et al., 2005). But if children are to develop forms of reasoning that are fundamental to mathematics, engage in creative problem-solving, and use mathematics in purposeful ways in their lives, then they must, with appropriate scaffolding, have opportunities to explore, experiment, and tinker. To reach these goals, many experts in the science of learning and development (Darling-Hammond et al., 2020) advocate for a mix of approaches with an asset-based view of children at the center, led by guided inquiry, with teacher demonstration in a supporting role. Yet, SoM promotes explicit instruction as the only "evidence-based" method of teaching mathematics. In other words, while explicit instruction does have an evidentiary basis, this pedagogical approach is far from comprehensive when considering the full landscape of research in mathematics education.

The Mischaracterization and Minimization of Alternatives to Explicit Instruction

SoM repeatedly mischaracterizes inquiry-based instruction as unassisted discovery of mathematics concepts and procedures. Mathematics learning with no or minimal guidance by the teacher is a caricature of inquiry-based instruction—a caricature upon which the SoM relied to make their argument. For more than 30 years, both mathematics and science educational research have been advocating for *guided inquiry*, in which teachers provide structure and support in well-designed inquiry-oriented activities (Brown & Campione, 1994; Mayer, 2004; Hmelo-Silver, 2007). Guided inquiry is more effective than either explicit instruction or unassisted discovery learning (Alfieri et al., 2011). A more complete analysis of research on mathematics teaching and learning finds a more complex picture of the efficacy of different pedagogies, with evidence supporting positive learning outcomes from both approaches, but stronger outcomes for conceptual understanding with guided inquiry and knowledge of specific procedures from more explicit approaches (see DeJong et al., 2023 for a summary of research in STEM). Even when controlling for student, teacher, and school characteristics, students who report experiencing more inquiry-based instruction in science and math have greater interest, perceptions of utility of these subjects, and self-efficacy in science and math (Riegle-Crumb et al., 2019). In our view, and based on a broader read of the research literature, motivations for teaching and learning are not grounded solely in considerations of efficacy or "what works;" they are also informed by the implications for social relationships, the purposes and meanings of learning (in this case mathematics), and importance of seeing all children as capable and having assets and perspectives worthy of consideration and care.

Explicit Instruction as a Pedagogy of Poverty

As alluded to previously, pedagogies based on teacher demonstration have, historically, predominated mathematics classrooms. For example, an analysis of 2012 Programme for International Student Assessment (PISA) data revealed that teacher-directed instruction (comprised of lecture, repetition, and memorization) was the most frequent mathematics pedagogy experienced by students in the U.S. (as well as in every other participating country) (Echazarra et al., 2016). But research also suggests that Black and Hispanic students have been given *even less access* to grade-level guided inquiry that includes discussion and collaborative problem solving (Weiss et al., 2005). Similarly, a recent study by the RAND Corporation found that mathematics classes in low-income areas spent over 50% of the time in teacher lecture, whereas those in high-income areas allocated only 18% of the time to lecture, with more time devoted to student problem-solving and discussion (Covelli et al., 2024).

In the early 1990s, Haberman (1991) referred to the dominant instructional approach of teacher-demonstrated procedures as a "pedagogy of poverty." He detailed 14 normalized acts often associated with such teaching, such as "giving information, asking questions, giving directions," and argued:

> "Taken separately, there may be nothing wrong with these activities. There are occasions when any one of the 14 acts might have a beneficial effect. Taken together and performed to the systematic exclusion of other acts, they have become the pedagogical coin of the realm in urban schools. They constitute the pedagogy of poverty…" (p. 82)

To be clear, the kind of explicit instruction for which SoM advocates is a more refined version of the conventional mathematics teaching that most U.S. students have received through the decades, as it focuses on "unambiguous, structured, systematic, and scaffolded instruction" that is deliberate about modeling, guided practice, substantive feedback, and high-level questioning. Yet, irrespective of its quality, explicit instruction, "performed to the systematic exclusion of other acts," fundamentally minimizes learners' autonomy, relegating them to primarily following and mimicking their teacher. Under current conditions, we need to re-engage students in mathematics. Recommitting to pedagogies of the past that fail to recognize all learners' assets is not a solution to the complex problems mathematics teachers face today.

Finding Solutions That Meet Today's Complex Problems

SoM oversimplifies the problem in mathematics education as low standardized test scores alone and offers explicit instruction as their primary solution. This one-size-fits-all solution belies the complexity of learning environments and learners in our schools, as well as the complex instructional approaches in mathematics. Much of the research on explicit instruction in mathematics is in small group intervention settings and moves at a deliberate pace (Gersten et al., 2025, p.3). There is little guidance for how such practices scale, particularly how these studies could be applied to entire schools. Explicit instruction is designed to meet students exactly where they are in terms of prior knowledge, thus implementing it in current general education classrooms with students at a wide variety of skill levels would be challenging. Might implementation of the goals of SoM result in more tracking and increased segregation of students who need more support? In addition, there is little research on explicit instruction on the mathematical content of secondary mathematics, even for older students with mathematical difficulties (Stevens et al., 2018). Thus, there has not been sufficient research in implementation for policy makers to rely on SoM to the exclusion of other approaches. More research is needed.

Research in mathematics education has certainly not provided a single answer to these complex questions but does offer ecologically valid research such as design research and programmatic research. For example, The Learning Policy Institute (Burns et al., 2019) did a study of "outlier districts" in California that outperformed districts with similar demographics. Among multiple findings, they found that these districts implemented collaborative, inquiry-based instruction with strong support for teachers and administrators to develop understanding of the new standards. Supporting teachers to support students to learn the complex mathematics we value is not easy, and we encourage those in educational research to produce knowledge that helps mathematics educators transform mathematics in our schools.

Conclusion

In an era saturated with data, reports, and research claims, it is essential to approach information with a critical and questioning orientation. When encountering claims that challenge—or further support—what is already well-established in the research literature, it will always be good practice to scrutinize the evidence, methods, and motivations behind those claims. A visually appealing graph, a confident statistical statement, or a powerful quote can be misleading if based on selective data, weak methodology, or flawed interpretation.

So, while SoM claims to be based on an established body of research with respect to multidisciplinary expertise, much like the Science of Reading, it is not. It provides a narrow view of mathematics teaching and learning that is misleading, and exaggerates claims about the research on explicit instruction. Secondly, by using a misleading research citational practice, their statements do not reflect what is known in current educational research; it instead presents a narrow view of the goals and possibilities for school mathematics. And by elevating an impoverished pedagogical approach to the exclusion of all other forms of teaching, SoM ignores the full complexity of learning environments and learners faced by teachers and school leaders, providing a one-size-fits-all answer. If such an approach worked, schools would have done this decades ago with tremendous success.

By asking questions such as, "Who produced this research? How were the data collected and analyzed? How do the context and conditions under which the data were collected shape the findings?" and "What perspectives or interests might influence the conclusions?" mathematics leaders can make better-informed decisions and, as a result, better support the teaching and learning of mathematics in their own context. In fact, all constituents—be they students, teachers, educational leaders, families or the broader school community—deserve and are entitled to a broader, robust, and asset-based mathematics education, a request that is unanswered by the science of math effort. Thus, *NCSM: Leadership in Mathematics Education* urges educators to exercise caution and be critical consumers of research, as findings from any study require understanding the context and procedures used; data are never neutral or generalizable to every school.

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