

SUPPLEMENTAL MATH INTERVENTION: Three Modes Boost Achievement in Elementary and Middle School Learners

Math Intervention Curriculum Team, McGraw-Hill Education

Schools are under pressure to lift educational performance and graduation outcomes for all students. This brings an increased focus on educational equity—meaning every student has access to the resources and educational rigor they need at the right moment in their education, despite race, gender, ethnicity, language, disability, family background, or family income.

Many students continue to struggle with mathematics coursework at the elementary and early secondary grade levels. With national Grade 4 math proficiency reported by NAEP stalling at 40% and Grade 8 at 33%, providing equitable access to a high-quality math curriculum is critical.¹ Striving learners need to be supported with instruction that provides enrichment, remediation, and intensive intervention.

Most US schools and districts employ multi-level systems of support to afford the differentiated mathematics instruction required to address the diversity of skills in numeracy for all students entering the class. In addition, students in grades K-8 need to develop strong competency for the challenges of Algebra facing them. Math curricula must incorporate strong evidence-based, supplemental intervention curriculum programs so each student is well prepared for success in secondary math.

Containing a variety of multi-modal resources, a supplemental math intervention program can be implemented with any core instruction model, and should accommodate various learning and expression styles to support the needs of a diverse student population. The best programs align to regular instructional models, align with state standards, and enable teacher-led, independent learning, and engaging small-group activities. Supplemental intervention resources should easily integrate with various classroom implementation models, including:

- Special Education and Pull-Out Services
- Inclusion Classrooms and Push-In Services
- Blending Learning
- Personalized Learning
- Math Workshop
- Traditional Differentiation
- Homework and After-School
- Summer School

The Arrive Math Booster Experience

Research-based supplemental intervention resources, provided in print-based and complementary digital formats, provide teachers with flexible lessons and resources for grade levels K-8 to provide the instruction needed to close gaps in student understanding.

The Arrive Math Booster program was designed based on the science of learning. In addition to collaborating with math leaders and instructors, McGraw-Hill Education conducted comprehensive research in a variety of topical areas to inform the development of Arrive Math Booster.

The focused research areas include:

1. Interactive, multi-modal learning experiences
2. Hands-on learning experiences
3. Game-based learning experiences

The content and resources in Arrive Math Booster support diverse student needs within the general math classroom. The program empowers teachers with the ability to effectively differentiate instruction to close gaps in understanding early, and instill confidence in students' ability to learn and apply mathematics.

Arrive Math Booster provides teachers with a comprehensive set of lessons and activities to supplement regular core instruction, including:

- Activities that can be completed in whole group, small group or individually
- An appropriate mix of teacher-guided instruction, assignable student-driven lessons and games
- A balance between tactile, online and print-based learning moments
- Opportunities for students to make real world connections and deepen their understanding

This approach to math instruction is intended to engage learners, and provide educators with strong and easy-to-implement tools to ensure equitable access to mathematical concepts and application.

Interactive, Multimodal Learning Experiences

A multimodal learning environment uses two modes—verbal and non-verbal—to present information to students, together with graphic representations that are directly relevant to the concept/skill being taught.² Multimodal supports can also take the form of gesture, physical manipulatives, virtual manipulatives, or kinesthetic activities.

According to university researchers Moreno and Duran, the most effective learning environments combine verbal and non-verbal representations of knowledge, and use a combination of visual and auditory inputs.³

In addition to a robust and well-known body of scholarly research—most notably by Richard Mayer and colleagues—the NCTM (National Council for Teachers of Mathematics) endorses the inclusion of visual and graphic depictions of problems as one of several key strategies to support struggling learners. This accompanies the more traditional use of verbal information in math learning contexts.⁴

Research shows that in addition to incorporating multiple modalities, it is important that educators also provide students with opportunities for interactive learning. According to researchers Ruth Clark and Richard Mayer, effective interactive learning environments are ones in which a learner's actions determine the presentation of information or the next stage of the learning activity. Furthermore, the learner's actions should foster learning by leading to the construction of knowledge.⁵

Moreno & Mayer identified several types of interactivity:

- Dialoguing – The learner receives questions and answers or received feedback to his/her input.
- Controlling – The learner determines the pace and order of presented information.
- Manipulating – The learner sets parameters for a simulation or moves objects around on a screen.
- Searching – The learner finds new content material by entering a query, receiving options, and selecting an option.
- Navigating – The learner moves to different content areas by selecting from available information sources.

In addition, key findings from NAEP report achievement gains among fourth grade and eighth grade students who reported working in pairs or small groups, with higher math scores than peers who did so less frequently.⁶

Multimodal learning in Arrive Math Booster

Multimodal learning opportunities are afforded within every Arrive Math Booster lesson. Each skill development area within a single standard offers a lesson that includes a “Take Another Look” digital mini-lesson, and a “Guided Support” small-group, hands-on mini-lesson.

Students experience a combination of verbal, nonverbal, visual, and kinesthetic cues throughout the lesson, when educators opt to use both parts of the lesson. Below is a table summarizing the modalities prevalent in each section of the lesson:

Component	Verbal	Non-Verbal	Graphics	Physical Manipulatives
Take Another Look				
Guided Support				
Game				

Hands-on learning experiences

It is important for students to gain opportunities for hands-on, tactile learning experiences in the math classroom. Educators can use manipulatives and concrete examples to develop each learner’s understanding across a continuum of concrete, representational and abstract reasoning skills. Manipulatives can be used both in physical form and through digital applications.

Providing manipulatives and tasks that feel familiar and applicable to the world outside the classroom can also help learners connect disparate concepts, especially those that are more abstract. This holds true for all learners, but is particularly important for struggling learners and striving students who have low self-efficacy or anxiety with math.⁷

When students are provided with learning opportunities that involve manipulatives, they often report higher levels of interest in math. Studies show that this higher interest level often correlates with improved performance as students progress through school.⁸

Hands-on learning in Arrive Math Booster

For students identified as requiring additional teacher-led support, a “Guided Support” activity is provided in each lesson. During Guided Support, students participate in a hands-on activity with the guidance of their teacher. Guided Support activities incorporate manipulatives and everyday classroom objects, and can be facilitated with an individual student or in a small group.

To reinforce and supplement Arrive Math Booster instruction, teachers can use the Arrive Math Games Kit. The kit offers 54 unique, manipulative-based and board games that align with K-8 state standards, allow students to engage in mathematical discourse, and practice fluency for critical math skills.

Game-based learning experiences

Research shows that games can help all learners, regardless of ability. However, games can be especially beneficial for struggling learners. This is because some of the task-related anxiety of mathematics appears to be diminished when games are incorporated into instruction, as when supplemental resources are applied to complement regular math instruction.

For learners who generally approach math with difficulty or discomfort, math games provide a more engaging—and less intimidating—context for introducing and practicing new skills. Some researchers believe the boost in learning outcomes from the incorporation of games is rooted in this engagement factor. In other words, the impact on motivation and engagement alone can explain much of the positive impact from games.⁹

While there are some inconsistencies in the literature with respect to the effectiveness of game-based learning on its own, when games are combined with other modes of instruction they appear to improve—rather than hinder—learning outcomes. Games provide students with opportunities to drive their own learning, develop problem solving skills, and receive immediate feedback. They also encourage productive struggle and persistence in the face of temporary setbacks, according to the NCTM.

As researchers continue to explore the complexities and specific design features that optimize game-based learning, the most effective way to implement games is in combination with other more traditional and research-based approaches.

Gamification in Arrive Math Booster

Arrive Math Booster leverages purposeful game play to engage students and build their understanding of critical math skills. Along with the instructional materials in the program, 54 games afford practice for the most critical math skills required in each grade level. As the leading research recommends, games in Arrive Math Booster are incorporated into instruction, together with other methods of instruction such as explicit teacher-driven modeling, and student-driven guided practice.

Arrive Math Booster leverages game-based learning in several areas of the lesson model including:

- **Guided Support:** With the support of a teacher, students may engage in a game-based activity during the Guided Support section of the lesson.
- **Games Kit:** The Games Kit offers 54 unique, board games that align with kindergarten through eighth-grade content standards, and allow students to practice foundational skills and improve conceptual understanding. Each game includes support for the teacher to facilitate classroom discussions focusing on the connections between game play, and the math concept being practiced.

Summary

School leaders today require progressive curriculum resources to raise the level of equitable instruction and access, and support student achievement objectives.

For students who have fallen behind, curriculum resources are needed to supplement primary math instruction, allow educators to deeply differentiate instruction, and increase students' ability to access on-level learning and gain higher outcomes.

Finding well-packaged, research-based classroom resources that support educators in differentiating and scaffolding instruction effectively is challenging, until now.

The Arrive Math Core Booster supplemental intervention program provides teachers with resources to meet every student at their level. It provides the appropriate amount of intervention each striving learner needs to become a successful, confident mathematician.

With strong curriculum support for 1) Interactive, multi-modal learning experiences, 2) Hands-on learning experiences, and 3) Game-based learning experiences, Arrive Math Booster is proven to be beneficial in remediating knowledge gaps, providing meaningful practice, and building conceptual knowledge.

The program unpacks complex standards and delivers a focus on building individual skills. Each content standard across kindergarten through eighth grade is available as a single skill set, comprising a module of instructional resources to help target and mitigate misconceptions, building knowledge to full standard understanding, and helping prepare learners for the challenges of Algebra and beyond.

For evaluation resources or to request a meeting with a curriculum expert, visit ArriveMath.com.

About McGraw-Hill Education

McGraw-Hill Education is a learning science company that delivers personalized learning experiences that help students, parents, educators and professionals drive results. McGraw-Hill Education has offices across North America, India, China, Europe, the Middle East and South America and makes its learning solutions available in nearly 60 languages. Visit us at mheducation.com or find us on Facebook or Twitter.

References

1. U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2017 NAEP Mathematics & Reading Assessments (2018).
2. Moreno, R., & Mayer, R. (2007). Interactive multimodal learning environments. *Educational Psychology Review*, 19(3), 309–326.
3. Moreno, R., & Durán, R. (2004). Do multiple representations need explanations? The role of verbal guidance and individual differences in multimedia mathematics learning. *Journal of Educational Psychology*, 96(3), 492.
4. National Council of Teachers of Mathematics (NCTM). (2007). *Effective Strategies for Teaching Students with Difficulties* (Research Brief). Retrieved from <http://www.nctm.org/Research-and-Advocacy/Research-Brief-and-Clips/Effective-Strategies-for-Teaching-Students-with-Difficulties/>
5. Clark, R. C., & Mayer, R. E. (2008). Learning by viewing versus learning by doing: Evidence-based guidelines for principled learning environments. *Performance Improvement*, 47(9), 5–13.
6. U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, National Assessment of Educational Progress (NAEP), 2017 NAEP Mathematics & Reading Assessments, 2017 Mathematics Results (2018).
7. Gundogdu, M. (2013, August). The impact of manipulatives on middle school special ED students' learning integers (M.A. Thesis). California State University, Long Beach. Retrieved from <https://search.proquest.com/openview/602a37669a4478230329f5bc5ecedd1/1?pq-origsite=gscholar&cbl=18750&diss=y>
8. Moore, S. D. (2014). Why teach mathematics with manipulatives? (ETA Hand2Mind Research Summary). ETA Hand2Mind. Retrieved from http://www.hand2mind.com/pdf/research/Why_Teach_Math_with_Manips.pdf
9. Ernest, P. (1986). Games. A rationale for their use in the teaching of mathematics in school. *Mathematics in School*, 15(1), 2–5.