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Powering Up Your Visual Learning Practice: Strategies to Help Students Succeed in Math

BY STUART J. MURPHY

Overview

Visual Model → **Explore** → **See the Math** → **Understand It** → **Apply It**

We talk a lot about visual learning, especially when it comes to comprehending mathematics. But, how often do we work to make it happen? How many of us have made visual learning part of our daily classroom practice?

Research has shown that visual learning strategies are especially appropriate to the teaching and learning of math. In the study "Seeing as Understanding: The Importance of Visual Mathematics for Our Brain and Learning, " Stanford mathematics professor Jo Boaler makes a strong case for the application of visual learning practice to the teaching of mathematics.

> Everyone uses visual pathways when we work on mathematics and we all need to develop the visual areas of our brains. The problem of mathematics in schools is it has been presented, for decades, as a subject of numbers and symbols, ignoring the potential of visual mathematics for transforming students' mathematical experiences and developing important brain pathways. (Boaler et al., 2016, p. 7)

I have heard many teachers express their support of the concept of using visual models and their awareness of its importance. At the same time, they readily indicate their frustration in knowing how to employ it on a constant productive basis.

The purpose of this paper is to highlight the importance of visual instruction in mathematics, innumerate the benefits that such instruction provides students, suggest ways in which visual learning practice can be reinforced and implemented, and provide specific strategies and examples for how to make that happen.

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Stuart is the author of the award-winning *MathStart* series, which includes a total of 63 children's books that present mathematical concepts in the context of stories for Pre-K through Grade 4. The series is published in six languages and over 12 million copies have been sold. He is also the author of *Stuart J. Murphy's I SEE I LEARN*, a 16-book series of storybooks for children in Pre-K, Kindergarten, and Grade 1 that focus on social, emotional, health and safety, and cognitive skills. Stuart is on the authorship team of a number of mathematics programs published by Savvas, including ***enVision***® *Mathematics* and a frequent presenter at educational conferences. Most of all, Stuart is an advocate of helping our children develop their visual learning skills so they become more successful students.

Part 1: The Importance of Visual Learning

In my paper, “Visual Learning in Elementary Mathematics: How Does Visual Learning Help Students Perform Better in Mathematics” (Murphy, 2006), I provide a number of reasons why visual learning is important. These include the fact that children are natural visual learners, they are able to assimilate visual information long before they have learned to read, and they readily find meaning in images. I also list a set of five visual learning skills: observation, recognition, perception, interpretation, and self-expression. In this paper, I would like to make a number of new points regarding the importance of visual learning in mathematics based on more recent research.

CHANGING READING HABITS

While speaking in 2008 at the MacWorld Expo, Steve Jobs famously announced, “The fact is that people don’t read anymore.” This was, of course, a great exaggeration, used to make a point regarding a new product introduction. People still do read. We read for information, for learning and for pleasure. Reading is an important part of our culture as literary beings.

However, there is no question that our reading habits are changing. Countless studies exist on the decline of reading habits in children and adults, why it is happening, and what might be done about it. As a follow-up to its seminal 2004 study “Reading at Risk,” the National Endowment for the Arts (NEA) published a report in 2007 entitled “To Read or Not to Read: A Question of National Consequence.” This report includes an impressive array of carefully gathered statistics regarding the decline of reading habits in the United States.

> These new statistics come from a variety of reliable sources, including large, nationally representative studies conducted by other federal agencies. Brought together here for the first time, the data prompt three unsettling conclusions:
>
> - Americans are spending less time reading.
> - Reading comprehension skills are eroding.
> - These declines have serious civic, social, cultural, and economic implications. (NEA, 2007, p. 7)

Much of this critical study focuses on reading for pleasure and the enjoyment and comprehension of stories in books, magazines and newspapers. However, these same findings relate to reading for information and instruction.

NEW DELIVERY METHODS

While we are well aware of the research regarding how our reading habits have changed, we continue to teach our children assuming they will read. Isn’t it time for us to rethink how we deliver instruction to our students? Educator Thomas West certainly feels that the time for this reconsideration is overdue.

> I believe we are now at the early stages of a major transition—moving from an old world of education and work largely based on words and numbers to a new world largely based on images that are rich in content and information. (West, 2004, p. 16)

I do not advocate for wordless texts and I strongly believe in the power of written language to express ideas. However, as we progress further into the digital age, we are acquiring a new universal “language” that is increasingly more visual. This has led to new methods of communication that can be more efficient and can help us reach a broader range of students.

As they strengthen their quantitative thinking, students at all levels more often use numbers and operations in situations across different areas of the curriculum, and not just in mathematics class.

BENEFITS OF VISUAL LEARNING PRACTICES

There are many benefits that derive from employing visual learning practice in the teaching of mathematics. While it is a challenge to consistently construct lessons that include visualizations, doing so is well worth the effort. The payoff can be huge.

Student Engagement: Visual models interest students. Students are able to “see” the math. Models provide easy entry to new concepts and ideas. They invite thinking and exploration. They help reduce math anxiety and promote positive attitudes toward math.

Comprehension: Visualizations help students to understand the math. They see what is going on and how it works. Visualizations help with problem solving and are especially useful in working with word problems.

Communication: Visuals provide ways for students to communicate their math thinking. They can show what they know. They can spot errors. They are able to manipulate and correct their models based on new thinking.

Connections: Visuals help students make connections between other areas of mathematical topics and ideas, other areas of learning, and their own real-life experiences. As indicated in *Principles to Actions* (NCTM, 2014), "An excellent mathematics program… develops connections among areas of mathematical study and between mathematics and the real world."

Assessment: Visual models created by students provide opportunities for assessment. Teachers are able to see what the student is thinking and how they got to where they are. Principles to Actions (NCTM, 2014) notes that, "an excellent mathematics program ensures that assessment is an integral part of instruction."

Creativity: The making of visual models encourages creative thinking. We want our students to be creative about math. My 2013 presentation at the National NCTM conference was entitled "From STEM to STEAM: The Critical Role of the Arts and Creativity in Elementary Mathematics Education. " I made the following point:

> We need to work together to infuse creativity—artistic expression and inventive thinking—into our everyday math instruction. Young students need to be fully engaged in creating math models, writing math stories, doodling and sketching, and using multiple means of expression to think about math. (Murphy, 2013)

Access: Visual models provide access to all students, regardless of their language capabilities and background. *Principles to Actions* supports this need. "An excellent mathematics program requires that all students have access to high-quality mathematics curriculum, effective teaching and learning, high expectations, and the support and resources needed to maximize their learning potential." (NCTM, 2014)

Jo Boaler adds to this discussion as follows:

> It seems possible that visual mathematics may contribute to equity, in valuing students' thinking in different ways, as well as encouraging deep engagement, as we have found all students to be excited to see mathematical ideas, and from there they have developed higher levels of understanding and performance. (Boaler et al., 2016, p. 10)

FUTURE WORKPLACE NEEDS

As we prepare our students for their working lives we must consider that the workplace is in a constant and rapid state of change. Part of that change is a movement toward a greater dependence on visual information.

> It seems all but inevitable that in time a great many of us will come to rely more and more on different ways of working with and understanding information—seeing patterns and trends in information in ways that were never possible before (or were limited to extraordinarily gifted visual thinkers alone). With these changes, a whole new set of visual talents will come to be highly valued—just as many capabilities that are now highly valued will come to be seen as associated with obsolescent technologies and will be valued less and less over time. (West, 2004, p. 16)

Part 2: Visual Learning/Visual Thinking

As we work to develop a new visual learning environment, we need to consider the relationships between visual learning and visual thinking, and between visual learning and other learning styles.

VISUAL THINKING

In 1916, Albert Einstein stated, "I very rarely think in words at all." (Wertheimer, 1959) Much has been written about Einstein's tendency to think visually and to work on problems from a totally visual perspective. The very title of Thomas West's book, *Thinking Like Einstein*, which I have quoted extensively in this paper, suggests that we promote in our children the ability to think visually.

LEARNING STYLES

Kinesthetic learning and experiential learning are by nature very visual. The use of manipulatives in the learning of math is considered crucial. It involves learning by doing and seeing. Once again, I quote Jo Boaler on this important point.

> Good mathematics teachers typically use visuals, manipulatives and motion to enhance students' understanding of mathematical concepts, and

> the U.S. national organizations for mathematics, such as the National Council for the Teaching of Mathematics (NCTM) and the Mathematical Association of America (MAA) have long advocated for the use of multiple representations in students' learning of mathematics. (Boaler et al., 2016, p. 2)

This overlap in learning styles suggests that we must be careful to not overly categorize learners. Columnist Laura Otis makes this point in her blog post, "A New Look at Visual Thinking: Creative Ideas Emerge When Visual Thinking Meets Verbal Communication." Otis observes, "New research indicates that we need to move beyond categorizing people as 'visual' or 'verbal' and consider the many different mental processes that visual thinking involves." (Otis, 2016, p. 1)

TECHNOLOGY

The relationships between learning styles becomes even more pronounced when we think about the many technologies that are available to us as educators and to our students. Children now have access to videos, digital games, websites, and many other media where the thinking and learning is visual, verbal and experiential all at the same time. *Principles to Actions* specifically calls for excellent mathematics programs that "integrate the use of mathematical tools and technology as essential resources to help students learn and make sense of mathematical ideas, reason mathematically, and communicate their mathematical thinking." (NCTM, 2014)

GIVE AND TAKE

As we consider what visual learning entails, we need to remember that it isn't just a one-way communication process. It is a give and take. It is about analyzing and understanding visual models—the take. And it's about communicating ideas to others through visuals—the give.

Visual learning is about acquiring and communicating information through visual representations. It is about making sense of complex data using visual models. Teachers need to use visual models in presenting mathematical concepts to students, and students need to use visual models to express their thinking about mathematics.

Part 3: Implementation

Having considered the current state of visual learning practice in our schools, we must now decide what to do about it. How do we put all this to work? What steps can we take to make the use of visual learning strategies, gaining all the benefits that doing so would provide, part of every math teachers daily classroom practice?

One way to assure that outcome would be to encourage math educators to teach in an intentional way and carefully plan to integrate these strategies into their lesson plans.

INTENTIONAL INSTRUCTION

In her important book, *The Intentional Teacher: Choosing the Best Strategies for Young Children's Learning*, Dr. Ann Epstein (2007) promotes a carefully developed five-step framework for intentional instruction. These steps include:

1. Establish the purpose.
2. Model thinking.
3. Guide student thinking by the use of questions, prompts, and cues.
4. Provide learning tasks for small group work and practice.
5. Provide independent assignments that require students to apply what they have learned.

In the early stages of developing such a plan, the employment of visual learning strategies to achieve these goals should be fully considered. Doing so may be the best way to reach your students and inspire their thinking. And this must be carefully and thoroughly planned. As Epstein notes, "To be intentional is to act purposefully, with a goal in mind and a plan for accomplishing it." She remarks elsewhere, "Intentional teaching does not happen by chance." (Epstein, 2007, pp. 1, 5)

OPEN-ENDED LEARNING

When preparing to use visual learning strategies, as with all teaching, it is important to consider how to keep the process open-ended and experiential—to provide critical teacher support while allowing students to learn by exploration and developing their own questions.

In a recently published paper, "Problem-Based Learning: Supporting Productive Struggle," Dr. Randall Charles highlights the importance of providing students with the opportunity to openly explore their ideas when solving math problems.

> Many teachers do not feel comfortable with the need for students to cognitively struggle to develop understanding. As a result, they use questions and comments that direct students' thinking and work; they might suggest a particular strategy or ask a specific question that tells students what to think and do. In other words, by trying to help, teachers reduce the complexity of the thinking required to solve the problem. As a result, teachers are making the key connections among ideas; connections that students should be making themselves in order to develop understanding. (Charles, 2018)

Thus, an effective way to use visual learning strategies in the teaching of mathematics is to carefully plan to do so from the very start. Epstein states, "Intentional teachers use their knowledge, judgment, and expertise to organize learning experiences for children." (2007, p. 1) And, the best way to employ such strategies is to keep them open, allowing for student enjoyment, experimentation and discovery.

PROJECT-BASED LEARNING

We also must consider the power of creating projects to develop mathematical thinking. Projects are typically multi-disciplinary. They often involve researching, planning, thinking, problem solving, representing, and presenting mathematical ideas. They typically relate to how we use math in real-life situations. And, they can be constructed as individual or group activities, and can be done at home or in school.

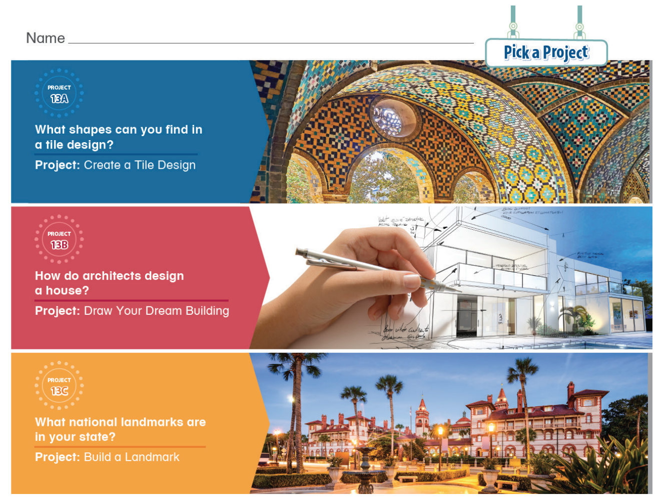
In *"It's a Project-Based World,"* John Larmer of the Buck Institute of Education makes this point: "When students engage in project-based learning over the course of their time in school, there's an accumulating effect. They feel empowered. They see that they can make a difference." They are also more likely to acquire the skills, knowledge, and attitudes useful for their success in college and in a career. (Larmer, 2016)

Many existing resources offer recommendations for rich projects. High among these are the books created by Catherine Kuhns, National Board Certified teacher and Presidential Award-Winner for Excellence in Mathematics and Science Teaching. Importantly, these projects have been tried and perfected and they are published, ready for use.

VISUAL LEARNING STRATEGIES

Following are a number of specific classroom strategies that will take advantage of and further develop the visual learning capabilities of your students.

- Work together to build visual models that bring learning to life. Use multiple modalities, such as print, video, animations, etc., to present intriguing problems that can be completed by individuals or in small groups at school or at home.



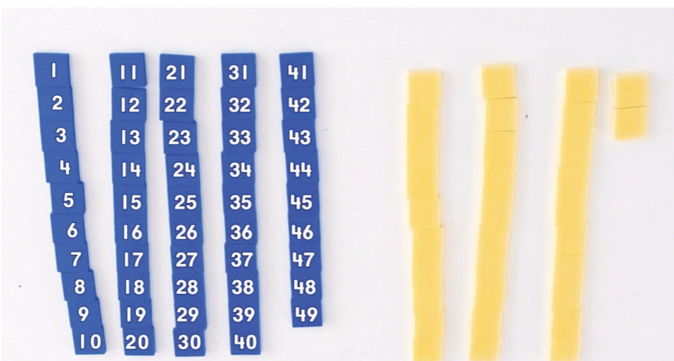
Source: ***enVision***® *Mathematics ©2020, Grade 2, Topic 13, p. 559 (Charles et al., 2020).*

Figure 1. Pick a Project

- Start a new math concept with a provocative visual. Have it on display when students enter the classroom. Encourage discussion before delving into the topic. See where students take it.

Source: ***enVision***® *Mathematics ©2020, Grade 1, Topic 13, p. 520 (Charles et al., 2020).*

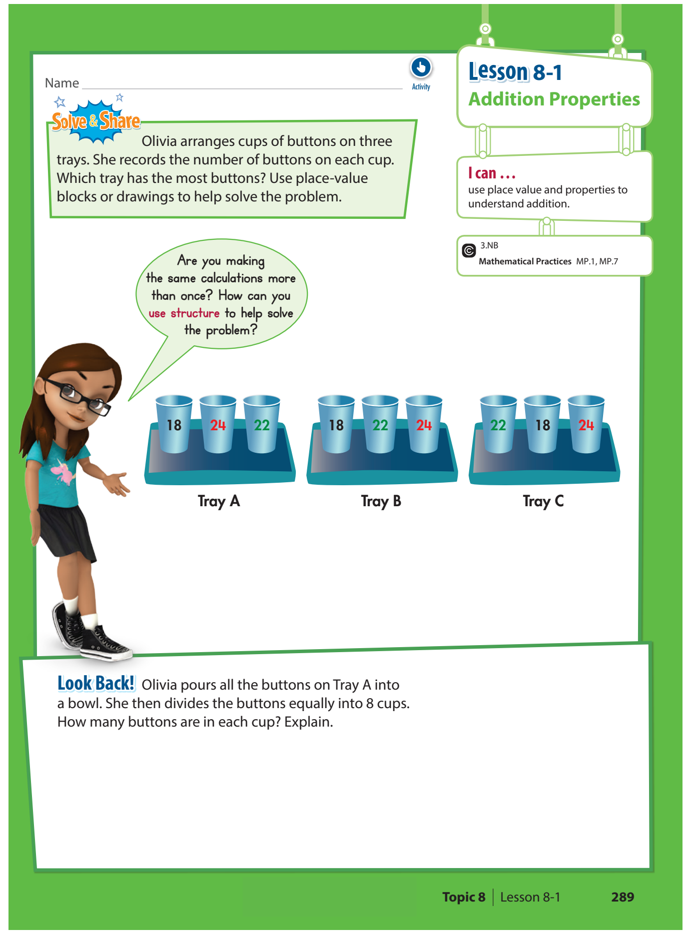
*Source: **enVision**® Mathematics ©2020, Grade 1, Topic 15, p. 608 (Charles et al., 2020).*



*Source: **enVision**® Mathematics ©2020 (Charles et al., 2020).*

Figure 2. 3-Act Math Tasks

- Create or have students create materials that help to explain math ideas. Post these and reference them in your daily practice. Encourage children to look at them and talk about them.

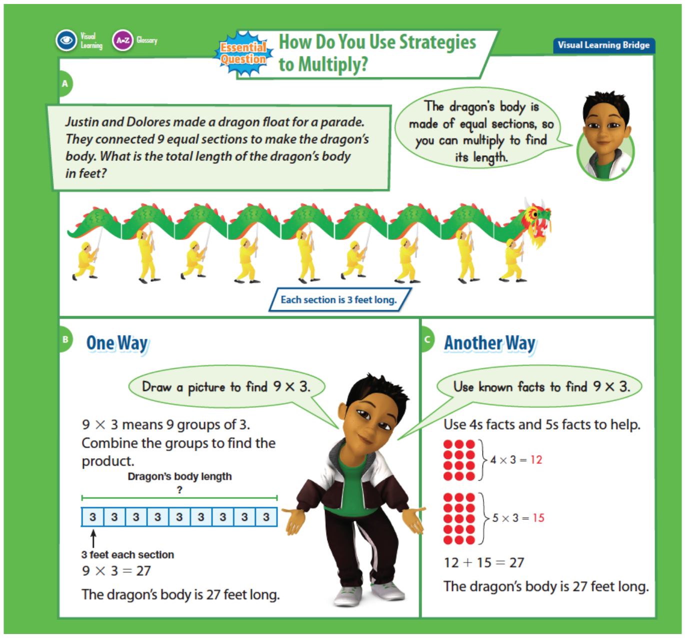


*Source: **enVision**® Mathematics ©2020, Grade 3, Topic 8, p. 289 (Charles et al., 2020).*

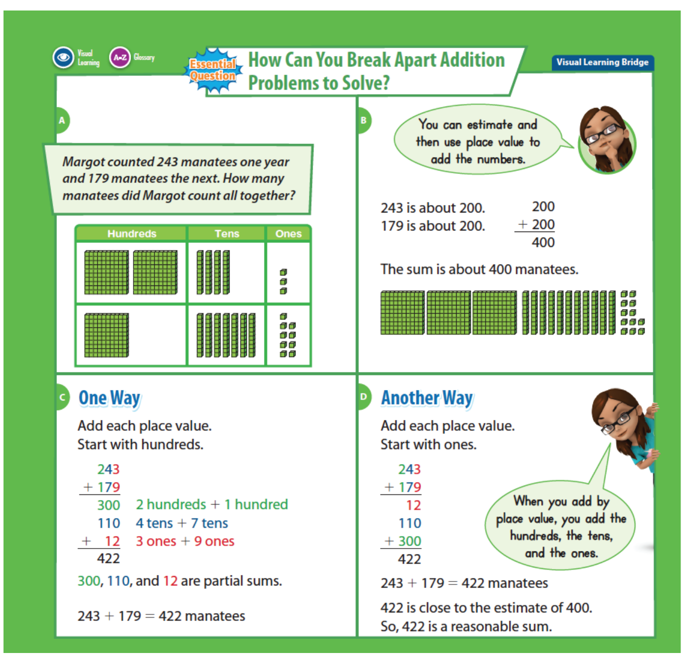
Figure 3. Solve & Share

- Show a new math concept as a progression from the concrete, a picture or photo of what is being described, to the abstract, a mathematical expression of the concept.
- Present a totally visual lesson—no words or numbers. Check out the video of Matthew Peterson, CEO of Mind Research Institute, doing his much-watched TEDx Orange Coast presentation, "Teaching Math without Words: A Visual Approach to Learning Mathematics." (TED, 2011)

- On field trips and in the playground, stop to examine things that you see. Have students describe the mathematical attributes of those things. Encourage them to use math language, such as *symmetrical, parallel, perpendicular, fewer than/more than,* etc. Help them to see patterns and to discover what makes those things what they are. Ask them to keep journals of their findings.



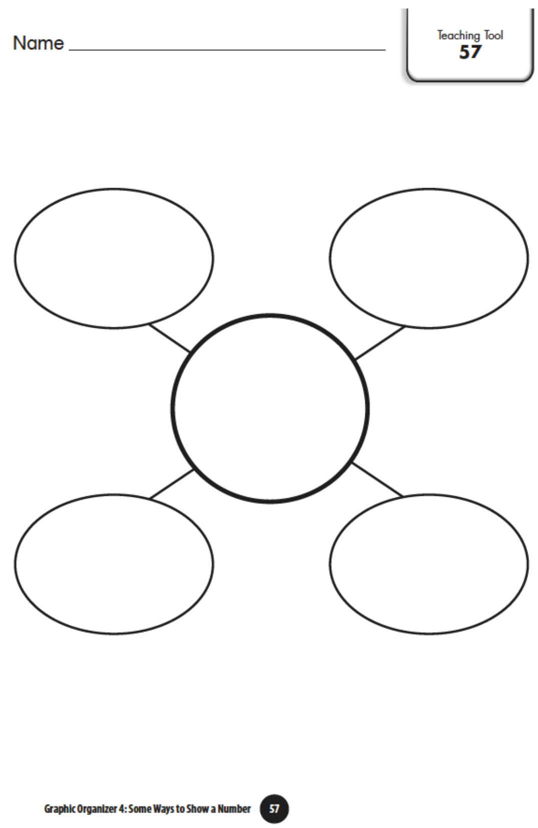
Source: ***enVision***® *Mathematics ©2020, Grade 3, Topic 3, p. 94 (Charles et al., 2020).*



Source: ***enVision***® *Mathematics ©2020, Grade 3, Topic 9, p. 338 (Charles et al., 2020).*

Figure 4. Visual Learning Bridge

- Ask students to find real-life examples of things they are learning about in mathematics. Suggest that they work with their families to take photos, clip pictures, or make drawings that relate to those things and to share those with the class.
- Encourage students to scribble and sketch as part of their ongoing note-taking process. Demonstrate how to use sketches to help solve word problems.
- Help students make connections between ideas by working with them to create concept maps and diagrams. Connect ideas within mathematics, links to other subjects, and relationships to real-life experiences. (See Appendix, Item 5: Graphic Organizers)



Source: ***enVision***® *Mathematics ©2020, Grade 2, Teaching Tool 57, Graphic Organizer 4: Some Ways to Show a Number (Charles et al., 2020).*

Figure 5. Graphic Organizers

Conclusion

The case has been made—by me and by those educators I have quoted in this document. Countless other research studies and opinion papers have been published on this topic. The evidence is clear. In order to address students today, to engage and inspire them about mathematics, to help them succeed in the study of math, and to prepare them for higher levels of education and the workplace, we must aggressively adopt a more visual approach to the teaching of mathematics.

We need to understand the value of visual instruction in mathematics, consider its many benefits, understand the relationships between visual learning and other learning styles, and systematically plan to employ visual learning practice in our work. The need is urgent. It is now our job to make it happen.

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