Language, Actions, and Learning Math

When I was a new teacher, language and actions weren't what I thought about first when providing math for my students with disabilities. Typically, I thought about which game or activity I would pull from my cupboard. As I look back, language and actions were precisely what I needed to think about. Language and active learning play major roles in solid math instruction. Language supports thought; active learning builds understanding. Learning math requires talking, thinking and doing. Solving a problem requires talking, thinking and doing.

I was under the wrong impression that math was all about memorization. I thought if my students memorized numbers, shortcuts and tricks, they would somehow find math useful in the real world and know how to apply it, especially if it involved a calculator. I thought if my students heard me say it, it was the same as my students saying it, doing it and understanding it. Little did I know that memorizing and shortcuts are not the substance of math; they're just nice to know once the math concepts are learned.

My students needed to actively learn and understand math concepts well enough to solve problems. Only then would math be useful to them. Only then could they use a shortcut like plugging numbers into a calculator or using memorized facts to solve a problem. The experience of using hands-on, multi-sensory materials to learn math concepts, language and actions is well-worth the effort, as it allows teachers the opportunity to find students' math potential and guide them as far as they can go.

Misperceptions about math, math instruction and access to math prevail to this day. There are many myths that have misguided our instruction for decades.

These myths include:

- Students need to learn a limited set of isolated math skills, defined as 'functional' skills, without learning pre-requisite skills.
- Students with disabilities require highly specialized 'methods' to learn, created only for students with disabilities, which focus on memorized responses not based on math.
- Differences in students with disabilities justify differences in math instruction.
- Math can be taught with only games or worksheets.
- Teachers need to teach the same skills to students with disabilities until mastered.
- Math is not connected.
- Problems can be solved in the real world with just a calculator by simply plugging in the numbers.
- Being good at math is a gift that only some people have.
- Math needs to be done quickly.
- Mistakes in math are only useful for determining weaknesses in skill and understanding.

These practices have brought on negative results, including splinter skills, little or no progress in math goals on Individual Education Plans (IEPs), a lack of confidence, low expectations and an inability to solve problems encountered in the real world. With

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few or no prerequisite skills taught, students learn a lot less math than their potential suggests they can learn.

The collective knowledge gained in the last decade regarding how we learn, how our brains work and what children with disabilities can do has had a very positive impact. Take-aways from that knowledge have influenced teachers in general and special education in how to think about math instruction and students with disabilities. Here are a few examples:

1. Math is connected within and between content areas in a comprehensive view.
2. When we make connections, we learn.
3. Multi-sensory, hands-on math instruction increases active learning and builds understanding.
4. Having language supports and influences thought.
5. Students with disabilities can and do learn math.

1. MATH IS CONNECTED.

When you carefully look at the National Council of Teachers of Mathematics (NCTM) Content Areas in mathematics (numbers and operations, geometry, measurement, algebra, and data and probability) it quickly becomes apparent that math content areas are connected. This is important because learning the system of numbers acts as a support for math learners and their understanding of mathematics across math content.

On a basic level, for example,

- I can make sense of a dial scale and a ruler (measurement) or a graph (data) more easily if I understand number order and comparisons (numbers and operations)
- When I solve a missing addend equation (numbers and operations), I can't help but think about an unknown represented by a letter in an equation (algebra).
- I can multiply amounts (numbers and operations) in an input-output table and find a number pattern (algebra)
- When I measure perimeter or area, I am applying skills I learned in measurement and geometry.
- I determine which shape is a hexagon and which is an octagon (geometry) when I know how to count the number of sides (numbers and operations)

It is important to note these connections within a curriculum are maximized when all math content areas are complete, with skills placed in a sensible order and pre-requisites included.

2. WHEN WE MAKE CONNECTIONS, WE LEARN.

Making connections matter in new learning and memory as it allows students to use math flexibly in their real-world experiences. Students connect what they know with what they are learning, their past experiences with new experiences, their math knowledge with real-world examples and known vocabulary with a new application of a learned vocabulary word. When lesson objectives are ordered specifically to support subsequent skills, the idea of making connections is utilized to support students by providing necessary pre-requisite skills and connecting them to new knowledge.

This is the very reason a well-constructed curriculum is useful and effective. We learn math over time, not in a vacuum specific to single skills requiring mastery. When a comprehensive curriculum is present, students build and learn math knowledge across lessons within and between content areas with specific, connected lesson objectives.

3. MULTI-SENSORY, HANDS-ON ACTIVE LEARNING IS ESSENTIAL.

Multi-sensory instruction is very useful for many reasons. Students are more engaged when they use a variety of tools, manipulatives, and points of view. Learning is experienced in multiple ways by increasing the modes of learning, positively affecting memory and recall.

Hands-on instruction in math allows students to visualize a problem and move objects around to make sense of it and try ways to solve it. Representations provided, such as concrete, semi-concrete, and abstract materials, are recommended for all students regardless of ability or age. In the learning sequence from concrete to abstract, students are shown, and then use, a concrete view with manipulatives, a semi-concrete view with drawings, picture symbols, photos, or cards and an abstract view with numerals and symbols. It is a commonly accepted practice in general education mathematics to utilize these representations to deepen understanding and assist in problem solving. These opportunities move students from passive learning to active learning experiences, which help anchor students in their understanding of math concepts.

4. HAVING LANGUAGE SUPPORTS AND INFLUENCES THOUGHT.

Language plays a large role in how and what we think. It is a significant part of learning when students begin to form thoughts about what is being learned. Emphasizing acquisition and the means of language access is a clear priority for students with disabilities, for both receptive and expressive language. Learning and understanding vocabulary is a staple of education as it has been proven to increase achievement.

To take advantage of this connection to learning, students need to have access to express their ideas, thoughts and answers about what is happening in math class. Many students also require a substantial reduction in the amount of language used

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to explain a problem, vocabulary meaning, or a math concept because they need more time to process information. This places more importance, then, on modeling actions and strategies using objects, tools, pictures or drawings to demonstrate solving a problem or depict the meaning of a math concept or vocabulary word. It also requires the opportunity for students to process the information and to have it repeated over time.

5. STUDENTS WITH DISABILITIES CAN AND DO LEARN MATH.

It is very hopeful and helpful to know that research indicates humans are born with math knowledge. Often, I have heard teachers talk about their students' abilities in terms of a specific developmental age. I never quite understood what that meant for my own students. When developmental ages are used to indicate potential, it can appear as a limitation of expectations, as opposed to a starting point for growth. We must be cautious when our views or practices reduce our expectations of what students can do, as research has shown raising expectations increases the probability of success. Lower expectations reduce opportunities for learning. However, when I increase my expectations, I eagerly put more in place for my students to learn.

In this age of testing and data collection, teachers need to remember to truly teach within multiple, meaningful learning opportunities. Quality math instruction is a strong indicator of success. Students should be supported and taught with models and guidance as they learn how to think about math concepts and solve problems. This includes learners who need a high amount of support. It is our responsibility as educators to give students the support to actively learn and show what they can do and understand.

AbleNet has brought strong evidence that students with disabilities at all levels of cognition can and do learn math with best practice instructional methodologies. This is shown in a four-year study and a one-year study measuring success for students using the original version and the newly revised Equals Math curriculum. Equals Math curriculum provides instruction specifically for students with disabilities in structured lessons with a complete and comprehensive set of lesson objectives placed in a specific order to maximize pre-requisite skills and connections within and between math content areas.

While the structure and quality of math instruction is very important in supporting students with disabilities, the difference between students with disabilities learning math and typically developing students learning math is access. Given that quality math instruction is present, access to it remains the golden ticket: the gateway to learning math for students with disabilities.

Access includes a large variety of practices and use of tools, materials and assistive technology for supporting students as they talk and perform actions related to their learning. Math instruction can be viewed within layers of access from placement in a foundational skills curriculum with embedded differentiation within lessons, and in the use of materials with built-in support to adaptations that support individual student needs, e.g. language and actions with the materials. It is equally important to keep in mind that access includes teaching with models and guiding students as they learn math concepts gradually over time, building their understanding. This is much preferred over the expectation that students master every math skill before moving on to the next.

Language support for students with disabilities begins with using their own communication system (e.g. speech generating, single message, or dedicated device; PECS or other language board for augmentative and alternative communication) as recommended by a speech and language professional. Students need access to those devices always, including in math class. Beginning communicators often have a communication system with limited message locations so they require a way to comment on what is happening in front of them in real time, in this instance during math class.

A math lesson should include enough materials (math tools, counters, workmats, cards and interactive materials) to be used for answering a question, making a choice and communicating what is happening in the moment. Creating a display with two-three choices on the table or in a pocket chart provides expanded, temporary communication access that relates to what is right in front of the students. Students choose an answer or a comment from this display by touching, pointing, eye gazing or rely on the teacher to point to each and indicate their choice by saying, "That's the one I want," with their own communication system or Step-by-Step communicator.

It's important that students who require language support have opportunities to learn what the provided choices mean. For example, we know that language begins with naming. Why not begin with naming the tools and materials students use in math class? How about naming the actions students are expected to complete with those tools?

Models, choices and naming with a communication system or display allows students to become familiar with tools and objects and how to use them. Familiarity with these things is as helpful as a familiar routine. When a student is taught what the choices are for tools, counters, vocabulary, and actions, they make better, informed choices. Once the lesson structure, tools and actions are known, students can feel more confident with new math concepts and problem solving and begin to focus on these skills.

Naming actions is more meaningful if students perform actions themselves. Often, that requires an adaptation, so students can be as independent as possible in performing the action. Again, models are important but active learning needs to follow. Hand-under-hand assistance should be a temporary support until a more independent adaptation is identified. The Equals Math Action Dictionary, a guide with abundant ideas to

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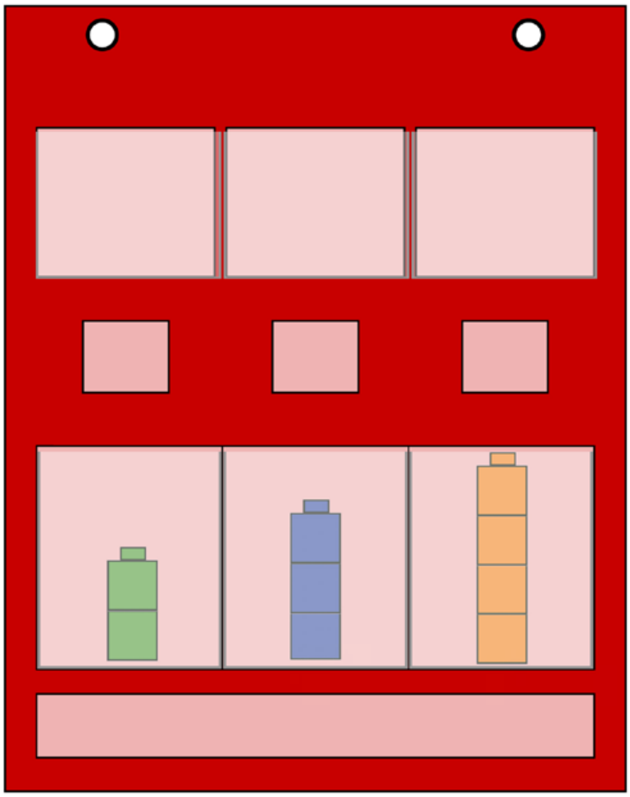
support students' access for both language and motor access, can help get you started. In your own school or district, be sure to seek out your speech and language professional, occupational therapist, and/or assistive technology professional, as they are invaluable resources that can provide options and a direction that best fit the needs of your students.

A few examples from the Equals Math Action Dictionary (below) support individual students who require adaptations for language use and actions performed in a math lesson. The adaptation ideas in the Action Dictionary can be used as is or tweaked for an individual's unique needs. Sometimes teachers use the ideas as a starting point that leads to a new one. Most materials needed to create these adaptations are present in the Equals Math curriculum kit but can be found elsewhere.

Equals Math Action Dictionary Sample

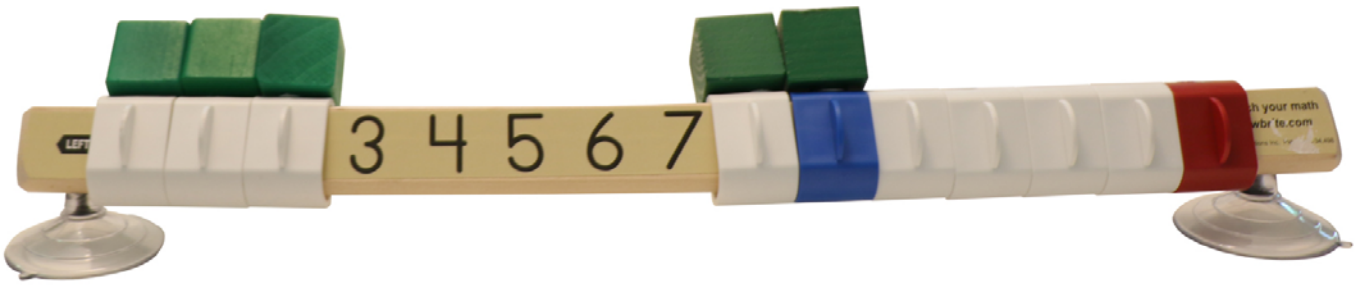
How can a student answer a question when she cannot remember or does not talk in a typical way?

Provide a display of two or three answer choices for a student to select. In the pictured example, stacks of 2, 3 and 4 connecting cubes represent the amount choices. For beginning learners, show more obvious differences. For example, if the solution is 4 cubes, place 1 cube and 10 cubes as distractors.



How does a student count with objects when he can't keep track of them?

Fasten counters onto MathLine tabs with Velcro. Students can slide the tabs with counters and manage to keep them organized to add, subtract, multiply or divide. All Equals counters fit on the tabs.

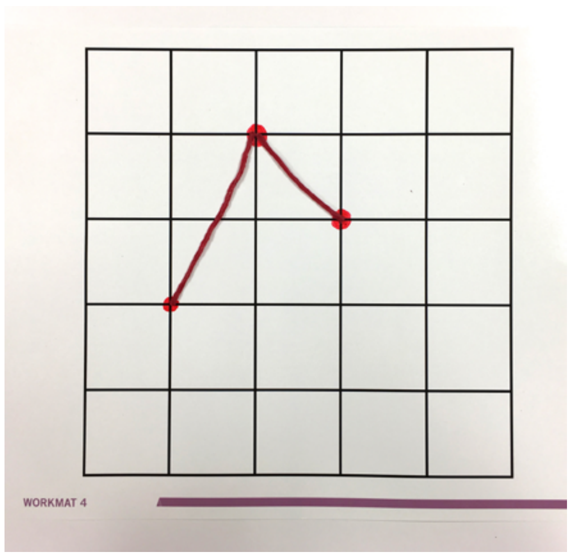


How can a student count when she does not talk with a verbal voice?

A Step-by-Step communicator has 120 seconds or recording time. There is no limit to the number of messages so it is possible to record the number list from 1 to 100 or any number between. With each activation, the first and subsequent numbers are heard, one at a time under the student's control.

How does a student connect the points on a graph when he is unable to hold a pencil or write with it?

The student places or presses Wikki Stix lengths to connect points present on the grid to create a line graph.



How does a student with low vision count with a 10-frame?

A 10-frame box with room for connecting cubes is an easy solution. The Equals Math curriculum kit includes 12 boxes so students can not only count cubes 1-10 but also group cubes by tens and ones and use in a place value chart.

How can a student estimate when she cannot picture an amount in her mind?

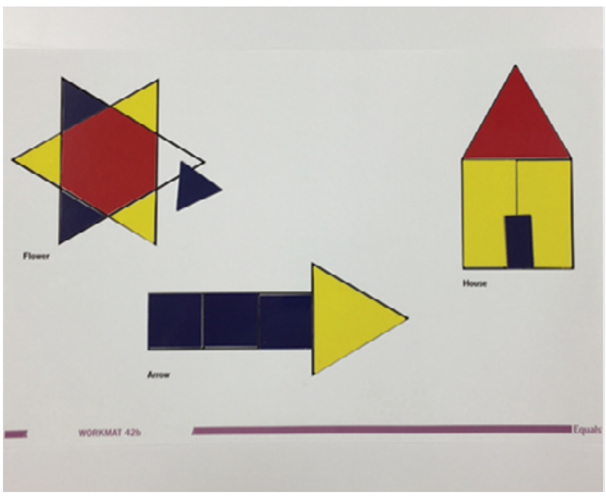
Providing choices is an easy adaptation when a student is inexperienced with amount or is unable to picture an amount. In this photo, the student is estimating the amount in the bowl (10). The choices are far apart: 20, 2, and 9. Choices of any amount can be used, some more challenging than other, depending on the needs of the student. Numerical representations could also be used.

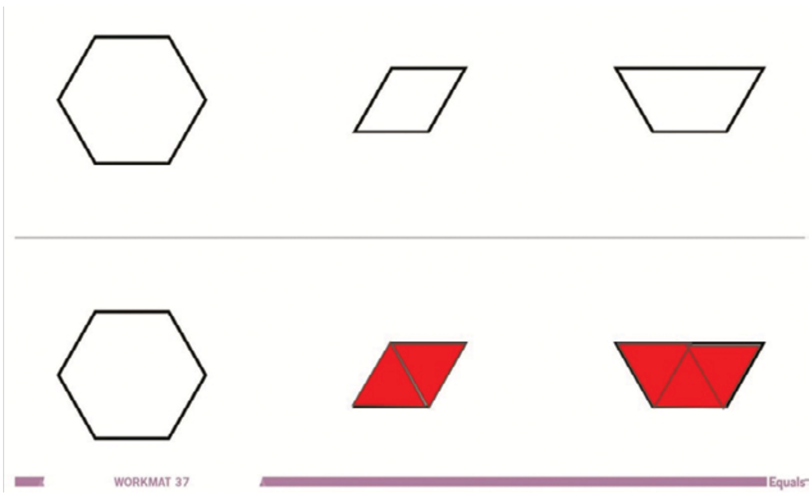
How does a student flip a shape when he is unable to pick it up?

Utilizing a 3-ring binder, page protectors, and Velcro tabs, the student can turn the page left-to-right or right-to-left to flip the shape. This action and the resulting alternative view of the shape helps a student understand congruency, e.g. the shape is the same despite its orientation in space.

How can a student make a shape when he is unable to draw it?

Using two-dimensional shapes and workmats from the Equals kit, students can use the shape outlines to place shapes to create a design or another shape. Fastening Wikki sticks to the top borders of the shapes helps students control their movements as they slide the shape into place.





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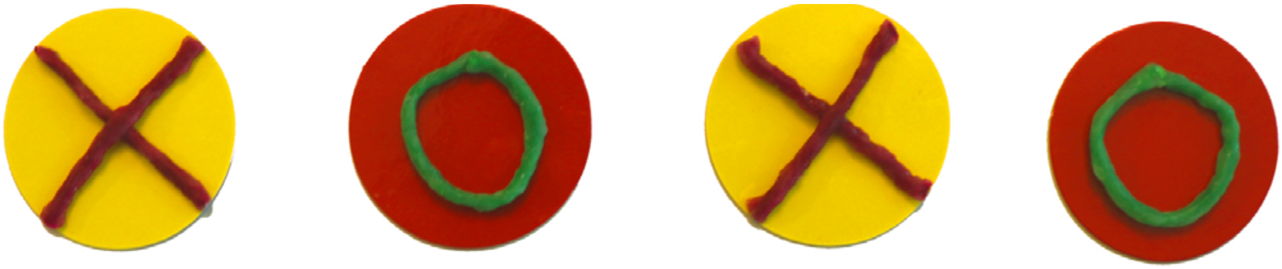
How can a student make a pattern when she is blind?

Use Wikki Stix to create and fasten X's and O's so the student can feel a distinct difference when creating an AB pattern.



The adaptation examples show only a small portion of possibilities for students with disabilities to access math. Once established for your students, access becomes a natural part of the day, often across other subject areas.

Teaching math for students with disabilities is much more complex and intricate than many teachers have realized. Math instruction based on research and an abundance of access options have opened doors and raised expectations. We now know what quality math instruction looks like and how to bring it to students. The results are astoundingly exciting and successful. At this moment, teachers are in the best position for providing quality math instruction for their students with disabilities than ever before. The tools are here. It's time to move forward and grasp them. ■

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