

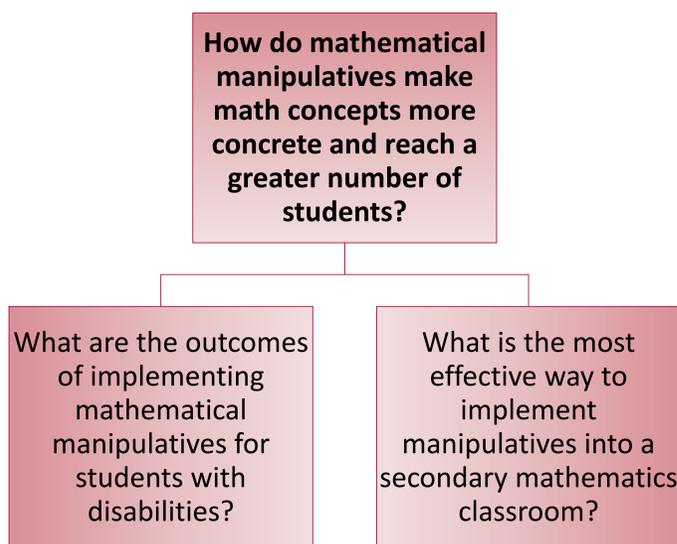


MATHEMATICS IS A PLACE FOR ALL.

Many students come into a secondary math classroom with an understanding of how a math class functions. Often, students of color, students with disabilities, or anyone not labeled “smart” knows that math curriculum was not created to serve them. It is important for mathematics educators to make gaining mathematical knowledge accessible to each learner in their class.

Through manipulatives, I believe that educators can reach students who may typically say that math is not for them. We can do this by making abstract concepts into concrete models to facilitate learning and new construction of knowledge.

INQUIRY QUESTIONS



MANIPULATIVES DEFINED

- Manipulatives in mathematics are concrete materials, or web-based materials that students can move and change in order to explore abstract concepts in mathematics.
 - Anything that students interact with to make mathematics more meaningful to a more diverse range of students.
- Concrete Manipulatives**
 - Physical objects that students are able to move around.
 - These can include;
 - Blocks, cups, scales, counters, tiles, or various classroom supplies that can be given mathematical meanings.
- Web-Based Manipulatives**
 - Online software that allows for virtual manipulation.
 - These can include, but are not limited to:
 - Desmos, balances, any online software that allows for students to move items and gain greater understanding.

TPEP Alignment:

Criterion 2: Demonstrating effective teaching practices.

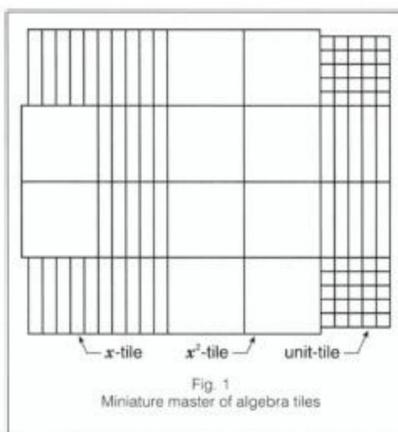
Descriptor: Instruction; the teacher uses research-based instructional practices to meet the needs of all students.

MOVING FROM ABSTRACT TO CONCRETE

As students enter the secondary levels, mathematics, especially algebra concepts become more and more abstract. Students may struggle to see how this math works, where it is derived or how it may apply to their lives.

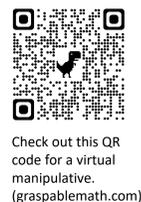
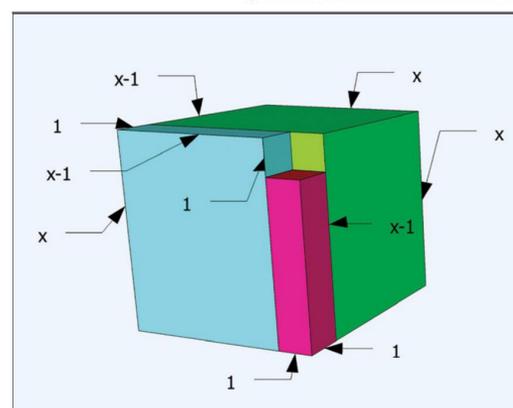
Mathematical manipulatives give meaning to where formulas are derived, and how mathematic principles work.

Algebra tiles (shown below) are a popularly researched tool to strengthen students’ algebraic skills. Algebra tiles represent algebraic concepts in a geometric way. There are many students who perceive geometry as a more concrete discipline of math, and therefore it is more attainable, and it is easier for students to see direct, real-world applications in geometry concepts. Representing algebraic ideas through shapes and a geometric perspective may reach a wider range of students (Leitze & Kitt, p. 463).



Right: Annette Ricks Leitze and Nancy A. Kitt give a figure for a master set of algebra tiles.

Below: An algebra concept, the expression $x^3 - 1$, through geometric ideas. (Safi & Desai, 2017)



Check out this QR code for a virtual manipulative. (graspablemath.com)

Provide multiple means of **Engagement** →

Affective Networks
The "WHY" of learning

Provide multiple means of **Representation** →

Recognition Networks
The "WHAT" of learning

Provide options for **Recruiting Interest** (7) →

- Optimize individual choice and autonomy (7.1) >
- Optimize relevance, value, and authenticity (7.2) >
- Minimize threats and distractions (7.3) >

Provide options for **Perception** (1) →

- Offer ways of customizing the display of information (1.1) >
- Offer alternatives for auditory information (1.2) >
- Offer alternatives for visual information (1.3) >

Provide multiple means of **Action & Expression** →

Strategic Networks
The "HOW" of learning

These are three of the 9 Universal Design for Learning (UDL) guidelines.

Provide options for **Physical Action** (4) →

- Vary the methods for response and navigation (4.1) >
- Optimize access to tools and assistive technologies (4.2) >

UDL guidelines help formalize how manipulatives can provide multiple means for students to access materials. (The UDL guidelines 2021)

“We recommend that concrete manipulatives can be effective instructional tools to help students with MD (mathematics disabilities) improve their conceptual and procedural understanding of algebraic equation solving. We suggest beginning instruction with concrete manipulatives focusing on building conceptual understanding. Then, connections between concrete and abstract representations must be explicitly taught when transitioning to the abstract phase, so that students can integrate abstract representations with their concrete understanding.”

-Namkung and Bicko p.121

EFFECTIVE IMPLEMENTATION OF MANIPULATIVES.

To create a successful classroom that implements manipulatives into daily learning there needs to be a focus on the developmental needs of students in a classroom. This requires that for educators to use manipulatives well in an inclusive classroom there should be:

- Exposure**
Allowing students to see all options that they have in order to learn new content including manipulatives.
- Clear Instruction**
It cannot be assumed that students know how to use manipulatives or apply them to math concepts.
- Consistent Availability**
For students to effectively use manipulatives they need to be able to always access the materials.

IMPLICATIONS FOR STUDENTS WITH LEARNING DISABILITIES

Having more access to manipulatives in a classroom will create a space that is more aligned to Universal Design for Learning (UDL) Guidelines. More manipulatives allow for more means of:

- Engagement** – manipulatives can allow for student choice and greater amounts of engagement in each lesson.
- Representation** – manipulatives, alongside traditional learning allows students to see content through multiple visual representations.
- Action & Expression** – manipulatives give students more options for how they can communicate understanding and allow for students to show knowledge through physical actions.

UDL Guidelines help to make classrooms more accessible for any type of learner, including students with disabilities. Through the option of manipulatives mathematical knowledge is more accessible.

NEXT STEPS FOR EDUCATORS

Through this research I have discovered the range of students that manipulatives can help at the secondary level. I find that more research should be done in order to continue to know how students are impacted in class wide manipulative use. Research shows clearly that students do well with small manipulative interventions, but I find that whole classroom use is under researched at the current moment.

I believe that having greater and more consistent use of manipulatives will make my classroom more inclusive of all types of learning styles and therefore make more students less nervous about overcoming the perceived hurdle that is secondary mathematics. There are many ways to incorporate concrete items into math classrooms to make each lesson have more representations of the same content.

To best use manipulatives, it should be built into the daily expectations of the classroom. My goal is to apply manipulatives into the daily flow of my classroom. All students will have access to these materials, and all students will know how to learn using manipulatives. I believe providing access to manipulatives will enrich the learning in my classroom and create more successful mathematicians.

REFERENCES

CHECK OUT THIS QR CODE TO DIVE INTO THE RESOURCES THAT INFORMED THIS INQUIRY

