Productive Struggle for All:

Supporting Students with Disabilities in a General Education Class
Malia Hite, Ed.D.

Educator Licensing Coordinator

Former Middle School Mathematics & Multi-Tiered System of Supports Specialist

Utah State Board of Education
malia.hite@schools.utah.gov
@maliahite
Who am I?

3rd Generation Educator
Who am I?

◈ 3rd Generation Educator
◈ Math, Music, ESL, and Special Educator

Math rocks!!
Who am I?

◈ 3\textsuperscript{rd} Generation Educator
◈ Math, Music, ESL, and Special Educator
◈ Mom, Sister, Aunt
Who am I?

- 3rd Generation Educator
- Math, Music, ESL, and Special Educator
- Mom, Sister, Aunt
- Currently Helping Homeschool Kids at the Kitchen Table
Are you running a “homeschool” for your own kids in your quarantine experience?

How’s it going?
Quarantine Home School

Homeschool Day 1: HOW DO I GET A KID TRANSFERRED OUT OF MY CLASS?
Quarantine Home School

Simon Holland @simoncholland

If you had asked me what the hardest part of battling a global pandemic would be I would have never guessed, “teaching elementary school math.”

2,215  6:16 AM - Mar 23, 2020

325 people are talking about this

Homeschool Day 1: HOW DO I GET A KID TRANSFERRED OUT OF MY CLASS?
Quarantine Home School

**Shonda Rhimes**
@shondarhimes

Been homeschooling a 6-year old and 8-year old for one hour and 11 minutes. Teachers deserve to make a billion dollars a year. Or a week.

456K  1:12 PM - Mar 16, 2020

**Simon Holland**
@simoncholland

If you had asked me what the hardest part of battling a global pandemic would be I would have never guessed, “teaching elementary school math.”

2,215  6:16 AM - Mar 23, 2020

325 people are talking about this

**Homeschool Day 1:**
HOW DO I GET A KID TRANSFERRED OUT OF MY CLASS?
Quarantine Home School

YOU SAID YOU FINISHED ALL OF YOUR E-LEARNING.
THE EMAIL FROM YOUR TEACHER DETERMINED THAT WAS A LIE.

Simon Holland @simoncholland
If you had asked me what the hardest part of battling a global pandemic would be I would have never guessed, “teaching elementary school math.”

shonda rhimes @shondarhimes
Been homeschooling a 6-year old and 8-year old for one hour and 11 minutes. Teachers deserve to make a billion dollars a year. Or a week.

Homeschool Day 1: HOW DO I GET A KID TRANSFERRED OUT OF MY CLASS?
3rd Grade “Morning Work”

Abby bought 8 packages of stickers with the same number of stickers in each package. She gave 15 stickers to her sister. Now Abby has 49 stickers. How many stickers were in each package?
3rd Grade “Morning Work”

Abby bought 8 packages of stickers with the same number of stickers in each package. She gave 15 stickers to her sister. Now Abby has 49 stickers. How many stickers were in each package?

How many stickers were in each package?

i do not no maby abby sod cont
Flashback to High School Math Foundations
3rd Grade “Morning Work”

Abby bought 8 packages of stickers with the same number of stickers in each package. She gave 15 stickers to her sister. Now Abby has 49 stickers. How many stickers were in each package?

How many stickers were in each package?

i do not no maby abby sod cont

____
“I don’t like that problem.”
“It’s about stickers and I don’t like stickers; they make my mouth feel funny.”
2. Abby bought 8 packages of \textit{sticks} with the same number of \textit{sticks} in each package. She gave 15 \textit{stickers} to her sister. Now Abby has 49 \textit{stickers}. How many \textit{stickers} were in each package?

\textbf{i do not no maby abby sod cont}}
2. Abby bought 8 packages of sticks with the same number of sticks in each package. She gave 15 stickers to her sister. Now Abby has 49 stickers. How many stickers were in each package?

“I’m making it about sticks. ‘Cause I like sticks!!”
What was causing him to refuse to engage in the mathematics?
What was causing him to refuse to engage in the mathematics?

- Not a bad attitude, not laziness
What was causing him to refuse to engage in the mathematics?

✧ Not a bad attitude, not laziness
✧ It was a *disability* (sensory processing disorder)
A learning disability is not a problem with intelligence or motivation. Kids with learning disabilities aren’t lazy or dumb. In fact, most have average or above average IQs. Their brains are simply wired differently. This difference affects how they receive and process information.

(Kemp, G.. Smith, M., & Segal, J., 2019)
Yes I have a learning disability.
No I'm not stupid.
Today’s Learning:

- What is productive struggle?
- How do learning disabilities affect learning in mathematics?
- What specific strategies will help to support students with disabilities to productively struggle with mathematics?
Effective
Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.
Effective teaching of mathematics consistently provides student, individually and collectively, with opportunities and supports to engage in **productive struggle** as they grapple with mathematical ideas and relationships. (p. 48)

NCTM’s *Principles to Action* (2014)
1. What is *productive struggle*?

*Put your answer in the chat box.*
Productive Struggle is…

• “Struggling at times with mathematics tasks but knowing that breakthroughs often emerge from confusions and struggle”

• Delving “more deeply into understanding the mathematical structure of problems and relationships among mathematical ideas, instead of simply seeking correct solutions”

NCTM’s Principles to Action (2014)
Zone of Proximal Development

Lev Vygotsky (1978)

(Collaborative) Zone of Proximal Development

No Struggle  Productive Struggle  Unnecessary Struggle

(Sengupta-Irving, T., 2017)
Zone of Proximal Development

Lev Vygotsky (1978)
Zone of Proximal Development is the **sweet spot** of Productive Struggle.
2. How do learning disabilities affect learning in mathematics?

What are the attributes you have noticed in your classes with your students?
What are the Issues in Teaching Mathematics to Students with Disabilities?

It’s NOT:
- Difficulty reading
- Paying attention
- Following directions
- Laziness
- Bad attitudes

It IS:
- Underdeveloped cognitive structures with are the mental processes necessary to connect new information with prior knowledge

(Geary, D., 2004)
Cognitive Structures/Processes

- Language disability
- Executive Functions
- Processing speed
- Poor recall/memory
- Attention difficulties

Specific Learning Disability in Mathematics (Dyscalculia):
  - Math Problem Solving
  - Math Calculation

5-7% of students
Executive Functions

What is it?
• Impulse control
• Self-Monitoring
• Planning & Prioritizing
• Starting Tasks
• Organizational Systems
• Time Management
• Connect past with present and future

What does it look like?
• Calling out of turn
• Missing assignments
• Disorganized work & backpacks
• “I forgot we had a test.”
• Problem-solving planning
• “What do I do next?”
Poor Working Memory

What is it?
• Short-term storage
• “Holding room” for information while working on other cognitive tasks
• Example: “What two numbers multiply to 12 and add to -8?”
  (Baddeley & Hitch, 1974)

What does it look like?
• Doesn’t follow directions
• Assignments that are started, but not finished
• “I don’t know what to do”
• Difficulty note-taking in class
• Organizing thinking
Processing Speed

What is it?
• Pace of taking in & recalling information
• Information recall speed
• Time needed to do a mental task
• Reaction time

What does it look like?
• “I didn’t have enough time to finish.”
• Poor mental math
• Gets overwhelmed
• Need for LOTS of example problems
• Difficulty following multiple directions
• Misses steps
Specific Learning Disability in Math Calculation

What is it?
Difficulties with:
• Computation/Arithmetic
• Quantity comparison
• Terminology
• Symbols, notation, & conventions
• Commutative Property

What does it look like?
• Can’t memorize math facts
• Use fingers to add/subtract
• “I’m bad at math.”
• Inconsistent notation
• Complex calculations incorrect, even with calculator
• Low test scores
Specific Learning Disability in Math Problem Solving

What is it?
- Visio-special-motor disorganization; pictures don’t help
- Decoding word problems
- Logical processes challenging

What does it look like?
- Forgets math procedures
- Limited strategic planning
- Avoid math class
- Difficulty with abstract ideas (variables, time & direction)
- HIGH math anxiety
3. What **specific strategies** will help to support students with disabilities to productively struggle with mathematics?

What **to you do to support student with disabilities in your classes?**
Pathway to Productive Struggle

Productive Struggle

Mathematics Teaching Practices

Standards for Mathematical Practice
Critical support for students with disabilities
Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Tools to alleviate computation
Tools to alleviate computation

EXPLICITLY TAUGHT
USE VISUAL CUES
ANCHOR CHARTS
USE VISUAL CUES
ANCHOR CHARTS

EXPLICITLY TAUGHT
REFERENCED OFTEN
Effective Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.
Foster Conceptual Understanding

Concrete → Representational → Abstract

(Miller, S., Mercer, C., 1993)
Foster Conceptual Understanding

Concrete → Semi-Concrete (Representational) → Abstract

(Miller, S., Mercer, C., 1993)
### Concrete

Students use algebra tiles for adding integers.

\[-2 + 5 = \]  

<table>
<thead>
<tr>
<th>Concrete</th>
<th>Representational</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students use algebra tiles for adding integers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>Representational</td>
<td>Abstract</td>
</tr>
<tr>
<td>----------</td>
<td>------------------</td>
<td>----------</td>
</tr>
<tr>
<td>Students use algebra tiles for adding integers.</td>
<td>Students use a drawing to model the algebra tiles.</td>
<td>- 2 + 5 = ?</td>
</tr>
</tbody>
</table>

\[-2 + 5 = ?\]
<table>
<thead>
<tr>
<th>Concrete</th>
<th>Representational</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students use algebra tiles for adding integers.</td>
<td>Students use a drawing to model the algebra tiles.</td>
<td></td>
</tr>
<tr>
<td>- 2 + 5 =</td>
<td><img src="image" alt="Diagram" /></td>
<td></td>
</tr>
</tbody>
</table>

- 2 + 5 = ?
### Concrete
Students use algebra tiles for adding integers.

\[-2 + 5 = \]

### Representational
Students use a drawing to model the algebra tiles.

\[
\begin{array}{c}
- \\
+ \\
+ \\
+ \\
\end{array}
\]

### Abstract
Students connect the concrete model and the drawings to the abstract algebraic notation.

\[
-2 + 5 = -2 + 2 + 3 = 0 + 3 = 3
\]
$(x+1)(x+2) = x^2 + 3x + 2$

(Safi, F., Desai, S., 2017)
Lennie and George dream of raising rabbits and living off the land. Assume Lennie and George started with two rabbits. Every month, each pair of rabbits has two babies.
Effective Mathematics Teaching Practices

1. Establish mathematics goals to focus learning.
2. Implement tasks that promote reasoning and problem solving.
3. Use and connect mathematical representations.
4. Facilitate meaningful mathematical discourse.
5. Pose purposeful questions.
6. Build procedural fluency from conceptual understanding.
7. Support productive struggle in learning mathematics.
8. Elicit and use evidence of student thinking.
Mathematical Discourse for SWD

1. Tell students, perhaps specific students, what to listen for.
2. Explicitly teach how to engage in that type of listening, if needed.
3. Explicitly teach & prepare students to share their thinking.
4. Provide models and/or sentence frames as a scaffold for mathematical discourse.
**Math Talk**

- **Math Talk Stems...**
  - What is another way to look at it?
  - What information is the same?
  - How can you explain your thinking?
USE VISUAL CUES
MATH TALK

EXPLICITLY TAUGHT
REFERENCED OFTEN
A 'math language routine' refers to a structured but adaptable format for amplifying, assessing, and developing students' language.
Mathematical Language Routines

1. Stronger and Clearer Each Time
2. Collect and Display
3. Critique, Correct, and Clarify
4. Information Gap
5. Co-craft Questions and Problems
6. Three Reads
7. Compare and Connect
8. Discussion Supports

(Zwiers, J., et. al., 2017)
Specific strategies to support students:

- Appropriate Tools
  - Calculators/Technology
  - Manipulatives
- Visual Cues
  - Anchor charts
- Concrete/Representational/Abstract
- Mathematical Discourse
  - Sentence frames
  - Mathematical Language Routines
Some students may need scaffolding, language support, culturally relevant pedagogy, or skill reinforcement before they are ready to grapple with a truly perplexing problem-solving situation.

(Gael, A., 2016)
“I don’t like that problem.”

“It’s about stickers and I don’t like stickers; they make my mouth feel funny.”
And maybe, just maybe, if you allow them to take ownership of their mathematical thinking by using sense-making tasks and routines, your students will surprise you and wonder something that is just as important mathematically as the original direction in which the lesson was meant to go.

(Gael, A., 2016)
Malia Hite
aka – Aunt Malia

Utah State Board of Education
malia.hite@schools.utah.gov
@maliahite


Karp, K. (2013). *The Invisible 10% - Preparing teachers to teach mathematics to students with special needs.* Annual Meeting of the Association of Mathematics Teacher Educators. Orlando, FL.


