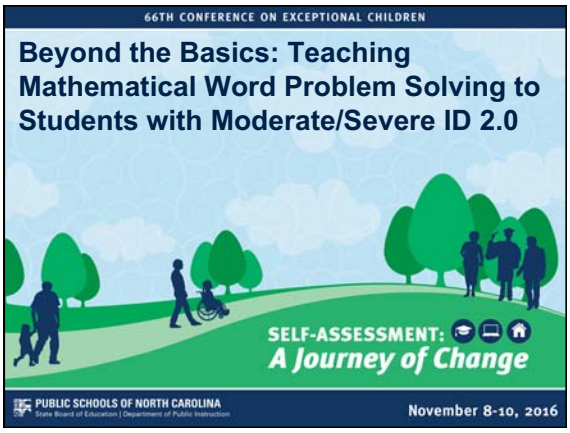

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The Solutions Project

UNC CHARLOTTE

cms Charlotte-Mecklenburg Schools

The Solutions Project
IES Grant #R324A130001

Note to viewers:

- This is the **participant version** of the presentation.
- Pictures of materials, student participants, and sample videos have been removed as this will be released in the public domain.
- These items will be included for the presentation during the conference.

Staff

- Diane Browder, PhD- Principal Investigator
- Fred Spooner, PhD- Project Co-Investigator
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- Luann Ley Davis- Graduate Research Assistant
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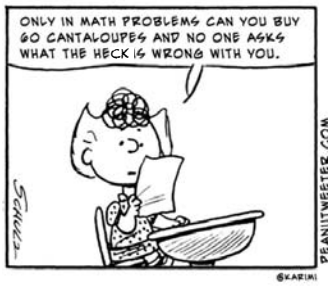
What we are…

- A federally funded grant set out to develop an effective, feasible method for teaching generalized problem solving to students with moderate/severe intellectual disability
- Combine effective methods to teach problem solving to students with high incidence disabilities with evidence-based practices for teaching mathematics to students with moderate/severe intellectual disability

What we are NOT…



Agenda

- WHY teach problem solving to students with moderate/severe ID
- WHAT to teach when teaching problem solving to students with moderate/severe ID
- HOW to teach problem solving to students with moderate/severe ID
- GENERALIZATION across standards, to technology, to general education, to real-world math problems

Part 1: THE "WHY"

WHY TEACH MATHEMATICS TO STUDENTS WITH SEVERE DISABILITIES

Why Mathematics is Important

- Growing recognition of importance of mathematics for skills needed to function in daily life in 21st century
  - Technology has increased need for mathematics in jobs that once relied on physical ability
  - Everyday living requires competence in mathematical problem solving
    - Do I have enough snacks to serve my friends?
    - How much time do I have to get ready?

➢"Problem solving is the cornerstone of mathematical learning."

~National Council of Teachers of Mathematics (2000)

➢Learning to solve story problems is the basis for learning to solve real-world mathematical problems.

~Van de Walle (2004)

➢Teaching calculation without problem solving only shows students *how*, but not *when* or *why*, to apply these skills.

GOALS OF TEACHING PROBLEM SOLVING:

- Increased number of opportunities that students may have never had before
- Increased independence as well as employability advantages
- Increased ability to apply mathematical skills to everyday life

Why is problem solving so difficult for students with disabilities?

- Linguistic Difficulties
  - Length of problem
  - Sentence structure and complexity
  - Vocabulary
  - Order key information appears in problem
  - Reliance on reading comprehension
- Executive Functioning Demands
  - Planning
  - Organizing
  - Deciding on strategies to use
  - Putting information from problem in working memory
  - Retaining strategies for solving

Additional Difficulties for Students with More Severe Disabilities

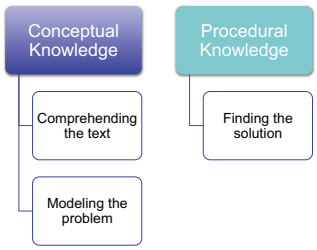
- working memory deficits
- attention deficits
- limited background knowledge and experiences
- difficulty with language comprehension
- early numeracy deficits and lack of fluency
- difficulty with self-regulation
  - (Donlan, 2007)

Must have **high quality**, **explicit instruction** with **repeated opportunities for practice** in order to be effective mathematical problem solvers

Part 2: The "WHAT"

WHAT TO TEACH WHEN TEACHING PROBLEM SOLVING TO STUDENTS WITH MODERATE/SEVERE DISABILITIES

Successful Problem Solvers Combine:



The Solutions Project Key Elements

1. **Schema-Based Instruction**
   - Explicitly teaches students to sort problems by type based on mathematical structures
   - Students are taught rules for solving each problem type
2. **Evidence-based Practices for Teaching Math to SSD**
   - Task analytic instruction
   - Least intrusive prompting
3. **Contextual Math**
   - Math is made meaningful to students
   - Math is anchored through multi-media or shared stories to provide context and engagement

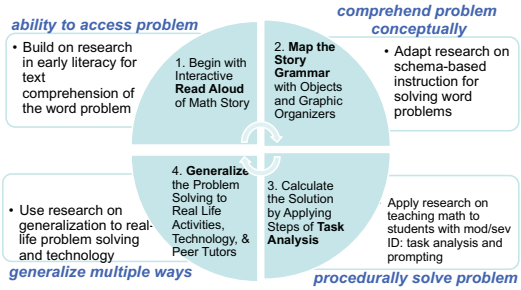
Key Element 1: Schema-based Instruction

- Conceptual teaching approach which combines mathematical problem solving AND reading comprehension strategies (Jitendra, 2008)

SBI vs. Modified SBI

Visual diagrams to show relationships between quantities in problem	More detailed graphic organizers with visual supports
Use of a heuristic (mnemonic) to teach problem solving process	Replace mnemonic with step-by-step task analysis for problem solving
Use explicit instruction to teach heuristic and problem solving process	Use explicit instruction + systematic instruction
Metacognitive strategy instruction	Rules taught with hand motions, self-monitoring checklist

Key Element 2: Combine with EBP for SSD



Key Element 3: Contextual Math

- Math is useful to students when they see it as a tool to accomplish everyday tasks
- Context makes math motivating and meaningful
- Multi-media or shared story anchors at the beginning of the lesson give context and themes will be carried on throughout the word problems for that lesson

How to give math context

- Choose a theme for word problems that is high interest and relevant
  - Scenarios student would encounter in future or current environments
  - Incorporate preferences
- Anchor the lesson for comprehension and engagement
  - Pictures
  - Videos
  - Objects
  - Movement

Don't lose focus of instruction!

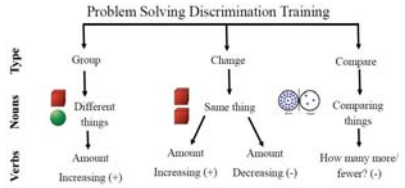
Problem Types and Guidelines for Writing Word Problems

Guidelines for Writing Word Problems

3 Problem Types for Addition and Subtraction

- ***Group*** problems combine two distinct things (parts) into one large group (whole)
- ***Compare*** problems involve two people/objects comparing amounts of one thing or one person/ object comparing amounts of two things
- ***Change*** problems involve one thing which either increases (change-add) or decreases(change-subtract) in value

How Problem Types Vary



Guidelines for Writing Word Problems
Avoid reliance on key words

- In SBI students learn to focus on underlying schema relation or problem structure before solving the problem
- Focus should be on teaching students to differentiate between problem types
- Keywords can be a part of SBI but do not always reflect problem types

Guidelines for Writing Word Problems
Avoid reliance on key words

Keywords can be a part of SBI but do not always reflect problem types

John has 5 notebooks. Mary has 3 notebooks. How many **more** notebooks does John have than Mary? → **Compare**

John has 4 math problems to do. He has done 2 math problems. How many **more** math problems does he have to do? → **Change**

John has 3 books to read. Mary has 1 **more** than John. How many books do they have altogether? → **Group**

Guidelines for Writing Word Problems

Word Choice

- Keep sentences the same length and use words which are easy to decode
- Use a *variety* of nouns ("things") which are
  - Familiar
  - Concrete
  - Relate to the theme
  - Make sense

Guidelines for Writing Word Problems

Names

- Choose names that will increase engagement
  - Students within classroom
  - Familiar people (family, people around school)
  - Reflection of interest (celebrities, athletes, etc.)

Guidelines for Writing Word Problems

Verbs

- Used verbs that clearly indicate action

Addition Verbs	Subtraction Verbs	General Verbs
make	take away	give
combine	lose	eat
put together/more	pop	share
pick	break	plant
find	smash	count
pick up	spill	grow
add	crack	
collect	pay	
gather		
buy		

Guidelines for Writing Word Problems

Numbers

- Intentionally choose numbers based on student ability
- Easiest to represent as numerals
- Zero or "none" is a difficult concept
- Sums of less than 10 for making sets
- Consider calculator use
- Alternate between putting smaller or larger number first in addition problems

Guidelines for Writing Word Problems

Check for Bias

- Gender
  - Equal use of female and male characters and themes
  - Avoid gender stereotypes
- Culture
  - Avoid cultural or racial stereotypes
  - Use scenarios that all students including culturally and linguistically diverse students can relate to or understand
  - Use scenarios that are relevant and meaningful for students

Group Problem Examples Theme: School Basketball Game

Formula	Examples	
Anchor sentence	Aaron and Jose bought snacks at the school basketball game.	There are cheerleaders at the school basketball game.
# thing 1	Aaron bought 2 buckets of popcorn.	There are 2 boys on the cheerleading team.
# thing 2	Jose bought 1 hotdog.	There are 4 girls on the cheerleading team.
Question with label	How many snacks did they buy in all?	How many cheerleaders are on the team?

Group problems have two different nouns with something in common.

Change Problem Examples Theme: School Basketball Game

Formula	Examples	
Anchor sentence	Aaron saved his money to go to the school basketball game.	Jose likes to eat sour straws at the basketball game.
1 Thing & beginning state (#)	Aaron had $5 to spend at the basketball game.	Jose had 8 sour straws.
Increase or decrease verb + increase or decrease amount	Aaron's mom gave him $3 more to spend at the basketball game.	Jose ate 3 sour straws.
Question with label	How much money does Aaron have now?	How many sour straws does Jose have left?

Change problems discuss one noun, and more is added to the noun or some is taken away. Dynamic problem.

Compare Problem Examples Theme: School Basketball Game

Formula	Examples	
Anchor Sentence	Aaron and Jose both like to go to basketball games.	Jose sees many coaches at the game.
Person/Thing 1 #	Aaron has been to 5 games.	Jose sees 4 female coaches.
Person/Thing 2 #	Jose has been to 2 games.	Jose sees 2 male coaches.
Question with label	How many more games has Aaron been to than Jose?	How many fewer coaches are male than female?

Boundary on Generalization	Example	Adding Difficulty
Numbers are always depicted by numerals.	John bought **3** stickers	John bought **three** stickers
The order the information is presented in the word problem is the same order that it will be recorded on the graphic organizer and on the number sentence. Group: small group, small group, big group Change: beginning set, change set, ending set Compare: bigger number, smaller number	**Change:** John bought 3 stickers. He gave 1 sticker away. How many stickers does John have left? (beginning set, change set, ending set)	**Change:** John gave 1 sticker away. He bought 3 stickers. How many stickers does John have left? (change set, beginning set, ending set)
The missing quantity is always presented in the final position. **(A+B=? or A-B=?)**	John bought 3 stickers. He gave 1 sticker away. How many stickers does John have left? **3-1=?**	John bought 3 stickers. He gave away some stickers on the way home. Now he has 2 stickers left. How many stickers did John give away? **3-?=2**

Boundary on Generalization	Example	Adding Difficulty
No **extraneous numerals or information** is included in the word problem outside of the anchor sentence.	John bought 3 stickers. He gave 1 sticker away. How many stickers does John have left?	John bought 3 stickers and 2 stamps. He gave 1 sticker away. How many stickers does John have left?
In a group problem, when each of the small parts are the same amount, the numeral is stated twice.	John bought 3 stickers. Bob bought 3 stickers. How many stickers did John and Bob buy in all?	John and Bob **each bought 3 stickers**. How many stickers did John and Bob buy in all?
Each element of the word problem is written in a separate sentence.	John bought 4 stickers. Bob bought 3 stamps. How many items did John and Bob buy in all?	John bought 4 stickers and Bob bought 3 stamps. How many items did they buy in all? **(paragraph form)**

Boundary on Generalization	Example	Adding Difficulty
In change problems, a numeral always depicts change amount.	John bought 4 stickers. He gave 2 stickers away. How many stickers does John have left?	John bought 4 stickers. He gave away half of his stickers. How many stickers does John have left?
In change problems, situations where "all" of something was lost do not occur because differences must be of 1 or greater.	John bought 4 stickers. He gave 2 stickers away. How many snickers does John have left?	John bought 4 stickers. He gave away 4 stickers. How many stickers does John have left?
In change problems, zero is not used in the change amount because it does not indicate a change, therefore situations where "nothing" was gained or lost does not occur.	John bought 4 stickers. Bob gave him 2 more stickers. How many stickers does John have now?	John bought 4 stickers. Bob did not give him any stickers. How many stickers does John have now?

Boundary on Generalization	Example	Adding Difficulty
In change-subtract and compare problems, the greater amount is presented first in the word problem to set the student up for a subtraction number sentence.	John bought 4 stickers. Bob bought 3 stickers. How many more stickers did John buy than Bob?	John bought 3 stickers. Bob bought 4 stickers. How many more stickers did Bob buy than John?
Unknown information is always to the right of the equal sign.	A + B = ?	? = A + B

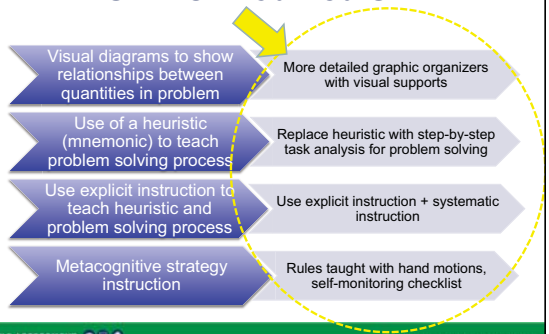
PART 3: The "HOW"

HOW to teach problem solving to students with moderate/ severe ID

Pre-requisite Skills

- Students should be able to:
  - Identify numbers 1-10 in random
  - 1:1 correspondence
  - Making sets

SBI vs. Modified SBI



Step 1: Graphic Organizers with Visual Supports

- Visually represent each problem type and relationship between quantities
- Purpose is to help students organize information from the problem
- Need space to use manipulatives (rather than writing in numbers)
- Color-coding and visual supports

Step 2: Heuristics/Task Analysis

- Two popular heuristics used in the literature:
  - **FOPS:** find the problem type, organize the information in the problem using the schematic diagram, plan to solve the problem, and solve the problem (Jitendra, 2008)
  - **RUNS:** read the problem, use a diagram, number sentence, and state the answer (Rockwell et al., 2011)
- Challenge for this population
  - Memorizing a heuristic may overload the working memory
  - Students may not have enough literacy skills to relate the letters of the heuristic to the words for which each letter stands

Step 3: Teach Using Explicit Instruction & Systematic Instruction

- Explicit Instruction:
  - Model, Lead, Test
    - Model: "First watch me…"
      - Errorless learning
    - Lead: "Let's do it together. You try first, and I will help you…"
      - Provide LIP prompts
    - Test: "Your turn to show me what you know"
      - Assessing student's knowledge; no prompts; may review afterwards

Step 3: Systematic Instruction

- Reminders:
  - Always secure student's attention first (e.g., redirect student's attention to problem or TA)
  - The instructional cue (e.g., "solve the word problem") is not a prompt
- Prompt Levels:
  - Prompt 1: nonspecific verbal & gesture; read and point to step on TA
  - Prompt 2: specific verbal; read step and provide additional information for student to perform step
  - Prompt 3: model then retest

Step 4: Metacognitive Strategy Instruction

- Student self-instruction checklist (TA embedded into a checklist format and made student friendly)
- Rules for each problem type
- Think alouds

Rules for Each Problem Type

- 3 "Rules" with hand motions to remember problem types
  - Group: **"small group, small group, BIG group"**
  - Change: **"one thing, add to it or take away, change"**
  - Compare: **"bigger number, smaller number, difference between the two"**

Think Alouds: Model explaining WHY it is that problem type

- "This is a group problem because it has two small groups of different things that I combine to make one BIG group."
- "This is a change problem. It is about the same thing, 1 thing. I need to select my change graphic organizer."
- "This is a compare problem. I see my compare phrase…How many fewer…"

PART 4: PLAN FOR GENERALIZATION

Plan for Generalization

1. Technology (SMART Board and iPad)
2. Real-World Problems Presented in Video Format
3. Across Standards
4. Across People & Settings (e.g., with peers and/or in gen ed setting)

Thank You for Attending!

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QUESTIONS??

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SELF-ASSESSMENT: A Journey of Change
66TH CONFERENCE ON EXCEPTIONAL CHILDREN