Based on your current level of understanding, what do you think the words **conceptual**, **procedural**, **strategic**, and **adaptive** mean?

### Assessing Beyond the Algorithm

Research in Mathematics Education
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### Response to Intervention Model

<table>
<thead>
<tr>
<th>Performance Level</th>
<th>Instructional Support</th>
<th>Level of Additional Instructional Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tier 1</td>
<td>Minimal Instructional Support</td>
<td>Level 1</td>
</tr>
<tr>
<td></td>
<td>40-49 Percentile Rank</td>
<td>50-69 Percentile Rank</td>
</tr>
<tr>
<td>Tier 2</td>
<td>Strategic Instructional Support</td>
<td>Level 2</td>
</tr>
<tr>
<td></td>
<td>15-49 Percentile Rank</td>
<td>60-69 Percentile Rank</td>
</tr>
<tr>
<td>Tier 3</td>
<td>Intensive Instructional Support</td>
<td>Level 3</td>
</tr>
<tr>
<td></td>
<td>5-14 Percentile Rank</td>
<td>70-90 Percentile Rank</td>
</tr>
</tbody>
</table>

- **Student needs urgent and intense interventions that are highly targeted to address individual needs.** Additional instructional time is needed. Programs should be clearly oriented to provide substantial additional support. Students should not need additional instructional support beyond the core instructional program, though they may benefit from differentiated instruction and strategies. Review is needed periodically. Programs should be clearly oriented to provide substantial additional support.

### Texas Algebra Ready Initiative

- **Goal:** Algebra Readiness

- MSTAR
  - Diagnostic Assessment
  - Universal Screener

- ESTAR
- EOC

### MSTAR Initiatives

- Professional Development
- MSTAR Initiatives
  - MSTAR Diagnostic Assessment
  - MSTAR Universal Screener
MSTAR Professional Development

- Provide connections to and strengthen participants' knowledge of CCRS, ELPS, RtI; and
- Available via face-to-face and online professional development courses.

MSTAR Initiatives

- Professional Development
- MSTAR Initiatives
- MSTAR Diagnostic Assessment
- MSTAR Universal Screener

MSTAR Universal Screener

- Identify students who are at-risk for struggling with algebra-related core instruction
  - Determine IF interventions are needed
  - Determine DEGREE OF INTENSITY of the intervention needed
  - Monitor students' RISK STATUS
- Not intended to provide diagnostic information
- Guides instructional decisions
- Designed to be administered in fall, winter, and spring

Response to Intervention Model

- Tier 1: Intensive Instructional Support
- Tier 2: Strategic Instructional Support
- Tier 3: Minimal Instructional Support

SMU Additional Online MSTAR Courses

- MSTAR Introduction: An Executive Summary
- MSTAR Academy I: Fraction/Decimal Relationships and Operations
- MSTAR Academy I: Review and Needs Assessment
- MSTAR Academy I: Lesson Study Model Implementation
- More about Tier II for the Math Learner
- Addressing the G/T Math Learner through RtI
- Addressing the College and Career Readiness Standards in Math

SMU Purpose of the MSTAR Universal Screener

- Identify students who are at-risk for struggling with algebra-related core instruction
  - Determine IF interventions are needed
  - Determine DEGREE OF INTENSITY of the intervention needed
  - Monitor students' RISK STATUS
- Not intended to provide diagnostic information
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Course: MSTAR Universal Screener Overview
**MSTAR Initiatives**

- **Professional Development**
- **MSTAR Initiatives**
- **MSTAR Diagnostic Assessment**
- **MSTAR Universal Screener**

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**Purpose of the MSTAR Diagnostic Assessment**

- Given as needed to address struggling students in Tiers 2 and 3 after the MSTAR Screener.
- Identify **WHY** students are struggling with algebra-related core instruction.
  - Identify students' current level of understanding in key algebra-related content.
  - Identify students' persistent misconceptions in key algebra-related content.
- Provides information that can be used to plan supplemental instruction.
- Not intended to provide screening information.

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**MSTAR Initiatives**

- **Professional Development**
- **MSTAR Initiatives**
- **MSTAR Diagnostic Assessment**
- **MSTAR Universal Screener**

- The MSTAR Universal Screener can be accessed through the Project Share Gateway at www.projectsharetexas.org.
- It can also be accessed directly at http://mstar.epssilen.com.

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**Focus on Assessment**

<table>
<thead>
<tr>
<th>Discussion Points</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal Design</td>
<td>Understand the anatomy of a test item</td>
</tr>
<tr>
<td>Levels of Mathematics Proficiency</td>
<td>Write test items at different proficiency levels</td>
</tr>
<tr>
<td>Appropriate Question Stems</td>
<td></td>
</tr>
<tr>
<td>Answer Choices: Including Student</td>
<td></td>
</tr>
<tr>
<td>Misconceptions</td>
<td></td>
</tr>
</tbody>
</table>

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**Assessing Beyond the Algorithm**

**Universal Design**
Universal Design

• Originated in the field of architecture
• Features of the environment influence the level of interaction by the user

Characteristics of the users should be considered during the design stages
• Allow for maximum accessibility by the greatest percentage of the population

Universal design is a process for ensuring that tests will be developed and administered to provide the widest range of students with the opportunity to demonstrate their construct-relevant skills, knowledge, and abilities, using techniques that do not compromise the validity of inferences drawn from test results.

– UDA Summit Partners (2006)

Principles of Universal Design for Assessment

• Accurately measured construct
• Respect for diversity
• Concise and readable text
• Clear and understandable format
• Visuals support and enhance content; clear and relevant
• Supports accommodations without changing the construct

Universally Designed Assessment Items

Traditional Item
• Sue picks a ball without looking. What is the probability she will pick a white ball if there are 8 black balls and 4 white balls in a box?

Universally Designed Item
• Sue picks a ball without looking. What is the probability of picking a white ball?
Jim and Bob workout at the same gym. Jim wants to bench press more than Bob. The sum of weight Jim and Bob bench press is 180 pounds, and if you subtract what Jim bench press from what Bob bench presses, you get half of the weight Bob bench presses. How many pounds does Bob bench press?

The sum of Jim and Bob's weight is 180 pounds. If you subtract Jim's weight from Bob's weight, you get half of Bob's weight. How many pounds does Bob weigh?

\[-J + B = 180\]
\[-B - J = \frac{1}{2}B\]
\[-B = ?\]

Intertwined Strands of Mathematical Proficiency

- “Interwoven and interdependent”

Conceptual Understanding

- Demonstrate an integrated and functional grasp of mathematical ideas
- Understand specific task as it relates to a whole concept
- Find relationships between pieces of information
- Make connections to similar representations
- Use models and multiple representations (e.g., pictures, numbers, real-life situations, words)

TEKS 3.3D

The student applies mathematical process standards to represent and explain fractional units. The student is expected to:

(D) Compose and decompose a fraction \(a/b\) with a numerator greater than zero and less than or equal to \(b\) as a sum of parts \(1/b\).

Correct answer: B
**SMU: Procedural Fluency**

- Use formal language or symbolic representations
- Carry out accurate computations
- Follow multiple steps sequentially
- Make proper use of algorithm and properties

**SMU: Procedural Fluency**

**TEKS 7.11A**

The student applies mathematical process standards to solve one-variable equations and inequalities. The student is expected to:

(A) Model and solve one-variable, two-step equations and inequalities.

Correct answer: C

**SMU: Strategic Competence**

- Ability to formulate a problem in mathematical terms
- Represent problem solving strategically (verbally, symbolically, graphically, or numerically)
- Identify and use strategy necessary to solve problems effectively (e.g. use the distributive property to solve)

**SMU: Strategic Competence**

**TEKS 7.11C**

The student applies mathematical process standards to solve one-variable equations and inequalities. The student is expected to:

(C) Write and solve equations using geometry concepts, including the sum of the angles in a triangle, and angle relationship.

Correct answer: A

**SMU: Adaptive Reasoning**

- Think logically about a problem, which requires reflecting on various approaches to solve a problem and deductively selecting an approach
- Rationalize and justify strategies
- Appropriately explain a procedure or concept

**SMU: Adaptive Reasoning**

**TEKS 3.3H**

The student applies mathematical process standards to represent and explain fractional units. The student is expected to:

(H) Compare two fractions having the same numerator or denominator in problems by reasoning about their sizes and justifying the conclusion using symbols, words, objects, and pictorial models.

Correct answer: A
SMU

**Gallery Walk**

- In your packet of materials is a 4 x 3 matrix with the 4 strands of mathematical proficiency along the top.
- Around the room are 12 problems written to align with the 6th grade TEKS.
- As you read each item, determine the strand of mathematical proficiency and relative level of difficulty.
- Write the number associated with the item in the appropriate cell.

**Assessing Beyond the Algorithm**

**Difficulty Levels**

- **Easy**
  - Basic Knowledge
  - Skills that are familiar to students
  - Sometimes conceptually based
- **Medium**
  - Skills that are peripheral to curriculum
  - Not all students will have mastered these
- **Difficult**
  - Made possible with the use of a tool

(Sleman 1995)

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**SMU**

**Procedural**

<table>
<thead>
<tr>
<th>Easy</th>
<th>Medium</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplify the expression: 11x + 5y - 2y + 4x</td>
<td>11x + 3y</td>
<td>15x + 7y</td>
</tr>
<tr>
<td>Simplify the expression: 7x + 3x + 3</td>
<td>4x + 3</td>
<td>4x + 3</td>
</tr>
<tr>
<td>Simplify the expression: 4(3 + 2) + 5r</td>
<td>17r + 8</td>
<td>17r + 2</td>
</tr>
</tbody>
</table>

**SMU**

**Conceptual**

<table>
<thead>
<tr>
<th>Medium</th>
<th>Difficult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which expression is equivalent? (x + 2)(x + 7)</td>
<td>(x^2 + 14)</td>
</tr>
<tr>
<td>Which expression is equivalent? (5 + 3)(x + 7)</td>
<td>(5 + 7)(3 + 7)</td>
</tr>
<tr>
<td>Which expression is equivalent? 2.1 x 3.5</td>
<td>(2 x 3.5)(0.1 x 3.5)</td>
</tr>
</tbody>
</table>
The length of John’s backyard is 50 feet. Which expression can be used to find the length of John’s backyard in inches?

- $50 \times 12$
- $50 + 12$
- $50 - 12$

Jake reads 3 pages in 1 minute. At this rate, which expression can be used to find how many pages Jake can read in 1 hour?

- $3 \times 60$
- $3 + 60$
- $3 - 60$
- $3 \div 60$

A class has 12 girls and 16 boys. Which expression can be used to find what percentage of the students in the class are boys?

- $\frac{16}{28} \times 100\%$
- $\frac{12}{28} \div 100\%$
- $\frac{16}{28} \div 100\%$
- $\frac{12}{28} \times 100\%$

Doug has 4 fish and 2 dogs. He buys another fish. How does the additional fish change the ratio of dogs to fish?

- The ratio gets smaller because only the denominator increases.
- The ratio gets smaller because only the numerator increases.
- The ratio gets larger because only the denominator increases.
- The ratio gets larger because only the numerator increases.

Which explanation best describes why Model A represents a greater fraction?

- The shaded portion of Model A covers more of the total area than Model B.
- The total area of Model A is larger than the total area of Model B.
- The squares are larger in Model A than in Model B.
- There are fewer un-shaded squares in Model A than in Model B.

Guidelines for Item Development

- Item writing requires careful consideration of:
  - general item-writing procedures
  - overall content of the items
  - response options in multiple choice items

General Item-Writing (Procedures)

- Avoid the complex multiple-choice format. (i.e., A and D, B and C).
- Use plain language.
  - Avoid conditional phrases (if..., then...).
- Keep the language of the stem and response options at the appropriate grade level.
- Minimize examinee reading time.

Assessing Beyond the Algorithm

Assessment Item Development

(SMU)
General Item-Writing (Content)

- Base each item on important content to learn; avoid trivial content.
- Keep the content of each item independent from content of other items on the test.
- Avoid cueing one item with another; keep items independent of one another.
- Avoid items based on opinions.
- Develop items that measure higher-level thinking.
- Avoid potentially insensitive content or language.
- Use present tense.

(Haladyna, 2004)

Response Development

- Make all distractors plausible.
  - Create distractors that represent common misconceptions you may have about the content being assessed.
- Keep all options in an item homogeneous in content and grammatical structure.
- Keep the length of options brief and fairly consistent.
- Phrase options positively, not negatively.

(Haladyna, 2004)

Example of a Well-Written Item

<table>
<thead>
<tr>
<th>Question Item</th>
<th>Stem-Graphic</th>
<th>Correct Answer</th>
<th>Response Choices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Which fraction is greater than zero but less than ( \frac{1}{2} )?</td>
<td>Stem-Graphic</td>
<td>1</td>
<td>A. 1/2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>B. 1/3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>C. 1/4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>D. ( \frac{1}{4} )</td>
</tr>
</tbody>
</table>

Examples of Poorly Written Math Items

- **Example of a Poorly Written Math Item**

  Sue has a box of 2 stars and 2 circles. She wants to make Michelle’s box of 6 stars and 3 circles proportional to her box. How many stars does she need to add to her box to make Michelle’s box proportional to hers?
  - A. 6
  - B. 0
  - C. 2
  - D. 20

Example Writing Practice

- **6.b.4.F**
  - The student applies mathematical process standards to develop an understanding of proportional relationships in problem situations. The student is expected to represent benchmark fractions and percents such as 1%, 10%, 25%, 33 1/3%, and multiples of these values using 10 by 10 grids, strip diagrams, number lines, and numbers.
- **7.b.3.B**
  - The student applies mathematical process standards to add, subtract, multiply, and divide while solving problems and justifying solutions. The student is expected to apply and extend previous understandings of operations to solve problems using addition, subtraction, multiplication, and division of rational numbers.
- **8.b.6.C**
  - The student applies mathematical process standards to develop mathematical relationships and make connections to geometric formulas. The student is expected to use models and diagrams to explain the Pythagorean theorem.
Some Final Thoughts & Take-Aways

• Assessment and instruction should be considered together – performance on assessments can inform instruction and assessments can be specifically designed to provide students with opportunities to demonstrate what they’ve learned during instruction.

• When designing tests or assessments for use in your classroom, be sure to include items that target multiple levels of Strands of Mathematical Proficiency.

• Revisit the guidelines for item development as often as needed to ensure that the items you write provide students with the best opportunity possible to demonstrate their knowledge and understanding of the content.

Get Involved With RME!

RME is always looking for qualified mathematicians, math teachers, and math coaches to partner with us in many ways.

• Item Writing
  – These items range all grades from pre-k to 8th grade, and are written to align with multiple mathematics content standards. RME provides training and writing can be done on-site or off campus.

• Item Reviewers
  – We review an item for language, visual representation, and mathematical content including vocabulary and concepts. In addition, reviewers examine each item for potential bias and to evaluate the effectiveness of the distractors.

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References


