Moving Learning Forward: Academic Measures

March 10, 2022
TeleEDGE: Department of Education Line
Moving Learning Forward Using a System of Assessment
Connecting Learning through a System of Assessment
Questions to Consider

1. How is learning connected through a system of assessment?
2. How and why should we assess at different levels of complexity?
3. How can we use rubrics and checklists to move learning forward?
Connecting learning through an assessment system

Oklahoma recognizes that a **robust assessment system** is tied closely to students’ learning and teachers’ instructional practices. (ESEA Plan, p. 48)
Elements of an assessment system

- There are multiple layers of an assessment system.
- The purposes and uses of assessment information differ at each layer.
- It is important to guard against practices that might have a negative impact on classroom instruction (e.g., teaching to the test, over-testing, narrowing of the curriculum, etc.).

Source: http://www.nicia.org/featured-resources/classroom-assessment
Considerations for connecting assessments in a system to move learning forward

Comprehensive
- The assessment system allows students to demonstrate their understanding in a variety of ways and reflects the breadth and depth of the state content standards.

Coherent
- The assessment system reflects a systemic educational approach to promote deeper and more meaningful learning for students. Assessments in the system are compatible with the underlying model of learning.

Continuous
- The assessment system continuously documents student progress over time.

Efficient
- Each assessment within the system is non-redundant and used to make educational decisions.

Useful
- The assessment system provides the necessary information to make better decisions in a timely fashion and at the right level of specificity to support intended uses.

See paper: “Not as Easy as It Sounds: Designing Balanced Assessment Systems”

Source: http://www.nciea.org/featured-resources/classroom-assessment
Comprehensive

Assessments within the system allows students to demonstrate their understanding in a variety of ways and reflects the breadth and depth of the state content standards.

Source: http://www.nclb.org/featured-resources/classroom-assessment
Coherent

The assessment system reflects a systemic educational approach to promote deeper and more meaningful learning for students. Assessments in the system are compatible with the underlying model of learning.

Source: http://www.ncliea.org/featured-resources/classroom-assessment
Coherent

Assessments and instruction are aligned to the standards. The standards outline grade-level expectations for what students should know and be able to do.

<table>
<thead>
<tr>
<th>Fifth Grade (5)</th>
<th>Sixth Grade (6)</th>
<th>Seventh Grade (7)</th>
<th>Pre-Algebra (PA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5.N.1 Divide multi-digit numbers and solve real-world and mathematical problems using arithmetic.</strong></td>
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<tr>
<td><strong>5.N.1.1 Estimate solutions to division problems in order to assess the reasonableness of results.</strong></td>
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<tr>
<td><strong>5.N.1.2 Divide multi-digit numbers, by one- and two-digit divisors, using efficient and generalizable procedures, based on knowledge of place value, including standard algorithms.</strong></td>
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<tr>
<td><strong>5.N.1.3 Recognize that quotients can be represented in a variety of ways, including a whole number with a remainder, a fraction or mixed number, or a decimal and consider the context in which a problem is situated to select and interpret the most useful form of the quotient for the solution.</strong></td>
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<tr>
<td><strong>5.N.1.4 Solve real-world and mathematical problems requiring addition, subtraction, multiplication, and division of multi-digit whole numbers. Use various strategies, including the inverse relationships between operations, the use of technology, and the context of the problem to assess the reasonableness of results.</strong></td>
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<tr>
<td><strong>6.N.1. Read, write, and represent integers and rational numbers expressed as fractions, decimals, percents, and ratios; write positive integers as products of factors; use these representations in real-world and mathematical situations.</strong></td>
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<tr>
<td><strong>6.N.1.1 Represent integers with counters and on a number line and rational numbers on a number line, recognizing the concepts of opposites, direction, and magnitude; use integers and rational numbers in real-world and mathematical situations, explaining the meaning of 0 in each situation.</strong></td>
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<tr>
<td><strong>6.N.1.2 Compare and order positive rational numbers, represented in various forms, or integers using the symbols &lt;, &gt;, and =.</strong></td>
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<tr>
<td><strong>6.N.1.3 Explain that a percent represents parts out of 100 and ratios “to 100.”</strong></td>
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<tr>
<td><strong>6.N.1.4 Determine equivalences among fractions, decimals, and percents. Select among these representations to solve problems.</strong></td>
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<tr>
<td><strong>6.N.1.5 Factor whole numbers and express prime and composite numbers as a product of prime factors with exponents.</strong></td>
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<tr>
<td><strong>6.N.1.6 Determine the greatest common factor of two or more numbers.</strong></td>
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<tr>
<td><strong>7.N.1 Read, write, represent, and compare rational numbers, expressed as integers, fractions, and decimals.</strong></td>
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<tr>
<td><strong>7.N.1.1 Know that every rational number can be written as the ratio of two integers or as a terminating or repeating decimal.</strong></td>
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<tr>
<td><strong>7.N.1.2 Compare and order rational numbers expressed in various forms using the symbols &lt;, &gt;, and =.</strong></td>
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<tr>
<td><strong>7.N.1.3 Recognize and generate equivalent representations of rational numbers, including equivalent fractions.</strong></td>
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<tr>
<td><strong>7.N.2 Calculate with integers and rational numbers, with and without positive integer exponents, to solve real-world and mathematical problems; explain the relationship between absolute value of a rational number and the distance of that number from zero.</strong></td>
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<tr>
<td><strong>7.N.2.1 Estimate solutions to multiplication and division of integers in order to assess the reasonableness of results.</strong></td>
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<tr>
<td><strong>7.N.2.2 Illustrate multiplication and division of integers using a variety of representations.</strong></td>
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<tr>
<td><strong>7.N.2.3 Solve real-world and</strong></td>
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<tr>
<td><strong>PA.N.1 Read, write, compare, classify, and represent real numbers and use them to solve problems in various contexts.</strong></td>
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<tr>
<td><strong>PA.N.1.1 Develop and apply the properties of integer exponents, including a^n = 1 (with a ≠ 0), to generate equivalent numerical and algebraic expressions.</strong></td>
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<tr>
<td><strong>PA.N.1.2 Express and compare approximations of very large and very small numbers using scientific notation.</strong></td>
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<tr>
<td><strong>PA.N.1.3 Multiply and divide numbers expressed in scientific notation, express the answer in scientific notation.</strong></td>
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<tr>
<td><strong>PA.N.1.4 Classify real numbers as rational or irrational; explain why the rational number system is closed under addition and multiplication and why the irrational system is not. Explain why the sum of a rational number and an irrational number is irrational; and the product of a non-zero rational number and an irrational number is irrational.</strong></td>
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<tr>
<td><strong>PA.N.1.5 Compare real numbers; locate real numbers on a number line. Identify the square root of a perfect square to 400 or, if it is not a perfect square root, locate it as an irrational number between two consecutive positive integers.</strong></td>
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</tbody>
</table>
Continuous

Assessments measure student progress on an ongoing basis to provide timely evidence of learning.
Each assessment within the system is non-redundant and provides timely information and evidence of student learning to make educational decisions.

1. Which assessments are you giving now?
2. Why are you giving this assessment? How is it intended to be used?
3. Is it fulfilling this purpose? How do you know?
4. How does the assessment embody learning goals and what evidence of learning does it provide?
5. To what extent does the information and uses from this assessment overlap with another assessment?

Source: Thompson & Lyons (2017)
Useful

Assessments within the system provide timely information and evidence of what students know and are able to do to inform teaching and learning.
Alignment and Role of State Assessments
State assessments within a balanced system

State, district, and classroom assessments can work together in a coherent system of assessment. Doing so provides educators with timely information on students’ progress and overall achievement each year.

![Diagram showing types of assessments](image)

**State assessments**

**STUDENT**

- **Anually**
  - **Summative:** As indicators of college and career readiness, these assessments are used for state accountability and to inform districts about changes that may be necessary to their programs.
- **Quarterly**
  - **Interim:** As valuable indicators of progress, these assessments can occur at the end of a unit and act as checkpoints to make certain all classes are on track for success across a school or district.
- **Weekly**
  - **Formative:** As checkpoints designed to inform instruction, these assessments are extremely useful for teachers and schools.
- **Daily**
  - **Minute by Minute**

MOVING LEARNING FORWARD: Academic Measures

OKLAHOMA Education
State Summative Assessments in a Typical Year

Grade-Level Expectations

- Is about proficiency on grade-level knowledge
- Is a single snapshot and does not tell the whole story
- Should be used in conjunction with district and classroom assessments to monitor progress and overall achievement

How far am I from end-of-year expectations?
State Summative Assessments from SY 2020-2021

Grade-Level Expectations

- Is still a sound comparison to grade-level expectations
- Tells us the “what” about student performance
- Does not tell us the “why” about student performance
- Helps us understand system-level supports that are necessary to help teachers and students

How much further am I from end-of-year expectations?
Data from state summative assessments

- **Performance Levels**
  - Relates **level of readiness** for the next grade, course or level by connecting student test scores to the OAS as described in the **Performance Level Descriptors (PLDs)**.
  - Four Levels- **Below Basic, Basic, Proficient or Advanced**

- **Performance Index Scale Score (OPI)**
  - Provides a **more specific measure** of readiness to be on track by relating where a score is relative to a **performance level**.
  - **Comparable** scale across all tests from 200-399 wherein 300 is always **Proficient**

- **Reporting Category**
  - Relates confidence level to which students are likely to demonstrate the Proficient level knowledge, skills and abilities (KSAs) with respect to the content represented in the **STANDARD and performance on related questions on the state test**.
  - Three Levels- **Below Standard, At/Near and Above Standard**
  - Students scoring **At/Near or Above** are likely to demonstrate the Proficient level KSAs
OPIs pinpoint performance within a level to help us measure progress from one year to the next.

<table>
<thead>
<tr>
<th>Grade 5 ELA</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 – 270</td>
<td>Below Basic</td>
</tr>
<tr>
<td>271 – 299</td>
<td>Basic</td>
</tr>
<tr>
<td>300 – 322</td>
<td>Proficient</td>
</tr>
<tr>
<td>323 – 399</td>
<td>Advanced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 5 Math</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 – 265</td>
<td>Below Basic</td>
</tr>
<tr>
<td>266 – 299</td>
<td>Basic</td>
</tr>
<tr>
<td>300 – 320</td>
<td>Proficient</td>
</tr>
<tr>
<td>321 – 399</td>
<td>Advanced</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 5 Science</th>
<th>Spring</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 – 271</td>
<td>Below Basic</td>
</tr>
<tr>
<td>272 – 299</td>
<td>Basic</td>
</tr>
<tr>
<td>300 – 329</td>
<td>Proficient</td>
</tr>
<tr>
<td>330 – 399</td>
<td>Advanced</td>
</tr>
</tbody>
</table>

Mean OPI scale scores pinpoint overall performance within a performance level.

OPI scores are obtained by converting raw scores onto a common scale to account for differences in question difficulty.
Why scale scores? Which student showed more mastery?

Student A: 4/6 correct

Student B: 4/6 correct

(1). $1 + 1 =$
(2). $9 + 5 =$
(3). $8.2 + 3.3 =$
(4). $\frac{1}{2} + \frac{1}{3} =$
(5). $6 \frac{2}{3} + 7 \frac{3}{4} =$
(6). $\sum_{n=1}^{100} (n - (n - 1))^n$
It's not about the number correct

Moving Learning Forward: Academic Measures
It's about the difficulty and complexity of what the student is being asked to do.

- **Difficulty** refers to the likelihood that the student will respond correctly.
  - How much effort is needed? (easy or hard)
  - How many people can answer the question correctly?

- **Cognitive complexity** refers to the mental processes required to meet the task.
  - What kind of thinking, action, or knowledge must be demonstrated? (simple or complex)
  - How many different ways can a question be answered, a problem addressed, or a task accomplished?

Source: Sousa: How the Brain Learns
Depth of Knowledge (DOK) is a way to measure Cognitive Complexity.

**DOK 1**
- What is the knowledge?
- Recall and Reproduction

**DOK 2**
- How can the knowledge be used?
- Basic Application of Concepts and Skills

**DOK 3**
- Why can the knowledge be used?
- Strategic Thinking

**DOK 4**
- What else can be done with the knowledge?
- Extended Thinking

Moving Learning Forward: Academic Measures
DOK is not sequential

- Recall and Reproduction
- Skills and Concepts
- Extended Thinking
- Strategic Thinking
<table>
<thead>
<tr>
<th><strong>DOK 1</strong></th>
<th><strong>DOK 2</strong></th>
<th><strong>DOK 3</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RECALL AND REPRODUCTION</strong></td>
<td><strong>SKILLS AND CONCEPTS</strong></td>
<td><strong>STRATEGIC THINKING</strong></td>
</tr>
<tr>
<td>Recall of information, facts, definitions, and/or a simple algorithm</td>
<td>Requires students to make some decisions about how to approach a problem or activity</td>
<td>Requires reasoning, planning, using evidence, and a higher level of thinking. Complexity comes from a higher demand for reasoning, not harder problems.</td>
</tr>
<tr>
<td>Following a set of procedures. (like a recipe)</td>
<td>Working with problems that have more than one step.</td>
<td>- Developing a logical argument,&lt;br&gt; - Making conjectures,&lt;br&gt; - Justifying responses,&lt;br&gt; - Solving non-routine problems</td>
</tr>
<tr>
<td>Applying a formula</td>
<td>Collecting, classifying, organizing, and comparing data.</td>
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<tr>
<td>Performing a clearly defined set of steps.</td>
<td>Organizing and displaying data in charts, graphs, and tables.</td>
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</table>
DOK on the state summative assessment

The Grade 5 test will approximately reflect the following “depth-of-knowledge (DOK)” distribution of items:

<table>
<thead>
<tr>
<th>Depth-of-Knowledge</th>
<th>Percent of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1—Recall and Reproduction</td>
<td>20–30%</td>
</tr>
<tr>
<td>Level 2—Skills and Concepts</td>
<td>65–75%</td>
</tr>
<tr>
<td>Level 3—Strategic Thinking</td>
<td>5–15%</td>
</tr>
</tbody>
</table>

DOK Ranges are based on the DOK of the OAS. The standards increase grade-level expectations and rigor, and set expectations for students to be college- and career-ready.

Source: Test and Item Specs: https://sde.ok.gov/assessment-material
Raising the DOK in math

5.N.3: Add and subtract fractions with like and unlike denominators, mixed numbers, and decimals to solve real-world and mathematical problems.

DOK 1
Find the difference.

\[ 5 \frac{1}{2} - 4 \frac{2}{3} \]

DOK 2
Using the digits 1 to 9 at most one time each, fill in the boxes to create three different mixed numbers that will make the equation true. You may reuse the same digits for each of the three mixed numbers.

\[ 5 \frac{4}{5} - \boxed{\frac{\phantom{1}}}{\boxed{\phantom{1}}} = 3 \frac{1}{20} \]

Source: https://robertkaplinsky.com/depth-of-knowledge-matrix-5th-grade/
Raising the DOK in math

5.N.3: Add and subtract fractions with like and unlike denominators, mixed numbers, and decimals to solve real-world and mathematical problems.

DOK 2
Using the digits 1 to 9 at most one time each, fill in the boxes to create three different mixed numbers that will make the equation true. You may reuse the same digits for each of the three mixed numbers.

\[ 5 \frac{4}{5} - \square \square \square = 3 \frac{1}{20} \]

DOK 3
Using the digits 1 to 9 at most one time each, fill in the boxes to make the smallest difference.

Source: https://robertkaplinsky.com/depth-of-knowledge-matrix-5th-grade/
Assessing at different levels of complexity

- Skills and knowledge must be extended beyond the narrow contexts in which they are initially learned in order for deeper learning to occur.
- It is imperative for the learner to develop a sense of the application of the knowledge (or when the knowledge can be used).
- Transfer most likely occurs when the learner knows and understands the underlying general principles that can be applied to problems in different contexts.
- Conceptual knowledge promotes learning.
- Learners are most successful at learning and will sustain their own learning if they are mindful of themselves as learners and thinkers (i.e., use a metacognitive approach to learning and instruction).

Source: How People Learn II (p.296)
Assessing to move learning forward

● “Assessment can drive the process of learning and motivation in a positive direction by providing feedback that identifies possible improvements and marks progress” (p. 153).

● “Effective formative assessment articulates the learning targets, provides feedback to teachers and students about where they are in relation to those targets, and prompts adjustments to instruction by teachers, as well as changes to learning processes and revision of work products by students” (p.155).

Source: How People Learn II
Excel Team Case Study
Math Theory of Improvement

**AIM**
Students will improve their mathematical reasoning and justification skills (as measured by rubric) each quarter.

**DRIVERS**
- Student Attitudes and Beliefs
- Student Knowledge and Skills
- Teacher Mindsets and Beliefs
- Teacher Knowledge and Skills

**CHANGE IDEAS**
- Selecting and Implementing Cognitively Complex Tasks
  - Puzzle Problems
- Student modeling to communicate understanding
  - Selecting and Implementing Open Ended Tasks
  - Address Unfinished Learning / Misconceptions / Levels of understanding
  - Facilitating discourse and connections
Math Networked Improvement Community

Plan

Act

Do

Study

Moving Learning Forward: Academic Measures
Oklahoma Excel Math Improvement Fellows

Angie Ledgerwood

Oklahoma Connections Academy 4th grade teacher and Excel team member year 1, Fellow years 2 and 3.

Master teacher and Onboarding Trainer for OKCA. Also a member of First Year Instructional Coaching NIC.

Tim Collier

McAlester High School math teacher during first two years as an improvement fellow.

Currently serving as McAlester Public Schools Secondary Academic Design Coordinator and year three improvement fellow.
### Puzzle Problem 32: WODB

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
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<td>2</td>
<td>3</td>
<td>5</td>
<td>4</td>
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Think about what you notice.

Which one doesn’t belong? Why? Explain your reason.

Can you find a reason why a different option doesn’t belong? Why? Explain your thinking.
Math Briefs & Links

How can promoting mathematical reasoning lead to student engagement?

Champions Brief #13

What’s the Issue?

Students often enter a mathematics classroom with anxiety due to negative prior experiences with mathematics. As a result, it can be difficult to maintain consistent student engagement in math topics. When math is taught in a way that allows students to share their own process to solve problems and work together as a team, students and teachers can deep deeply engaged in the material to analyze the task at hand, access background knowledge, synthesize problem-solving strategies, and make inferences about future mathematics concepts and tasks.

As students see their existing and emerging understanding, with collaboration and social negotiation of ideas available, they engage in mathematical reasoning that is essential for the productive and applicable mathematics learning classroom.

This brief provides considerations for fostering a mathematics classroom that encourages students to develop their mathematical reasoning skills and abilities.

WHY IT MATTERS TO YOU

Research shows that students are more likely to retain mathematics that has its foundation in reasoning and sense-making processes. The results of the National Assessment of Educational Progress (NAEP) indicate a list of isolated skills.

Students who are engaged in the education not only learn stronger academic achievements, but also develop better social skills and are more likely to persist through future academic endeavors.

When students have the necessary baseline skills and abilities and are adequately challenged, they can demonstrate high levels of focus and engagement in their learning.

Number Talks, used developed for teachers to engage students in mental math with tasks that increase sense-making and encourage mathematical discussion. Number talks are short and structured strategies that allow students to talk about math with their peers. Students develop a better understanding of math through discovering multiple ways to achieve a math solution. Students use the math that is meaningful to them in different situations. Number Talks use "less time" or "high ceiling" tasks that allow multiple entry points to the task and can vary the difficulty.

Steps for Implementation

1. Start with a mathematical learning goal. All discussions should be anchored by what key understanding the student should have at the end of the session.
2. Choose the number talk. The number talk is the key to helping students compute grade appropriate math tasks without mental strategies. Students should be able to place their thoughts and ideas in their heads and be able to highlight during the student discussion.
3. Plan for student responsibility. Students need to be prepared by their peers with their roles clearly outlined and highlighted during the student discussion.
4. Plan for student responses to the discussion. Have guiding questions or free date notes for the help provide for the students.
5. Present the problem to the students. The students need to take the problem mentally, using whatever strategy works for them. This will allow students multiple entry points to the task and see various ways of solving.
6. Allow students time to thinking. This time allows students to process and then be more comfortable sharing their thoughts with others.
7. Encourage students to examine their own responses. Make sure students are not left to think all students share their ideas with the entire class. Instead, have each student share their mathematical thinking to someone else.
8. Select a few students to share their mathematical thinking. Students need to share their thinking to someone else. This will help students make connections to the mathematical thinking of others.

Considerations

- The focus is not only on the correct answers but also on the possible methods to solving the problems and the explanations of their strategies.
- Make sure your learning goal is represented and that you know which students might struggle with the task at hand.

ALSO SEE CHAMPIONS BRIEFS

150-200: Math Briefs
151: Customizable Math Talks
152: Always, Sometimes, Never

Number Talks

Always, Sometimes, Never

Champions Brief #15 version 0.2

Introduction

A teacher’s job is rich with math tasks that allow a wide range of capabale for our students. This book, Always, Sometimes, Never is an engaging and enriching math strategy that allows students to take a chance at a math problem. These are judgments, true or false, justifications, or informal assessments. When this strategy is used as the basis of class, it helps connect mathematical instruction skills that are essential for a successful student.

1. Plan for students time. Students need sufficient time for students to do research and develop a formulation for their answers. Students should be able to define “why” they chose one of the three responses, justifying logical.

2. Arrange students to share their ideas. Students should be engaged with the discussion. All students need to share their ideas for the discussion to be successful. Students who are sharing their ideas and discussion need to be engaged with the class. Students who discuss their ideas need to be engaged with the class. Students who share their ideas need to be engaged with the class. Students who are sharing their ideas and discussion need to be engaged with the class.

3. Use the number talk. Students need to share their ideas for the discussion. Students who are sharing their ideas and discussion need to be engaged with the class. Students who share their ideas need to be engaged with the class. Students who are sharing their ideas and discussion need to be engaged with the class.

4. Make sure students take their turn. If a student is not engaged or in need of additional support, provide the student with support to ensure their success.

5. Discuss the mathematical reasoning. Consider the question of how we engage with our students. Students need to engage with their peers and share their ideas. This will help students make connections to the mathematical thinking of others.

6. Select a few students to share their ideas. Students need to share their ideas for the discussion. Students who are sharing their ideas and discussion need to be engaged with the class. Students who share their ideas need to be engaged with the class. Students who are sharing their ideas and discussion need to be engaged with the class.

Considerations

- There should be an entry point for every student regardless of content mastery. These tasks should have a "low floor" and "high ceiling" so every student can take their chance with what they see in their mathematical thinking.

- Perform a self-assessment. Each student should assess their own understanding by stating "always, sometimes, never" in response to the statement.

- Encourage students to engage. Engage them in the discussion and highlight their ideas. Students need to share their ideas for the discussion. Students who are sharing their ideas and discussion need to be engaged with the class. Students who share their ideas need to be engaged with the class. Students who are sharing their ideas and discussion need to be engaged with the class.
Math Justification and Reasoning Rubric

This rubric allows for a formative assessment of how students are able to explain their mathematical thinking and provide a justification. Justifications evaluated using the rubric can be written or verbal.

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<thead>
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<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No attempt was made to justify OR Justification is missing all critical components</td>
<td>Justification is too difficult to understand or is missing 3 of the critical components AND The solution may be correct or incorrect</td>
<td>Justification is difficult to understand and/or is missing 2 of the critical components AND The solution may be correct or incorrect</td>
<td>Justification is clear and includes at least 3 critical components AND The solution may be correct, but may also include minor calculation errors</td>
<td>Justification is detailed and clear and includes all 4 critical components AND The solution must be correct</td>
</tr>
</tbody>
</table>

Critical Components of Mathematical Justifications
- WHAT they got as the answer
- HOW they got to that answer
- WHY they chose the strategies or operations they used
- WHY their answer is correct
Justification and Reasoning Data

**McAlester 19/20**

Average Score and Mode Score by Administration

**OKCA 19/20**

Average Score and Mode Score by Administration
Cognitively Complex Tasks

Cognitively Complex Math Tasks
(Champions Brief #20 version 0.4)

Introduction
When students engage in tasks that are cognitively demanding and complex, it helps them make connections between math and real-life experiences all while deepening their level of understanding. With proper planning, students will likely find these tasks exciting as they experience the rigor, richness, and flexibility of math. When students engage with a cognitively demanding task, they must rely on multiple mental resources, including higher thinking skills and the ability to make connections. It encourages students to do “processes with connections” and to be “doing math.” NCTM and the Mathematics Tasks Framework identifies four Levels of Cognitive Demand that can be used to analyze the complexity of classroom tasks.

Steps for Implementation
1. Start with a mathematical learning goal. All instruction should be anchored by which key understandings you need students to walk away with.
2. Try the task yourself to evaluate the rigor of the task and identify potential student processes, misconceptions, or roadblocks.
3. Make your existing tasks more complex with some simple adjustments such as removing a number or value from a problem, words or labels from a visual, or phrase the question in an open-ended format.
4. Create or locate new tasks that emphasize having students think, connect, and require considerable cognitive effort.
5. Take the time to plan the implementation of your appropriate task. Planning out responses to student misconceptions and thought processes ensures a smoother implementation of the task. Prepare yourself with guiding questions to move their thinking forward and toward the lesson goal.
6. Task directions should be clear, concise, and allow for freedom of thought. Ambiguity of “what” to do in a task is an obstacle that can lead to lower student performance.
7. Create a classroom culture where students know what to do if they engage in productive struggle or feel stuck.
8. Establish classroom discussion norms before attempting collaboration or discourse so students feel safe and secure in sharing their ideas and thoughts and understand all voices have value.
9. Plan for appropriate think time to process and ask questions when giving cognitively demanding tasks. Students should not immediately know the answer and will have to process, question, make a plan, test, and modify thinking, which takes time.

Considerations
- Cognitive complexity is not synonymous with complicated. Complexity indicates that depth of thinking is required rather than complicated tasks with multiple steps to be followed.
- Cognitively complex tasks use rigorous thought to engage students in activities of sustained mental taxation. Rigor is embedded within a cognitively complex

Depth of Knowledge Matrix – Elementary & Secondary Math
February 4, 2015

Depth of Knowledge Matrix - Elementary & Secondary Math

<table>
<thead>
<tr>
<th>CCSS</th>
<th>Adding Whole Numbers</th>
<th>Money</th>
<th>Fractions on a Number Line</th>
<th>Area and Perimeter</th>
<th>Subtracting Mixed Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>DOK 1 Example</td>
<td>Find the sum.</td>
<td>44 + 27 =</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 2 Example</td>
<td>Fill in the boxes below using the whole numbers 1 through 9, no more than one time each, and make it a true equation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 3 Example</td>
<td>If you have 2 dimes and 7 pennies, how many cents do you have?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 4 Example</td>
<td>Which point is located at 3 1/4 on the number line? Be as precise as possible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 5 Example</td>
<td>Label the point where 1 1/4 belongs on the number line. Be as precise as possible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 6 Example</td>
<td>Make 47¢ in change with four different ways. Be as precise as possible.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 7 Example</td>
<td>Write three different fractions that will make the equation true by using whole numbers from 1 through 9, no more than one number per equation.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOK 8 Example</td>
<td>Use each of the numbers 1 through 9, no more than one number per equation, to make the equation true.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Also see Champions Briefs:
#14 Which One Doesn't Belong?
#15 Would You Rather?
#19 Number Talks
#21 Always, Sometimes, Never

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https://edl.ca.ok.gov/elementary-math-development
Math Justification and Reasoning Rubric

This rubric allows for a formative assessment of how students are able to explain their mathematical thinking and provide a justification. Justifications evaluated using the rubric can be written or verbal.

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>No attempt was made to justify OR Justification is missing all critical components</td>
<td>Justification is too difficult to understand or is missing 3 of the critical components AND The solution may be correct or incorrect</td>
<td>Justification is too difficult to understand and/or is missing 2 of the critical components AND The solution may be correct or incorrect</td>
<td>Justification is clear and includes at least 3 critical components AND The solution may be correct, but may also include minor calculation errors</td>
<td>Justification is detailed and clear and includes all 4 critical components AND The solution must be correct</td>
</tr>
</tbody>
</table>

Critical Components of Mathematical Justifications

- WHAT they got as the answer
- HOW they got to their answer - visual or mathematical representation
- HOW they got to their answer - written or verbal explanation
- WHY they chose the strategies or operations they used OR WHY their strategy works to solve the problem
Implementing Cognitively Complex Tasks

McAlester 20/21

OKCA 20/21

*Data interruptions due to Covid
Mathematical Modeling

Once students became familiar with explaining and justifying the reasons for their answers, the NIC moved up to implementing mathematical modeling tasks.

These cognitively complex tasks incorporate:

• low floors/ high ceilings to enter the problem,
• comprehension of the question,
• selecting an appropriate strategy, establishing connections to the work,
• and making sure the solution/model answered the original question.
Choosing appropriate tasks are important

Modeling Task Checklist

During PDSA cycles 1 & 2, present students with 2 modeling tasks each cycle. Use this checklist to analyze the modeling task. Attach the checklist with a task lesson plan and upload to the District Task Folder as one document with your name and date taught as the document title. These are required and will be used to reflect upon data at a later time.

MUST HAVES:

☐ The task encourages students to start with a big, messy, real-world problem?
☐ The task is accessible to learners with a wide range of abilities.
☐ The task lends itself to a variety of approaches and representations.
☐ This task addresses the learning target.
☐ The task helps students connect to math outside of the classroom?
☐ This task encourages collaboration and discussion.
☐ This task is interesting and engaging from a student viewpoint.
☐ This task encourages creativity, individuality, and variety in the application of knowledge.

Task reflection:

Implementation reflection:
Student Facing Checklist

Before you turn in your math modeling, did you:

- Answer the problem (PS)
- Show an equation (Communicate)
- Use math words to explain (Connect)
- Explain how your answer connects to the problem with words (Connect)
- Show your thinking: use pictures, models, tables, or some that explains how you got your answer (PS & Representation)
Assess the Task- Formative or Summative

Math Academic Achievement Modeling Rubric (v.2)

Every PDSA cycle, present students with 2 modeling tasks. Use this rubric to analyze their work and upload scores to the district data sheet. Scores will be given for the four components and also the final total score.

<table>
<thead>
<tr>
<th>Problem Solving (identify problem, choose strategy, generate solution)</th>
<th>Communication (Evidence)</th>
<th>Connections (Justify/Reason)</th>
<th>Representation (Conclusion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Expert</td>
<td>An efficient strategy is chosen and progress toward a solution is evaluated, with a reasonable answer.</td>
<td>Formal math language is used to share and clarify ideas. At least two formal math terms or symbolic notations are evident in any combination.</td>
<td>Mathematical connections are used to extend the solution to other mathematics or to a deeper understanding of the mathematics in the task.</td>
</tr>
<tr>
<td>3 Practitioner</td>
<td>A correct strategy is chosen based on the mathematical situation in the task with a reasonable answer.</td>
<td>Formal math language is used to share and clarify ideas. One formal math term or symbolic notation is used in any combination.</td>
<td>A mathematical connection is made. Proper contexts are identified (if the both the connection and the solution in the task are correct).</td>
</tr>
<tr>
<td>2 Apprentice</td>
<td>A partially correct strategy is chosen, or a correct strategy for solving only part of the task is chosen.</td>
<td>An attempt is made to use formal math language. Zero formal math terms or symbolic notation is evident.</td>
<td>A mathematical connection is attempted but is partially incorrect or lacks contextual relevance.</td>
</tr>
<tr>
<td>1 Novice</td>
<td>No strategy is chosen, or a strategy is chosen that will not lead to a solution.</td>
<td>No formal mathematical terms or symbolic notations are evident.</td>
<td>NO connections are made or connections are mathematically or contextually irrelevant.</td>
</tr>
</tbody>
</table>

Generate a total score as overall justification and reasoning score: 4-8 = Novice, 7-10 = Apprentice, 11-14 = Practitioner (Mastery), 15-16 = Expert
Questions for Tim and Angie

● Can you describe how you use these tasks in your classrooms with students?
● Describe your experience before Oklahoma Excel in assessing student thinking.

● What impact has using these tasks and rubrics had on teaching and learning in your classroom?
● What challenges, or limitations, have you encountered with using rubrics to assess student justifications?
● What advice would you give to other teachers who are interested in using complex tasks and rubrics?
Next Echo

- April 14th: 3:30-4:30
- Using Practical Measures to Move Learning Forward