2020-2021 Mathematics Restart
Instructional Resource Guide

Introduction for K-12 Stakeholders

This document is designed to organize and deliver high quality mathematical resources available to stakeholders involved in the mathematics education of students in our schools. As you are aware, COVID 19 moved classrooms filled with discovery, voice, collaboration, dialogue, debate, observation, empathy, cross pollination, a teacher's nod (hug, smile etc.), to a screen or worksheet based instructional world. This new world has led to increased opportunity gaps for many students in our schools. The equity and access issues have become even more impactful. This document will serve as a support to help equalize the status of all learners as they enter back into our buildings or online platforms in the Fall of 2020. Please do not stop grade level instruction and reteach concepts from the end of 2019/20, but rather seamlessly and authentically weave it into the discovery process of on grade level material. The Ohio standards are scaffolded and progress so beautifully that this should come rather quickly.

The classroom teacher is the single most impactful element in students' learning. With that in mind, this document will deliver resources and information that can be used to guide the teacher. This document will provide many resources for content, but it is how students interact with the content that truly makes learning meaningful in math. One consideration while planning lessons is the Standards for Mathematical Practice (SMP's). Think of these as your instructional targets with the content standards as the vehicle to teach the SMP's. Also, please consider that most students learn best and conceptualize when they are innovating and creating solution pathways of their own. This means the direct instruction on how to simplify expressions, or solve equations should not be taught and practiced, but rather explored so that solution pathways are created and invented by the students. This allows for them to enter at their own levels of understanding and will help equalize classroom status through more access. Learning will become authentic as opposed to practicing someone else's thinking with no meaning or ownership. This authentic approach is precisely how we encourage students to fill gaps from prior years.

Finally, we know this document will not "fix" all the difficulties stakeholders will face, but it will guide you to high quality supports. The resources, assessments, and suggestions for professional development are based upon colleagues' experiences from a variety of districts around the state. These are not endorsed by the Ohio Department of Education nor are they mandated by the ODE. They are recommended resources for districts that may choose to use them. Research shows a single process or program will not work for all children. Therefore, districts need to utilize multiple literacy and numeracy measures to reach all children. Remember, it is how students interact with the content standards that will matter most, not the content itself. This is exciting work, and we should all embrace and champion our calling.

"We thrive not when we have done it all, but when we still have more to do." Sarah Lewis

How to use this document:

1. **As you consider a local plan for the return to school, use this document as a guide to support cohesive instruction by becoming familiar with content across grade levels and identifying opportunities and strategies to embed missing content within current grade-level instruction.**

2. **Work with previous course or grade-level teachers to determine which standards were underemphasized or left out in the spring of 2020. Use this document to quickly find related topics where these standards can be addressed with the students in your classroom. Note that topics may need to be recovered over multiple years as standards develop. Remember, the goal is not to cover material, but to expand the questions you ask and tasks you provide to allow students to explore the standards they may have missed. The COVID-19 Gap Analysis tools linked here for K-8 and High School, will be helpful to stimulate conversations across grade levels and courses as teachers determine where students may need additional support.**

3. **Read the text outlining the Standards for Mathematical Practice (SMPs), Critical Areas of Focus, and Conceptual Categories (High School)**

    a. **"The Standards for Mathematical Practice describe the skills that mathematics educators should seek to develop in their students." Note that each SMP begins with a statement indicating what the students will do. Teachers should use care to build these practices in students, beyond demonstrating them as instructors. Every lesson should be designed to support students working in one or more of these practices. (Obtained from Ohio's Descriptions of Standards for Mathematical Practices)**
    b. **The Critical Areas of Focus for K-8 and the Conceptual Categories for High School "portray a coherent view of mathematics." They paint the mathematical learning picture using broad strokes. For High School the Conceptual Categories are then narrowed down to Critical Areas of Focus for each course, which are supported by specific standards. (Obtained from 2017 Ohio's Learning Standards)**

4. **Explore the Model Curriculum and other resources.**
    a. **Remember that the standards inform the teachers what content to teach. They are not intended to instruct teachers on how to teach. The ODE provides the Model Curriculum with Instructional Supports to help teachers take a deep dive into their pedagogical practice, but ultimately the teacher is the expert in the classroom who is responsible for selecting best practices for his or her students.**
    b. **Please see the "How to Facilitate Learning" section for best practices. This section includes: *Executive Summary of Principles to Actions, Nix the Tricks, Tru Teaching for Robust Learning and Restarting School: Planning for Acceleration in 20/21.***

Quick Link to Grades K-2
Quick Link to Grades 3-5
Quick Link to Grades 6-8
Quick Link to High School

Back to Top

Critical Areas at a Glance K-2

Kindergarten **(Critical Areas/Big Ideas)**	**Grade 1** **(Critical Areas/Big Ideas)**	**Grade 2** **(Critical Areas/Big Ideas)**
1. Representing and comparing whole numbers, initially with sets of objects 2. Describing shapes and space *More learning time in Kindergarten should be devoted to number play than to other topics	1. Developing understanding of addition, subtraction, and strategies for addition and subtraction within 20 2. Developing understanding of whole number relationships and place value, including grouping in tens and ones 3. Developing understanding of linear measurement and measuring lengths as iterating length units 4. Reasoning about attributes of, and composing and decomposing geometric shapes	1. Extending understanding of base-ten notation 2. Building fluency with addition and subtraction 3. Using standard units of measure 4. Describing and analyzing shapes
In kindergarten emphasis should be on the development of conceptual understanding through mathematical play. Students should leave kindergarten having experienced number play through 100. These experiences, to name a few, should include patterns of base ten, decade patterns, and the use of number words such as before/after and less/more. Students will gradually develop and strengthen computational skills through multiple opportunities to subitize numbers. As foundational skills develop with repeated and consistent opportunities to explore and learn conceptually, memorization is not appropriate or necessary. Through mathematical play, students will recognize the structure and patterns needed to count to 100, and build the basis for place value used in later grades.	*Students in first grade will extend the counting sequence from 100 to 120. This extension should include counting by 1's and 10's. Also, if students can cross 100, they will most likely be able to extend patterns to cross other centuries and develop the ability to extend patterns. Also, counting by the 10's off the decade will be an important instructional shift for students.* *Computation starts with building the structure of 10. Students will use their knowledge of 5's from K, to help them build their 10's. Developing structure to ten will be an important step in developing non-count by one strategies. Teachers should not teach count-on, count-back, count-up to subtract, or make a friendly 10, etc. These strategies develop authentically when students understand the base ten patterns and have structure.* *Building true conceptual place value begins with 10's and 1's (positions need not be taught understanding should be discovered based on value).*	*Second grade is the hallmark place value year for addition and subtraction computation. It is when students take an understanding of 10's and 1's and start to generalize to 100's, but more importantly they use place value as an efficient strategy to compute. The strategies invented and created in first grade through the authentic experiences, and not simply shown how, are expanded upon, and strategically used for efficiency. For example, decomposing into place value multiples works well for addition, but not subtraction. This is something students need to explore and play with all year. Do not start triple digit exploration until the last part of school. Time spent developing these concepts will support the students' future learning.* *Counting routines are still very important, and expand on 1's and 10's (on and off decade) to include 100's on and off the century….passing the millennium to extend patterns.* *Structure builds from the 5 and 10 to 20 in grade two. This would satisfy the fluency standard of single digit numbers (Memorization of facts does not deepen their understanding).*
Kindergarten Resources/Supports	**1st Grade Resources/Supports**	**2nd Grade Resources/Supports**

Back to Top

Critical Areas at a Glance 3-5

Grade 3 **(Critical Areas/Big Ideas)**	**Grade 4** **(Critical Areas/Big Ideas)**	**Grade 5** **(Critical Areas/Big Ideas)**
1. Developing understanding of multiplication and division and strategies for multiplication and division within 100 2. Developing understanding of fractions, especially unit fractions (fractions with numerator 1) 3. Developing understanding of the structure of rectangular arrays and of area 4. Describing and analyzing two-dimensional shapes 5. Solving multi-step problems	1. Developing an understanding and fluency with multi-digit multiplication, and developing understanding of dividing to find quotients involving multi-digit dividends as part of effectively and efficiently performing multi-digit arithmetic 2. Developing an understanding of fraction equivalence, addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers 3. Understanding that geometric figures can be analyzed and classified based on their properties, such as having parallel sides, perpendicular sides, and particular angle measures.	1. Developing fluency with addition and subtraction of fractions and developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions) 2. Extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations 3. Developing understanding of volume 4. Modeling numerical relationships with the coordinate plane 5. Classifying two-dimensional figures by properties
The third grade is the opportune time to facilitate the understanding of multiplication and fractions. Developing multiplicative thinking will build students' fact fluency. Students will invent and create strategies for single digit times single digit numbers. Skip counting by multiples as a strategy to multiply interrupts important multiplicative thinking. *Third grade is the time to slow down and allow students to develop their understanding of multiplication and fractions. Instruction of fractions must allow for the full development of understanding in the relationship between numerator/denominator. Teaching students a computational strategy, or a concrete tool that gives them the correct answer, will not deepen their understanding.* *Third graders should be finalizing their place value computational strategies at this level while extending from 100's to millions. Third grade also marks the beginning of area and perimeter and should be taught throughout the year.*	*Fourth grade students will extend their inventive strategies to solve and conceptualize multiplicative thinking to double digit numbers, and to comparisons. These are two big ideas, and allowing students to experiment with inventive strategies, will deepen their understanding. The area model as a teaching tool to get answers, should be introduced only after students have invented partial products strategies using place value or other parts. Remember not to rush instruction just to get to answers. These are skills and understanding that are deep and will take time for young students to work through.* *Place value will be generalized from whole numbers to 10ths and 100ths. This transition is only difficult if students have not conceptualized place value in whole numbers. Decimals are a part of the number system, and should be used naturally all year.* *Fractions should focus on equivalence and unit fractions. Please see the resources later in this document.*	*Fifth graders take their fraction understanding from fourth grade (equivalence, computation with same denominator) and extend to adding and subtracting fractions with unlike denominators.* *Fifth graders also begin their multiplication and division of fractions, and it is very important that these are not algorithmically taught. They must be explored and proved using reasoning and models. Teaching and showing the model does not equal conceptualization (we can't teach to conceptualize, only offer situations so students can conceptualize). Multiplication by fraction by fraction and division with a whole number and unit fraction (with either being the divisor or dividend).* *The only standard algorithm fifth grade sees is for multiplication of whole numbers. This does not include fractions or decimals. Students will invent solution pathways to division of decimal by whole number problems ("Swooping the decimal" is an algorithm).*
3rd Grade Resources/Supports	**4th Grade Resources/Supports**	**5th Grade Resources/Supports**

Back to Top

Critical Areas at a Glance 6-8

Grade 6 **(Critical Areas/Big Ideas)**	**Grade 7** **(Critical Areas/Big Ideas)**	**Grade 8** **(Critical Areas/Big Ideas)**
1. Connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems 2. Completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers 3. Writing, interpreting, and using expressions and equations 4. Developing understanding of statistical problem solving 5. Solving problems involving area, surface area, and volume	1. Developing understanding of and applying proportional relationships 2. Developing understanding of operations with rational numbers and working with expressions and linear equations 3. Solving problems involving scale drawings and informal geometric constructions, angles, and working with two- and three-dimensional shapes to solve problems involving area, surface area, and volume 4. Drawing inferences about populations based on samples 5. Investigating chance	1. Formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations 2. Grasping the concept of a function and using functions to describe quantitative relationships 3. Analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem 4. Working with irrational numbers, integer exponents, and scientific notation
Students develop the concept of ratio and rate in the 6th grade and discover how these ideas are similar to and different from fractions. Emphasis should be placed on understanding that a ratio compares two things (units matter) and that there are numerous ways to find equivalent ratios and unit rates. Proportional reasoning begins in sixth grade but is formally defined in grade 7. Students should not be shown "cross products" as there are many other ways students can focus on finding equivalence. *Students come to sixth grade with a strong understanding of fractions and finish their work with computing with fractions by developing numerous ways to divide fractions by fractions. Students' reasoning is developed through the use of models which are then connected to number sentences. They may develop many models for grouping and sharing strategies that connect to division number sentences.* *6th Grade students apply and extend previous*	*Students continue to strengthen their understanding and use of equivalent ratios, and define this concept as a proportion. Students learn what it means for two geometric shapes to be similar and use their proportional reasoning knowledge to create similar shapes and find missing side lengths within these shapes. As in sixth grade the focus for finding missing values in proportional situations should not emphasize cross products. There should be an emphasis placed on the multiple strategies students create including but not limited to, repeated addition or multiplication that relates things being compared. Given quality tasks, time to explore, and time to analyze/critique various strategies, students will develop very efficient and meaningful ways to see equivalence in ratios.* *Students develop their understanding of linear relationships of the form y=mx. Students need ample opportunities to explore rates of change in linear relationships with tables, graphs, stories, and equations. When students have a strong understanding of*	*Students continue their work with linear relationships by expanding to situations that don't have a y-intercept of 0. Again, students deserve plenty of experiences working with tables, graphs, stories, and equations as they explore how rates of change and y-intercepts impact each representation.* *Students also work with systems of linear equations to find the number of solutions (none, one, or infinite solutions). The main emphasis in eighth grade is on using tables, graphs, and making inferences to do this analysis.* *Students begin understanding the meaning of a function although emphasis on function notation is not required. Teachers are highly encouraged not to teach the vertical line test. Instead, students need to develop understanding that functions have at most one dependent value for each independent value.* *Students explore the area of squares off sides of right*

understandings of numbers to the system of rational numbers (including decimals and negative numbers). A great deal of time in sixth grade is focused on helping students move from arithmetic to algebraic thinking, representation, and notation. Order of operations, the Distributive Property, working with whole number exponents, and writing equivalent expressions with variables are explored. Students are also asked to represent and analyze relationships between dependent and independent variables. *Students extend their understanding of the area of rectangles in previous grades to an understanding of the area of other polygons. Students discover that the area of any triangle is half of the area of a parallelogram. Students begin work with volume in grade 5 and grade 6 continues this using fractional edge lengths. Students also develop strategies for finding the surface area of prisms, pyramids, and other solids using nets. This will be the foundation for future work in geometric measurement for three-dimensional figures.* *Students will be introduced to and develop a conceptual understanding of the four steps of the GAISE model for statistical problem solving, which will be used throughout high school. The focus of these standards is to recognize and understand the process of the GAISE model, with focus on steps 1 and 2, Level A. Students begin to think and reason statistically by first recognizing and formulating a statistical question as one that can be answered by collecting data. They learn that the data collected to answer a statistical question have a distribution that is often summarized in terms of center, variability, and shape.*	*proportion, they can develop ways to examine linear relationships and know when the relationship between the two variables is proportional because they see equivalent ratios from the data set (excluding the origin). They are able to do this without memorizing a rule such as "if the line goes through the origin of a graph…"* *In grade 7 students begin exploring probability and extend their knowledge from 6th grade to statistical situations.*	*triangles, and develop the Pythagorean Theorem as they realize the sum of the areas of the squares of the legs of any right triangle will equal the area of the square off the hypotenuse side. Students use this understanding to find missing side lengths for right triangles. This work can help students develop their understanding of irrational numbers.* *Students also continue their work with volume and learn that the volumes of cones, cylinders, and spheres who have the same radius and height have a wonderful fractional relationship. The cone's volume is ⅓ of the cylinder and ½ of the sphere. And, the sphere's volume is twice that of the cone and ⅔ of the cylinder.*
6th Grade Resources/Supports	**7th Grade Resources/Supports**	**8th Grade Resources/Supports**

Back to Top

High School Conceptual Categories at a Glance

Algebra 1	Geometry	Algebra 2
Modeling: Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. **Statistics and Probability** ● Descriptive Statistics **Number and Quantity** ● Quantities **Algebra** ● Seeing Structure in Expressions ● Arithmetic with Polynomials and Rational Expressions ● Creating Equations ● Reasoning with Equations and Inequalities **Functions** ● Interpreting Functions ● Building Functions ● Linear, Quadratic, and Exponential Models	**Modeling:** Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. **Statistics and Probability** ● Conditional Probability and the Rules of Probability ● Using Probability to Make Decisions **Geometry** ● Congruence ● Similarity, Right Triangles, and Trigonometry ● Circles ● Modeling in Geometry ● Expressing Geometric Properties with Equations ● Geometric Measurement and Dimension	**Modeling:** Modeling is best interpreted not as a collection of isolated topics but rather in relation to other standards. **Statistics and Probability** ● Interpreting Categorical and Quantitative Data ● Making Inferences and Justifying Conclusions **Number and Quantity** ● The Real Number System ● The Complex Number System **Algebra** ● Seeing Structure in Expressions ● Arithmetic with Polynomials and Rational Expressions ● Creating Equations ● Reasoning with Equations and Inequalities **Functions** ● Interpreting Functions ● Building Functions ● Linear, Quadratic, and Exponential Models ● Trigonometric Functions **Geometry** ● Similarity, Right Triangles, and Trigonometry ● Circles
Algebra 1 Resources/Supports	**Geometry Resources/Supports**	**Algebra 2 Resources/Supports**

At the high school level, students build on mathematical understanding that is developed in earlier grades. Content and reasoning become more sophisticated, and standards become more specific. Also, many schools maintain the Algebra 1, Geometry, Algebra 2 course sequence. Thus, there is a temptation for teachers to compartmentalize instruction and methodology to only those topics that immediately pertain to the specific course he or she teachers. While a thorough understanding of course standards is crucial for effective instruction, teachers in any circumstance could improve student learning by developing an understanding of how student learning progresses throughout a high school career. Our hope is that this document will provide an overview of high school content while supporting teachers in their own professional development from the resources available for cohesive instruction across the high school courses. The course-specific resources and supports provide more detailed information on course content and practices and should serve as a springboard for further investigation.

Back to Top

Kindergarten

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Representing, relating, and operating on whole numbers, initially with sets of objects

Students use numbers, including written numerals, to represent quantities and to solve quantitative problems, such as counting objects in a set; counting out a given number of objects; comparing sets or numerals; and modeling simple joining and separating situations with sets of objects, or eventually with equations such as 5 + 2 = 7 and 7 – 2 = 5. (Kindergarten students should see addition and subtraction equations, and student writing of equations in kindergarten is encouraged, but it is not required.) Students choose, combine, and apply effective strategies for answering quantitative questions, including quickly recognizing the cardinalities of small sets of objects, counting and producing sets of given sizes, counting the number of objects in combined sets, or counting the number of objects that remain in a set after some are taken away.

Critical Skills from PreK to K

ODE Progressions

PreK (3-5 years)

- Count to 20 by ones with increasing accuracy (Number Sense: Number Sense and Counting)
- Identify and name numerals 1-9 (Number Sense:Number Sense and Counting)
- Demonstrate one-to-one correspondence when counting objects up to 10 (Number Sense: Number Sense and Counting)
- Understand that the last number spoken tells the number of objects counted (Number Sense:Number Sense and Counting)
- Identify whether the number of objects in one group is greater than, less than or equal to the number of objects in another group up to 10(Number Sense:Number Sense and Counting)
- Count to solve simple addition and subtraction problems with totals smaller than 8, using concrete objects(Number Relationships and Operations:Number Relationships)
- Identify without counting small quantities of up to 3 items (Subsidize) (Number Sense: Number Sense and Counting)
- Recognize, duplicate and extend simple patterns using attributes such as color, shape or size (Algebra: Patterning)

How to Facilitate Learning

(We believe students should be doing the thinking)

PDF Executive Summary of NCTM's Principles to Actions
(The big picture of what our students deserve)

Kindergarten Model Curriculum
(Instructional supports coming soon)

Teaching for Robust Learning (Tru) Framework
(Explore the five dimensions of powerful classrooms)

Restarting School: Planning for Acceleration in 20/21
(Embedding missed content into current grade level material)

Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

Kindergarten Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In Kindergarten, students begin to build the understanding that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Real-life experiences should be used to support students' ability to connect mathematics to the world. To help students connect the language of mathematics to everyday life, ask students questions such as "How many students are absent?" or have them gather enough blocks for the students at their table. Younger students may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" or they may try another strategy.

MP.2 Reason abstractly and quantitatively. Younger students begin to recognize that a number represents a specific quantity. Then, they connect the quantity to written symbols. Quantitative reasoning entails creating a representation of a problem while attending to the meanings of the quantities. For example, a student may write the numeral 11 to represent an amount of objects counted, select the correct number card 17 to follow 16 on a calendar, or build two piles of counters to compare

Kindergarten Continued

- Order objects by measurable attribute (e.g., biggest to smallest, etc. (Measurement and Data: Describe and Compare Measurable Attributes)
- Sort and classify objects by one or more attributes (e.g, size, number) (Algebra: Group and Categorize)
- Create patterns (Algebra: Patterning)
- Collect data by categories to answer simple questions (Measurement and Data: Data Analysis)
- Measure length and volume(capcity) using non-standard or standard measurement tools(Measurement and Data: Describe and Compare Measurable Attributes)

Information obtained from:
Ohio's Early Learning & Development Standards • www.education.ohio.gov • www.jfs.ohio.gov

K

- Know number names and the count sequence. (K.CC.1,2,3)
- Count to tell the number of objects (K.CC.4,5)
- Compare numbers (K.CC.6,7)
- Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from (K.OA.1,2,3,4,5)
- Work with numbers 11-19 to gain foundations for place value(K.NBT.1)
- Identify, describe, and compare measurable attributes (K.MD.2)
- Classify objects and count the number of objects in each category (K.MD.3)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 2: Describing shapes and space.

Students describe their physical world using geometric ideas, e.g., shape, orientation, spatial relations, and vocabulary. They identify, name, and describe basic two-dimensional shapes, such as squares, triangles, circles, rectangles, and hexagons, presented in a variety of ways, e.g., with different sizes and orientations, as well as three-dimensional shapes such as cubes, cones, cylinders, and spheres. They use basic shapes and spatial reasoning to model objects in their environment and to construct more complex shapes.

Critical Skills from PreK to K
ODE Progressions

PreK (3-5 years)

- Describe and compare objects using measurable attributes (e.g., length, size, capacity and weight)(Measurement and Data: Describe and Compare

the numbers 5 and 8. In addition, kindergarten students begin to draw pictures, manipulate objects, or use diagrams or charts to express quantitative ideas. Students need to be encouraged to answer questions such as "How do you know?", which reinforces their reasoning and understanding and helps students develop mathematical language.

MP.3 Construct viable arguments and critique the reasoning of others. Younger students construct arguments using concrete referents, such as objects, pictures, drawings, and actions. They also begin to develop their mathematical communication skills as they participate in mathematical discussions involving questions like "How did you get that?" and "Why is that true?" They explain their thinking to others and respond to others' thinking. They begin to develop the ability to reason and analyze situations as they consider questions such as "Are you sure that ___?", "Do you think that would happen all the time?", and "I wonder why ___?"

MP.4 Model with mathematics. In early grades, students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, acting out, making a chart or list, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. For example, a student may use cubes or tiles to show the different number pairs for 5, or place three objects on a 10-frame and then determine how many more are needed to "make a ten." Students rely on manipulatives (or other visual and concrete representations) while solving tasks and record an answer with a drawing or equation.

MP.5 Use appropriate tools strategically. Younger students begin to consider the available tools (including estimation) when solving a mathematical problem and decide when certain tools might be helpful. For instance, kindergarteners may decide that it might be advantageous to use linking cubes to represent two quantities and then compare the two representations side-by-side or later, make math drawings of the quantities. Students decide which tools may be helpful to use depending on the problem or task and explain why they use particular mathematical tools.

MP.6 Attend to precision. Kindergarten students begin to develop precise communication skills, calculations, and measurements. Students describe their own actions, strategies, and reasoning using grade level appropriate vocabulary. Opportunities to work with pictorial representations and concrete objects can help students develop understanding and descriptive vocabulary. For example, students describe and compare two- and three-dimensional shapes and sort objects based on appearance. While measuring objects iteratively (repetitively), students check to make sure that there are no gaps or overlaps. During

Measurable Attributes)

Kindergarten Continued

- Demonstrate understanding of the relative position of objects using terms such as in/on/under/up/down, inside/outside, above/below, beside/between, in front of/behind and next to.(Geometry: Spatial Relationships)
- Understand and use names of shapes when identifying objects.(Geometry: Identify and Describe Shapes)
- Name three-dimensional objects using informal, descriptive vocabulary (e.g., “cube” for box, “ice cream cone” for cone, “ball” for sphere, etc.).(Geometry: Identify and Describe Shapes)
- Compare two-dimensional shapes, in different sizes and orientations using informal language.(Geometry: Analyze, Compare and Create Shapes)
- Create shapes during play by building, drawing, etc.(Geometry: Analyze, Compare and Create Shapes)
- Combine simple shapes to form larger shapes.(Geometry: Analyze, Compare and Create Shapes)

Information obtained from:
Ohio’s Early Learning & Development Standards • www.education.ohio.gov • www.jfs.ohio.gov

K

- Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres). (K.G.1,2,3,4,5,6)
- Identify, describe, and compare measurable attributes. (K.MD.1)

Information obtained from:
Ohio’s K-8 Learning Progressions

tasks involving number sense, students check their work to ensure the accuracy and reasonableness of solutions. Students should be encouraged to answer questions such as, “How do you know your answer is reasonable?”

MP.7 Look for and make use of structure. Younger students begin to discern a pattern or structure in the number system. For instance, students recognize that 3 + 2 = 5 and 2 + 3 = 5. Students use counting strategies, such as counting on, counting all, or taking away, to build fluency with facts to 5. Students notice the written pattern in the “teen” numbers—that the numbers start with 1 (representing 1 ten) and end with the number of additional ones. Teachers might ask, “What do you notice when ___?”

MP.8 Look for and express regularity in repeated reasoning. In the early grades, students notice repetitive actions in counting, computations, and mathematical tasks. For example, the next number in a counting sequence is 1 more when counting by ones and 10 more when counting by tens (or 1 more group of 10). Students should be encouraged to answer questions such as, “What would happen if ___?” and “There are 8 crayons in the box. Some are red and some are blue. How many of each could there be?” Kindergarten students realize 8 crayons could include 4 of each color (8 = 4 + 4), 5 of one color and 3 of another (8 = 5 + 3), and so on. For each solution, students repeatedly engage in the process of finding two numbers to join together to equal 8.

(NOTE) Resources Created by Organizations from Outside of Ohio

Some resources were created by professional organizations outside of Ohio and are not guaranteed to fully align to the Ohio Learning Standards for Mathematics. When reviewing these resources, educators can use the expectations for learning and content elaborations contained in the Model Curriculum to help make determinations on whether to use the materials with their instruction.

Additional Content/Informational Resources

- ODE Newly Revised Standards (Kindergarten) - Provide learning outcomes for the end of the kindergarten academic year.
- ODE Math Resources Grades PK-5 - Resources packed through ODE specific to mathematics and grade levels.
- Achieve the Core - These guides will help educators understand and implement the mathematics standards. They can use the guides as they observe teachers giving instruction and provide them with feedback that supports their planning and reflection.
    - K - 8 Content Emphases
    - K - 8 Instructional Practice Guide

- Arizona Progressions - These narrative documents describe the typical learning progression of a topic, informed by both research on children's cognitive development and the logical structure of mathematics.

Kindergarten Continued

- Equip – Provides educators with tools to identify high-quality materials for use in classrooms and national examples of high-quality materials aligned to the standards
- The Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric provides criteria to measure alignment and overall quality of lessons and units.
- Illustrative Mathematics – This site illustrates the range and types of mathematical work that students should experience as teachers use Ohio's Learning Standards in Mathematics. It also presents other tools supporting standards-based instruction.
- Depth of Knowledge information posted by ODE
- Progression Videos of "How" students build math knowledge

Instructional Resources

- Erikson Institute Early Math Collaborative - Developmentally aligned information and instructional activities.
- Teaching Channel - Provides guiding questions to use during planning and instruction. Classroom videos model best practices. Learning activities showcase rigorous problems that deepen conceptual understanding.
- YouCubed – Showcases research-based teaching methods, mathematics tasks, videos and ideas on how to bring about high levels of student engagement.
- National Library of Virtual Manipulatives - The site contains manipulatives and concept tutorials across the grade bands.
- Inside Mathematics - Educators can find exemplary standards-based lesson ideas on this site, as well as classroom videos. Teachers interested in the lessons can search under "performance task" for lesson ideas organized by grade and course.
- Illuminations - This project by the National Council of Teachers of Mathematics provides quality lessons and interactive resources for teaching and learning mathematics.
- Resources for 3-Act Math Class (Choose appropriateness for your grade level. These are tasks that foster mathematical modeling.

Dan Meyer	Graham Fletcher	Robert Kaplinsky
Andrew Stadel	John Stevens	Michael Fenton
Geoff Krall	Jon Orr	Kyle Pearce

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Kindergarten Continued

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- Visual Patterns - great site for students to think algebraically and build expression to model the world with mathematics.
- Clothesline Math - if you have not installed your class clothesline, get on it. What an amazing resource.
- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.

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Assessment data can be collected in many forms. In most cases understanding where students are in their learning pathway is about listening to their thinking during a Number Talk, rich tasks, solution pathways used in curricular work, etc. Understanding student thinking towards a specific goal will be more impactful than focusing on what they know or don't know. A sound use of formative assessment (conversations, observations, written, thinking) in real time can offer much more instructional information than any given assessment.

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Grade 1

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Developing understanding of addition, subtraction, and strategies for addition and subtraction within 20

Students develop strategies for adding and subtracting whole numbers based on their prior work with small numbers. They use a variety of models, including discrete objects and length-based models, e.g., cubes connected to form lengths, to model add-to, take-from, put-together, take-apart, and compare situations to develop meaning for the operations of addition and subtraction, and to develop strategies to solve arithmetic problems with these operations. Students understand connections between counting and addition and subtraction, e.g., adding two is the same as counting on two. They use properties of addition to add whole numbers and to create and use increasingly sophisticated strategies based on these properties, e.g., "making tens", to solve addition and subtraction problems within 20. By comparing a variety of solution strategies, children build their understanding of the relationship between addition and subtraction.

Critical Skills from Kindergarten and Connect to 1st Grade

ODE Progressions

K

- Understanding addition as putting together and adding to, and understand subtraction as taking apart and taking from (K.OA.1,2,3,4,5)
- Work with numbers 11-19 to gain foundations for place value (K.NBT.1)

Information obtained from:
Ohio's K-8 Learning Progressions

1st

- Represent and solve problems involving addition and subtraction (1.OA.1,2)
- Understand and apply properties of operations and the relationship between addition and subtraction (1.OA.3,4)
- Add and subtract within 20 (1.OA.5,6)
- Work with addition and subtraction equations (1.OA.7,8)
- Use place value understand and properties of operations to add and subtract (1.NBT.4,5,6)

Information obtained from:
Ohio's K-8 Learning Progressions

How to Facilitate Learning

(We believe students should be doing the thinking)

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Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

First Grade Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In first grade, students realize that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Younger students may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" They are willing to try other approaches.

MP.2 Reason abstractly and quantitatively. Younger students recognize that a number represents a specific quantity. They connect the quantity to written symbols. Quantitative reasoning entails creating a representation of a problem while attending to the meanings of the quantities. In first grade students make sense of quantities and relationships while solving tasks. They represent situations by decontextualizing tasks into numbers and symbols. For example, "There are 60 children on the playground and some children go line up. If there are 20 children still playing, how many children lined up?" Students translate the situation into the equation: 60 – 20 = and then solve the task. Students also

Grade 1 Continued

Critical Area 2: Developing understanding of whole number relationships and place value, including grouping in tens and ones

Students develop, discuss, and use efficient, accurate, and generalizable methods to add within 100 and subtract multiples of 10. They compare whole numbers (at least to 100) to develop understanding of and solve problems involving their relative sizes. They think of whole numbers between 10 and 100 in terms of tens and ones (especially recognizing the numbers 11 to 19 as composed of a ten and some more ones). Through activities that build number sense, they understand the order of the counting numbers and their relative magnitudes. Students use money as a tool to reinforce concepts of place value using pennies (ones) and dimes (tens).

Critical Skills from Kindergarten and Connect to 1st Grade
ODE Progressions

K

- Work with numbers 11-19 to gain foundations for place value (K.NBT.1)
- Classify objects and count the number of objects in each category (K.MD.3)

Information obtained from:
Ohio's K-8 Learning Progressions

1st

- Extend the counting sequence (1.NBT.1)
- Understand place value (1.NBT.2,3)
- Work with money (1.MD.3b)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 3: Developing understanding of linear measurement and measuring lengths as iterating length units

Students develop an understanding of the meaning and processes of measurement, including underlying concepts such as iterating (the mental activity of building up the length of an object with equal-sized units) and the transitivity principle for indirect measurement.

contextualize situations during the problem-solving process. For example, students refer to the context of the task to determine they need to subtract 20 from 60 because the total number of children on the playground is the total number less the 20 that are still playing. Students might also reason about ways to partition two-dimensional geometric figures into halves and fourths.

MP.3 Construct viable arguments and critique the reasoning of others. First graders construct arguments using concrete referents, such as objects, pictures, drawings, and actions. They also practice their mathematical communication skills as they participate in mathematical discussions involving questions like "How did you get that?", "Explain your thinking.", and "Why is that true?" They not only explain their own thinking, but listen to others' explanations. They decide if the explanations make sense and ask questions. For example, "There are 15 books on the shelf. If you take some books off the shelf and there are now 7 left, how many books did you take off the shelf?" Students might use a variety of strategies to solve the task and then share and discuss their problem-solving strategies with their classmates.

MP.4 Model with mathematics. In early grades, students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, acting out, making a chart or list, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. First grade students model real-life mathematical situations with a number sentence or an equation and check to make sure equations accurately match the problem context. Students use concrete models and pictorial representations while solving tasks and also write an equation to model problem situations. For example, to solve the problem, "There are 11 bananas on the counter. If you eat 4 bananas, how many are left?" students could write the equation 11 – 4 = 7. Students also create a story context for an equation such as 13 – 7 = 6.

MP.5 Use appropriate tools strategically. In first grade, students begin to consider the available tools (including estimation) when solving a mathematical problem and decide when certain tools might be helpful. For instance, first graders decide it might be best to use colored chips to model an addition problem. In first grade students use tools such as counters, place value (base ten) blocks, hundreds number boards, number lines, concrete geometric shapes (e.g., pattern blocks, 3-dimensional solids), and virtual representations to support conceptual understanding and mathematical thinking. Students determine which tools are the most appropriate to use. For example, when solving 12 + 8 = , students

Grade 1 Continued

Critical Skills from Kindergarten and Connect to 1st Grade
ODE Progressions

K

- Identify , describe measurable attributes (K.MD.1,2)
- Classify objects and count the number of objects in each category (K.MD.3)

Information obtained from:
Ohio's K-8 Learning Progressions

1st Grade

- Measure lengths indirectly and by iterating length units (1.MD.1,2,3)
- Work with time (1.MD.3a)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 4: Reasoning about attributes of, and composing and decomposing geometric shapes

Students compose and decompose plane or solid figures, e.g., put two triangles together to make a quadrilateral, and build understanding of part-whole relationships as well as the properties of the original and composite shapes. As they combine shapes, they recognize them from different perspectives and orientations, describe their geometric attributes, and determine how they are alike and different, to develop the background for measurement and for initial understandings of properties such as congruence and symmetry

Critical Skills from Kindergarten and Connect to 1st Grade
ODE Progressions

K

- Identify and describe shapes (squares, circles, triangles, rectangles, hexagons, cubes, cones, cylinders, and spheres) (K.G.1,2,3)
- Describe, compare, create, and compose shapes (K.G.4,5,6)

Information obtained from:
Ohio's K-8 Learning Progressions

1st

- Reason with shapes and their attributes (1.G.1,2,3)

Information obtained from:
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explain why place value blocks are more appropriate than counters.

MP.6 Attend to precision. As young children begin to develop their mathematical communication skills, they try to use clear and precise language in their discussions with others and when they explain their own reasoning. In grade one, students use precise communication, calculation, and measurement skills. Students are able to describe their solutions strategies to mathematical tasks using grade-level appropriate vocabulary, precise explanations, and mathematical reasoning. When students measure objects iteratively (repetitively), they check to make sure there are no gaps or overlaps. Students regularly check their work to ensure the accuracy and reasonableness of solutions.

MP.7 Look for and make use of structure. First graders begin to discern a pattern or structure. For instance, if students recognize 12 + 3 = 15, then they also know 3 + 12 = 15. (Commutative property of addition.) To add 4 + 6 + 4, the first two numbers can be added to make a ten, so 4 + 6 + 4 = 10 + 4 = 14. While solving addition problems, students begin to recognize the commutative property, for example 7 + 4 = 11, and 4 + 7 = 11. While decomposing two-digit numbers, students realize that any two-digit number can be broken up into tens and ones, e.g. 35 = 30 + 5, 76 = 70 + 6. Grade one students make use of structure when they work with subtraction as a missing addend problem, such as 13 – 7 = can be written as 7 + = 13 and can be thought of as how much more do I need to add to 7 to get to 13?

MP.8 Look for and express regularity in repeated reasoning. Grade one students begin to look for regularity in problem structures when solving mathematical tasks. For example, students add three one-digit numbers by using strategies such as "make a ten" or doubles. Students recognize when and how to use strategies to solve similar problems. For example, when evaluating 8 + 7 + 2, a student may say, "I know that 8 and 2 equals 10, then I add 7 to get to 17. It helps if I can make a 10 out of two numbers when I start." Students use repeated reasoning while solving a task with multiple correct answers. For example, solve the problem, "There are 12 crayons in the box. Some are red and some are blue. How many of each could there be?" Students use repeated reasoning to find pairs of numbers that add up to 12 (e.g., the 12 crayons could include 6 of each color (6 + 6 = 12), 7 of one color and 5 of another (7 + 5 = 12), etc.)

Grade 1 Continued

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Grade 1 Continued

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Back to Top

Grade 2

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Extending understanding of base-ten notation.

Students extend their understanding of the base-ten system. This includes ideas of counting in fives, tens, and multiples of hundreds, tens, and ones, as well as number relationships involving these units, including comparing. Students understand multi-digit numbers (up to 1000) written in base-ten notation, recognizing that the digits in each place represent amounts of thousands, hundreds, tens, or ones, e.g., 853 is 8 hundreds + 5 tens + 3 ones.

Critical Skills from 1st Grade and Connect to 2nd Grade

ODE Progressions

1st Grade

- Extend the counting sequence (1.NBT.1)
- Understand place value (1.NBT.2,3)

Information obtained from:
Ohio's K-8 Learning Progressions

2nd Grade

- Understand place value (2.NBT.1,2,3,4)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 2: Building fluency with addition and subtraction

Students use their understanding of addition to develop fluency with addition and subtraction within 100. They solve problems within 1000 by applying their understanding of models for addition and subtraction, and they develop, discuss, and use efficient, accurate, and generalizable methods to compute sums and differences of whole numbers in base-ten notation, using their understanding of place value and the properties of operations. They select and accurately apply methods that are appropriate for the context and the numbers involved to mentally calculate sums and differences for numbers with only tens or only hundreds. They apply their understanding of addition and subtraction to data represented in the picture and bar graphs.

How to Facilitate Learning

(We believe students should be doing the thinking)

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(The big picture of what our students deserve)

Second Grade Model Curriculum
(Instructional supports coming soon)

Teaching for Robust Learning (Tru) Framework
(Explore the five dimensions of powerful classrooms)

Restarting School: Planning for Acceleration in 20/21
(Embedding missed content into current grade level material)

Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

Second Grade Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In second grade, students realize that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. They may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" They make conjectures about the solution and plan out a problem-solving approach. An example for this might be giving a student an equation and having him/her write a story to match.

MP.2 Reason abstractly and quantitatively. Younger students recognize that a number represents a specific quantity. They connect the quantity to written symbols. Quantitative reasoning entails creating a representation of a problem while attending

Grade 2 Continued

Critical Skills from 1st Grade and Connect to 2nd Grade
ODE Progressions

1st Grade

- Use place value understanding and properties of operations to add and subtract (1.NBT.4,5,6)
- Represent and solve problems involving addition and subtraction (1.OA.1,2)
- Understand and apply properties of operations and the relationship between addition and subtraction (1.OA.3,4)
- Add and subtract within 20 (1.OA.5,6)
- Work with addition and subtraction equations (1.OA.7,8)
- Work with time and money (1.MD.3)
- Represent and interpret data (1.MD.4)

Information obtained from:
Ohio's K-8 Learning Progressions

2nd Grade

- Use place value understanding and properties of operations to add and subtract (2.NBT.5,6,7,8,9)
- Represent and solve problems involving addition and subtraction (2.OA.1)
- Add and subtract within 20 (2.OA.2)
- Work with equal groups of objects to gain foundations for multiplication (2.OA.3,4)
- Relate addition and subtraction to length (2.MD.5,6)
- Work with time and money (2.MD.7,8)
- Represent and interpret data (2.MD.10)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 3: Using standard units of measure.

Students recognize the need for standard units of measure (centimeter and inch), and they use rulers and other measurement tools with the understanding that linear measure involves an iteration of units. They recognize that the smaller the unit, the more iterations they need to cover a given length. They also apply number concepts solving real-world problems.

Critical Skills from 1st Grade and Connect to 2nd Grade
ODE Progressions

to the meanings of the quantities. Second graders begin to know and use different properties of operations and relate addition and subtraction to length. In second grade students represent situations by decontextualizing tasks into numbers and symbols. For example, in the task, "There are 25 children in the cafeteria, and they are joined by 17 more children. How many students are in the cafeteria?" Students translate the situation into an equation, such as: 25 + 17 = and then solve the problem. Students also contextualize situations during the problem-solving process. For example, while solving the task above, students might refer to the context of the task to determine that they need to subtract 19 if 19 children leave.

MP.3 Construct viable arguments and critique the reasoning of others. Second graders may construct arguments using concrete referents, such as objects, pictures, drawings, and actions. They practice their mathematical communication skills as they participate in mathematical discussions involving questions like "How did you get that?", "Explain your thinking.", and "Why is that true?" They not only explain their own thinking, but listen to others' explanations. They decide if the explanations make sense and ask appropriate questions. Students critique the strategies and reasoning of their classmates. For example, to solve 74 – 18, students may use a variety of strategies, and after working on the task, they might discuss and critique each other's' reasoning and strategies, citing similarities and differences between various problem-solving approaches.

MP.4 Model with mathematics. In early grades, students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, acting out, making a chart or list, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. In grade two students model real-life mathematical situations with a number sentence or an equation and check to make sure that their equation accurately matches the problem context. They use concrete manipulatives and pictorial representations to explain the equation. They create an appropriate problem situation from an equation. For example, students create a story problem for the equation 43 + 17 = ? such as "There were 43 gumballs in the machine. Tom poured in 17 more gumballs. How many gumballs are now in the machine?"
MP.5 Use appropriate tools strategically. In second grade, students consider the available tools (including estimation)

Grade 2 Continued

1st Grade

- Measure lengths indirectly and by iterating length units (1.MD.1,2)
- Work with time and money (1.MD.3)
- Represent and interpret data (1.MD.4)

Information obtained from:
Ohio's K-8 Learning Progressions

2nd Grade

- Measure and estimate lengths in standard units (2.MD.1,2,3,4)
- Work with time and money (2.MD.7)
- Represent and interpret data (2.MD.9)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 4: Describing and analyzing shapes

Students describe and analyze shapes by examining their sides and angles. Students investigate, describe, and reason about decomposing and combining shapes to make other shapes. Through building, drawing, and analyzing two and three-dimensional shapes, students develop a foundation for understanding area, volume, congruence, similarity, and symmetry in later grades. They apply number concepts in real-world problems

Critical Skills from 1st Grade and Connect to 2nd Grade
ODE Progressions

1st Grade

- Reason with shapes and their attributes (1.G.1,2,3)
- Represent and solve problems involving addition and subtraction (1.OA.1,2)
- Understand and apply properties of operations and the relationship between addition and subtraction (1.OA.3,4)
- Add and subtract within 20 (1.OA.5,6)
- Work with addition and subtraction equations (1.OA.7,8)

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2nd Grade

- Reason with shapes and their attributes (2.G.1,2,3)
- Work with equal groups of objects to gain foundations for multiplication (2.OA.4)

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when solving a mathematical problem and decide when certain tools might be better suited. For instance, second graders may decide to solve a problem by drawing a picture rather than writing an equation. Students may use tools such as snap cubes, place value (base ten) blocks, hundreds number boards, number lines, rulers, virtual manipulatives, and concrete geometric shapes (e.g., pattern blocks, three-dimensional solids). Students understand which tools are the most appropriate to use. For example, while measuring the length of the hallway, students can explain why a yardstick is more appropriate to use than a ruler.

MP.6 Attend to precision. As children begin to develop their mathematical communication skills, they try to use clear and precise language in their discussions with others and when they explain their own reasoning. Second grade students communicate clearly, using grade-level appropriate vocabulary accurately and precise explanations and reasoning to explain their process and solutions. For example, while measuring an object, students carefully line up the tool correctly to get an accurate measurement. During tasks involving number sense, students consider if their answer is reasonable and check their work to ensure the accuracy of solutions.

MP.7 Look for and make use of structure. Second grade students look for patterns and structures in the number system. For example, students notice number patterns within the tens place as they connect skip counting by 10s to corresponding numbers on a 100s chart. Students see structure in the base-ten number system as they understand that 10 ones equal a ten, and 10 tens equal a hundred. Students adopt mental math strategies based on patterns (making ten, fact families, doubles). They use structure to understand subtraction as a missing addend problems (e.g., 50 – 33 = ? can be written as 33 + ? = 50 and can be thought of as "How much more do I need to add to 33 to get to 50?")

MP.8 Look for and express regularity in repeated reasoning. Second grade students notice repetitive actions in counting and computation (e.g., number patterns to skip count). When children have multiple opportunities to add and subtract, they look for shortcuts, such as using estimation strategies and then adjust the answer to compensate. Students continually check for the reasonableness of their solutions during and after completing a task by asking themselves, "Does this make sense?"

Grade 2 Continued

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- Visual Patterns - great site for students to think algebraically and build expression to model the world with mathematics.
- Clothesline Math - if you have not installed your class clothesline, get on it. What an amazing resource.
- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.

Assessment Resources

Assessment data can be collected in many forms. In most cases understanding where students are in their learning pathway is about listening to their thinking during a Number Talk, rich tasks, solution pathways used in curricular work, etc. Understanding student thinking towards a specific goal will be more impactful than focusing on what they know or don't know. A sound use of formative assessment (conversations, observations, written, thinking) in real time can offer much more instructional information than any given assessment.

(Caution, please use assessments that are designed to actually perform the action you are calling on it to provide. For example, do not use a universal screener as a diagnostic. It is important that all stakeholders understand Universal Screeners, Benchmarks, Progress Monitors, Diagnostics, Growth Measures, Adaptive...and the pedagogical consequences of using inappropriately)

- Ohio Department of Education Approved Vendor Assessments
- Ohio Diagnostic Assessments (Screeners/Full Measures) - provides screeners and benchmark tools to measure understanding of content.
- AIMS - Assessment of Early Numeracy - provides developmentally appropriate measures for Kindergarten. Assessment purposes include universal screener, benchmark, and progress monitor.
- Depth of Knowledge Sample Problems - Sample assessment items or tasks aligned to DOK levels.
- Depth of Knowledge - Website with information on building assessments using Depth of Knowledge
- Cognition-Based Assessment - Assessments used for diagnostic purposes. Used to develop targeted interventions with aligned interventions. Best used as an interview.
- AIMS plus - Universal screener, benchmark and progress monitor
- Math Recovery / Math AddVantage - Diagnostic assessment and targeted activities up through 5th grade

**Struggle is a situation and should not become an identity. We need to ensure mindful, appropriate responses to all assessment.*

Back to Top

Grade 3

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Developing and understanding of multiplication and division and strategies for multiplication and division within 100

Students develop an understanding of the meanings of multiplication and division of whole numbers through activities and problems involving equal-sized groups, arrays, and area models; multiplication is finding an unknown product, and division is finding an unknown factor in these situations. For equal-sized group situations, division can require finding the unknown number of groups or the unknown group size. Students use properties of operations to calculate products of whole numbers, using increasingly sophisticated strategies based on these properties to solve multiplication and division problems involving single-digit factors. By comparing a variety of solution strategies, students learn the relationship between multiplication and division.

Critical Skills from 2nd Grade that Connect to 3rd grade

ODE Progressions

2nd Grade

- Work with equal groups of objects to gain foundations for multiplication (2.OA.3,4)
- Understand place value (2.NBT.1,2,3,4)
- Use place value understanding and properties of operations to add and subtract (2.NBT.5,6,7,8,9)
- Relate addition and subtraction to length(2.MD.5,6)

Information obtained from:
Ohio's K-8 Learning Progressions

3rd Grade

- Represent and solve problems involving multiplication and division (3.OA.1,2,3,4)
- Understand properties of multiplication and the relationship between multiplication and division (3.OA.5,6)
- Multiply and divide within 100 (3.OA.7)
- Solve problems involving the four operations, and identify and explain patterns in arithmetic (3.OA.8,9)
- Use place value understanding and properties of operations to perform multi-digit arithmetic (3.NBT.3)
- Geometric measurement: understand concepts of area and relate area to multiplication and to addition (3.MD.7)

Information obtained from:
Ohio's K-8 Learning Progressions

How to Facilitate Learning

(We believe students should be doing the thinking)

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(The big picture of what our students deserve)

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Teaching for Robust Learning (Tru) Framework
(Explore the five dimensions of powerful classrooms)

Restarting School: Planning for Acceleration in 20/21
(Embedding missed content into current grade level material)

Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

3rd Grade Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them.
In third grade, mathematically proficient students know that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Students may use concrete objects, pictures, or drawings to help them conceptualize and solve problems, such as "Jim purchased 5 packages of muffins. Each package

Grade 3 Continued

Critical Area 2: Developing understanding of fractions, especially unit fractions (fractions with numerator 1)

Students develop an understanding of fractions, beginning with unit fractions. Students view fractions in general as being built out of unit fractions, and they use fractions along with visual fraction models to represent parts of a whole. Students understand that the size of a fractional part is relative to the size of the whole. For example, 1/2 of the paint in a small bucket could be less paint than 1/3 of the paint in a larger bucket, but 1/3 of a ribbon is longer than 1/5 of the same ribbon because when the ribbon is divided into 3 equal parts, the parts are longer than when the ribbon is divided into 5 equal parts. Students are able to use fractions to represent numbers equal to, less than, and greater than one. They solve problems that involve comparing fractions by using visual fraction models and strategies based on noticing equal numerators or denominators.

Critical Skills from 2nd Grade that Connect to 3rd grade
ODE Progressions

2nd Grade

- Reason with shapes and their attributes (2.G.3)

Information obtained from:
Gojak, L. and Miles, R.(2016). The common core mathematics companion, grades 3-5. Thousand Oaks: Corwin, p. 114.

- Represent and interpret data (2.MD.9,10)

Information obtained from:
Ohio's K-8 Learning Progressions

3rd Grade

- Develop understanding of fractions as numbers (3.NF.1,2,3)
- Represent and interpret data (3.MD.4)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 3: Developing understanding of the structure of rectangular arrays and of area

Students recognize area as an attribute of two-dimensional regions. They measure the area of a shape by finding the total number of same-size units of area required to cover the shape without gaps or overlaps, a square with sides of unit length being the standard unit for measuring area. Students understand that rectangular arrays can be decomposed into identical rows or into identical columns. By decomposing rectangles into rectangular arrays of squares, students connect area to multiplication, and justify using multiplication to determine the area of a rectangle.

contained 3 muffins. How many muffins did Jim purchase?" or "Describe another situation where there would be 5 groups of 3 or 5 × 3." Students may check their thinking by asking themselves, "Does this make sense?" Students listen to other students' strategies and are able to make connections between various methods for a given problem.

MP.2 Reason abstractly and quantitatively. Third graders should recognize that a number represents a specific quantity. They connect the quantity to written symbols and create a logical representation of the problem at hand, considering both the appropriate units involved and the meaning of quantities. For example: students apply their understanding of the meaning of the equal sign as "the same as" to interpret an equation with an unknown. When given 4 × = 40, they might think: • 4 groups of some number is the same as 40 • 4 times some number is the same as 40 • I know that 4 groups of 10 is 40 so the unknown number is 10 • The missing factor is 10 because 4 times 10 equals 40. Teachers might ask, "How do you know" or "What is the relationship between the quantities?" to reinforce students' reasoning and understanding.

MP.3 Construct viable arguments and critique the reasoning of others. Students may construct arguments using concrete referents, such as objects, pictures, and drawings. They refine their mathematical communication skills as they participate in mathematical discussions that the teacher facilitates by asking questions such as "How did you get that?" and "Why is that true?" Students explain their thinking to others and respond to others' thinking. For example, after investigating patterns on the 100s chart, students might explain why the pattern makes sense.

MP.4 Model with mathematics. Students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing

Grade 3 Continued

Critical Skills from 2nd Grade that Connect to 3rd grade
ODE Progressions

2nd Grade

- Measure and estimate lengths in standard units (2.MD.4)
- Relate addition and subtraction to length (2.MD.5,6)
- Reason with shapes and their attributes (2.G.1)

Information obtained from:
Ohio's K-8 Learning Progressions

3rd Grade

- Geometric measurement: understand concepts of area and relate area to multiplication and to addition (3.MD.5,6,7)
- Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures (3.MD.8)
- Reason with shapes and their attributes (3.G.2)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 4: Describing and analyzing two-dimensional shapes.

Students describe, analyze, and compare properties of two-dimensional shapes. They compare and classify shapes by their sides and angles, and connect these with definitions of shapes. Students also relate their fraction work to geometry by expressing the area of part of a shape as a unit fraction of the whole.

Critical Skills from 2nd Grade that Connect to 3rd grade
ODE Progressions

2nd Grade

- Reason with shapes and their attributes (2.G.1, 3)

Information obtained from:
Gojak, L. and Miles, R. (2016). The common core mathematics companion, grades 3-5. Thousand Oaks: Corwin, p. 114.

3rd Grade

- Reason with shapes and their attributes (3.G.1)
- Develop an understanding of fractions as numbers (3.NF.1,2,3)

Information obtained from:
Ohio's K-8 Learning Progressions

pictures, using objects, acting out, making a chart, list, or graph, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. Third graders should evaluate their results in the context of the situation and reflect on whether the results make sense For example, students use various contexts and a variety of models (e.g., circles, squares, rectangles, fraction bars, and number lines) to represent and develop understanding of fractions. Students use models to represent both equations and story problems and can explain their thinking. They evaluate their results in the context of the situation and reflect on whether the results make sense. Students should be encouraged to answer questions, such as "What math drawing or diagram could you make and label to represent the problem?" or "What are some ways to represent the quantities?"

MP.5 Use appropriate tools strategically. Third graders consider the available tools (including drawings and estimation) when solving a mathematical problem and decide when certain tools might be helpful. For instance, they may use graph paper to find all the possible rectangles that have a given perimeter. They compile the possibilities into an organized list or a table, and determine whether they have all the possible rectangles. Students should be encouraged to answer questions such as, "Why was it helpful to use ___?"

MP.6 Attend to precision. As third graders develop their mathematical communication skills, they try to use clear and precise language in their discussions with others and in their own reasoning. They are careful about specifying units of measure and state the meaning of the symbols they choose. For instance, when figuring out the area of a rectangle they record their answers in square units.

Grade 3 Continued

Critical Area 5: Solving multi-step problems.

Students apply previous understanding of addition and subtraction strategies and algorithms to solve multi-step problems. They reason abstractly and quantitatively by modeling problem situations with equations or graphs, assessing their processes and results, and justifying their answers through mental computation and estimation strategies. Students incorporate multiplication and division within 100 to solve multi-step problems with the four operations.

Critical Skills from 2nd Grade that Connect to 3rd grade
ODE Progressions

2nd Grade

- Represent and solve problems involving addition and subtraction (2.OA.1)
- Understand place value (2.NBT.1,2,3,4)
- Relate addition and subtraction to length (2.MD.5,6)
- Work with time and money (2.MD.7,8)
- Represent and interpret data (2.MD.9.10)

Information obtained from:
Ohio's K-8 Learning Progressions

3rd Grade

- Solve problems involving the four operations, and identify and explain patterns in arithmetic (3.OA.8)
- Use place value understanding and properties of operations to perform multi-digit arithmetic (3.NBT.1,2)
- Solve problems involving money and measurement and estimation of intervals of time, liquid volumes, and masses of objects (3.MD.1,2)
- Represent and interpret data (3.MD.3)

Information obtained from:
Ohio's K-8 Learning Progressions

MP.7 Look for and make use of structure. Students look closely to discover a pattern or structure. For instance, students use properties of operations (e.g., commutative and distributive properties) as strategies to multiply and divide.
Teachers might ask, "What do you notice when ___?" or "How do you know if something is a pattern?

MP.8 Look for and express regularity in repeated reasoning. Students in third grade should notice repetitive actions in computation and look for more shortcut methods. For example, students may use the distributive property as a strategy for using products they know to solve products that they don't know. For example, if students are asked to find the product of 7 × 8, they might decompose 7 into 5 and 2 and then multiply 5 × 8 and 2 × 8 to arrive at 40 + 16 or 56. In addition, third graders continually evaluate their work by asking themselves, "Does this make sense? Students should be encouraged to answer questions, such as, "What is happening in this situation?" or "What predictions or generalizations can this pattern support?"

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Grade 3 Continued

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- Illuminations - This project by the National Council of Teachers of Mathematics provides quality lessons and interactive resources for teaching and learning mathematics.
- Resources for 3-Act Math Class (Choose appropriateness for your grade level. These are tasks that foster mathematical modeling.

Dan Meyer	Graham Fletcher	Robert Kaplinsky
Andrew Stadel	John Stevens	Michael Fenton
Geoff Krall	Jon Orr	Kyle Pearce

- Steve Wyborney - Awesome web page for elementary. You will find popular activities (Splat, Hundred Maze, Subitizing, Fraction Splat, Primary Tile, Tile Area, Esti mystery)
- MCTM Collection of Cognitively Demanding Tasks - Amazing collection of web resources for finding those rich multidimensional math tasks.
- Number Talks-provide video resources about how to engage students in mathematical conversation using mental math to solve problems.
    - Building Number Sense (Jo Boaler, Ruth Parker, Sherry Parrish)
    - Inside Mathematics Number Talks

3rd Grade Continued

- Fraction Talks - Subitize or Don't, but these awesome pictures open up a world of fraction understanding based on the relationship between a numerator/denominator while the students are quantifying the value the entire time.
- Visual Patterns - great site for students to think algebraically and build expression to model the world with mathematics.
- Clothesline Math - if you have not installed your class clothesline, get on it. What an amazing resource.
- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.
- Estimation 180-great site to have students work on estimation skills
- Would You Rather- students are given a prompt and are asked to select a path and justify their response
- Open Middle-problems that allow multiple ways to approach to solve problems, requiring higher Depth of Knowledge
- Numberless Word Problems-numberless word problems are designed to provide scaffolding that allows students the opportunity to develop a better understanding of the underlying structure of word problems
- DESMOS Activities (Grades 3-5)-these activities are designed for playful exploration of mathematical ideas

Assessment Resources

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- ODE Grade 3 Testing Resources
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Grade 4

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Developing an understanding and fluency with multi-digit multiplication, and developing understanding of dividing to find quotients involving multi-digit dividends as part of effectively and efficiently performing multi-digit arithmetic.

Students generalize their understanding of place value to 1,000,000, understanding the relative sizes of numbers in each place. They apply their understanding of models for multiplication (equal-sized groups, arrays, and area models), place value, and properties of operations, in particular the distributive property, as they develop, discuss, and use efficient, accurate, and generalizable methods to compute products of multi-digit whole numbers. Depending on the numbers and the context, they select and accurately apply appropriate methods to estimate or mentally calculate products. They develop fluency with efficient procedures for multiplying whole numbers; understand and explain why the procedures work based on place value and properties of operations; and use them to solve problems. Students apply their understanding of models for division, place value, properties of operations, and the relationship of division to multiplication as they develop, discuss, and use efficient, accurate, and generalizable procedures to find quotients involving multi-digit dividends. They select and accurately apply appropriate methods to estimate and mentally calculate quotients, and interpret remainders based upon the context. Students efficiently and effectively add and subtract multi-digit whole numbers.

Critical Skills from 3rd Grade that Connect to 4th grade

ODE Progressions

3rd Grade

- Represent and solve problems involving multiplication and division. (3.OA.1,2,3,4)
- Understand properties of multiplication and the relationship between multiplication and division. (3.OA.5,6)
- Multiply and divide within 100. (3.OA.7)
- Solve problems involving the four operations, and identify and explain patterns in arithmetic. (3.OA.8)
- Use place value understanding and properties of operations to perform multi-digit arithmetic. A range of strategies and algorithms may be used. (3.NBT.1,2,3)
- Solve problems involving money and measurement and estimation of intervals of time, liquid volumes, and masses of objects (3.MD.1,2)
- Geometric measurement: understand concepts of area and relate area to multiplication and to addition (3.MD.5,6,7)

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(Embedding missed content into current grade level material)

Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

4th Grade Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them.
In fourth grade, students know that doing mathematics involves solving problems and discussing how they solved them. Students explain to themselves the meaning of a problem and look for ways to solve it. Fourth graders may use concrete objects or pictures to help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" They listen to the strategies of others and will try different approaches. They often will use another method to check their answers. Students might use an equation strategy to solve the word problem. For example, students could solve the problem "Chris bought clothes for school. She bought 3 shirts for $12 each and a skirt for $15. How much money did Chris spend on her new school clothes?" with the equation 3 × $12 + $15 = *aa*. Fourth graders may use concrete objects or pictures to

Grade 4 Continued

- Geometric measurement: recognize perimeter as an attribute of plane figures and distinguish between linear and area measures. (3.MD.8)

Information obtained from:
Ohio's K-8 Learning Progressions

4th Grade

- Use the four operations with whole numbers to solve problems. (4.OA.1,2,3)
- Gain familiarity with factors and multiples. (4.OA.4)
- Generalize place value understanding for multi-digit whole numbers less than or equal to 1,000,000. (4.NBT.1,2,3)
- Use place value understanding and properties of operations to perform multi-digit arithmetic with whole numbers less than or equal to 1,000,000. (4.NBT.4,5,6)
- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit. (4.MD.2,3)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 2: Developing an understanding of fraction equivalence, addition and subtraction of fractions with like denominators, and multiplication of fractions by whole numbers.

Students develop understanding of fraction equivalence and operations with fractions. They recognize that two different fractions can be equal, e.g., 15/9 = 5/3, and they develop methods such as using models for generating and recognizing equivalent fractions. Students extend previous understandings about how fractions are built from unit fractions, composing fractions from unit fractions, decomposing fractions into unit fractions, and using the meaning of fractions and the meaning of multiplication to multiply a fraction by a whole number. Students also solve problems involving measurement and conversion of measurements by using fractions.

Critical Skills from 3rd Grade that Connect to 4th grade
ODE Progressions

3rd Grade

- Solve problems involving the four operations and identify and explain patterns in arithmetic (3.OA.9)
- Develop understanding of fractions as numbers (3.NF.1,2,3)
- Represent and interpret data (3.MD.3,4)

Information obtained from:
Ohio's K-8 Learning Progressions

help them conceptualize and solve problems. They may check their thinking by asking themselves, "Does this make sense?" They listen to the strategies of others and will try different approaches. They often will use another method to check their answers.

MP.2 Reason abstractly and quantitatively. Fourth graders should recognize that a number represents a specific quantity. They connect the quality to written symbols and create a logical representation of the problem at hand, considering both the appropriate units involved and the meaning of quantities. They extend this understanding from whole numbers to their work with fractions and decimals. Students write simple expressions, record calculations with numbers, and represent or round numbers using place value concepts. Students might use base 10 blocks or drawings to demonstrate 154 × 6, as 154 added six times, and develop an understanding of the distributive property. For example: 154 × 6 = (100 + 50 + 4)× 6 = (100 × 6) + (50 × 6) + (4 × 6) = 600 + 300 + 24 = 924

MP.3 Construct viable arguments and critique the reasoning of others. In fourth grade, students may construct arguments using concrete referents, such as objects, pictures, and drawings. They explain their thinking and make connections between models and equations. They refine their mathematical communication skills as they participate in mathematical discussions involving questions like "How did you get that?", "Explain your thinking," and "Why is that true?" They not only explain their own thinking, but listen to others' explanations. Students explain and defend their answers and solution strategies as they answer questions that require an explanation. For example, "Vincent cuts 2 meters of string into 4 centimeter pieces for a craft. How many pieces of string does Vincent have? Explain your reasoning." Students ask appropriate questions and they decide if explanations make sense.

MP.4 Model with mathematics. Students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, making a chart, list, or graph, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. Fourth graders should evaluate their results in the context of the situation and reflect on whether the results make sense. For example, students may use money (i.e. dollars and coins)

Grade 4 Continued

4th Grade

- Generalize and analyze patterns (4.OA.5)
- Extend understanding of fraction equivalence and ordering limited to fractions with denominators 2,3,4,5,6,8,10,12,and 100 (4.NF.1,2)
- Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (Fractions need not be simplified (4.NF.3,4)
- Understand decimal notation for fractions, and compare decimal fractions limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (4.NF.5,6,7)
- Solve problems involving measurement and conversions of measurements from a larger unit to a smaller unit (4.MD.1,2)
- Represent and interpret data (4.MD.4)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 3: Understanding that geometric figures can be analyzed and classified based on their properties, such as having parallel sides, perpendicular sides, and particular angle measures.

Students describe, analyze, compare, and classify two-dimensional shapes. Through building, drawing, and analyzing two-dimensional shapes, students deepen their understanding of properties of two-dimensional objects and the use of them to solve problems.

Critical Skills from 3rd Grade that Connect to 4th grade
ODE Progressions

3rd Grade

- Geometric measurement: understand concepts of area and relate area to multiplication and to addition (3.MD.5,6,7)
- Reason with shapes and their attributes (3.G.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

4th Grade

- Geometric measurement: understand concepts of angle and measure angles (4.MD.5,6,7)
- Draw and identify lines and angles, and classify shapes by properties of their lines and angles (4.G.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

or base10 blocks to solve the following problem: Elsie buys a drink for $1.39 and a granola bar for $0.89. How much change will she receive if she pays with a $5 bill?

MP.5 Use appropriate tools strategically. Fourth graders consider the available tools (including estimation) when solving a mathematical problem and decide when certain tools might be helpful. For instance, they may use graph paper, a number line, or base 10 blocks to represent, compare, add, and subtract decimals to the hundredths. Students in fourth grade use protractors to measure angles. They use other measurement tools to understand the relative size of units within a given system and express measurements given in larger units in terms of smaller units.

MP.6 Attend to precision. As fourth graders develop their mathematical communication skills, they try to use clear and precise language in their discussions with others and in their own reasoning. For instance, they may use graph paper or a number line to represent, compare, add, and subtract decimals to the hundredths. Students in fourth grade use protractors to measure angles. They are careful about specifying units of measure and state the meaning of the symbols they choose. For instance, they use appropriate labels when creating a line plot.

MP.7 Look for and make use of structure. In fourth grade, students look closely to discover a pattern or structure. For instance, students use properties of operations to explain calculations (partial products model). They relate representations of counting problems such as arrays and area models to the multiplication principle of counting. They generate number or shape patterns that follow a given rule using two-column tables.

MP.8 Look for and express regularity in repeated reasoning. Students in fourth grade should notice repetitive actions in computation to make generalizations. Students use models to explain calculations and understand how algorithms work. They also use models to examine patterns and generate their own algorithms. For example, students use visual fraction models to write equivalent fractions.

Grade 4 Continued

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Back to Top

Grade 4 Continued

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- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.
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- Would You Rather- students are given a prompt and are asked to select a path and justify their response
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Assessment Resources

Assessment data can be collected in many forms. In most cases understanding where students are in their learning pathway is about listening to their thinking during a Number Talk, rich tasks, solution pathways used in curricular work, etc. Understanding student thinking towards a specific goal will be more impactful than focusing on what they know or don't know. A sound use of formative assessment (conversations, observations, written, thinking) in real time can offer much more instructional information than any given assessment.

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Grade 5

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Developing fluency with addition and subtraction of fractions and developing understanding of the multiplication of fractions and of division of fractions in limited cases (unit fractions divided by whole numbers and whole numbers divided by unit fractions)

Students apply their understanding of fractions and fraction models to represent the addition and subtraction of fractions with unlike denominators as equivalent calculations with like denominators. They develop fluency in calculating sums and differences of fractions, and make reasonable estimates of them. Students also use the meaning of fractions, of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for multiplying and dividing fractions make sense. They apply their understanding of fractions to solve real-world problems. (Note: this is limited to the case of dividing unit fractions by whole numbers and whole numbers by unit fractions.)

Critical Skills from 4th Grade that Connect to 5th grade

ODE Progressions

4th Grade

- Extend understanding of fraction equivalence and ordering limited to fractions with denominators 2,3,4,5,6,8,10,12,and 100 (4.NF.1,2)
- Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (4.NF.3,4)
- Understand decimal notation for fractions, and compare decimal fractions limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (4NF.5,6,7)
- Solve problems involving money and measurement and estimation of intervals of time, liquid volumes, and masses of objects (4.MD.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

5th Grade

- Use equivalent fractions as a strategy to add and subtract fractions (Fractions need not be simplified.) (5.NF.1,2)
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (Fractions need not be simplified.) (5.NF.3,4,5,6,7)
- Convert like measurement units within a given measurement system. (5.MD.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

How to Facilitate Learning

(We believe students should be doing the thinking)

PDF Executive Summary of NCTM's Principles to Actions
(The big picture of what our students deserve)

Grade 5 Model Curriculum
(Instructional supports coming soon)

Teaching for Robust Learning (Tru) Framework
(Explore the five dimensions of powerful classrooms)

Restarting School: Planning for Acceleration in 20/21
(Embedding missed content into current grade level material)

Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

5th Grade Standards for Mathematical Practice
(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. Students solve problems by applying their understanding of operations with whole numbers, decimals, and fractions including mixed numbers. They solve problems related to volume and measurement conversions. Students seek the meaning of a problem and look for efficient ways to represent and solve it. For example, Sonia had 2 1 3 candy bars. She promised her brother that she would give him 1 2 of a

Grade 5 Continued

Critical Area 2: Extending division to 2-digit divisors, integrating decimal fractions into the place value system and developing understanding of operations with decimals to hundredths, and developing fluency with whole number and decimal operations.

Students develop understanding of why division procedures work based on the meaning of base-ten numerals and properties of operations. They finalize fluency with multi-digit addition, subtraction, multiplication, and division. They apply their understandings of models for decimals, decimal notation, and properties of operations to add and subtract decimals to hundredths. They develop fluency in these computations, and make reasonable estimates of their results. Students use the relationship between decimals and fractions, as well as the relationship between finite decimals and whole numbers (i.e., a finite decimal multiplied by an appropriate power of 10 is a whole number), to understand and explain why the procedures for multiplying and dividing finite decimals make sense. They compute products and quotients of decimals to hundredths efficiently and accurately.

Critical Skills from 4th Grade that Connect to 5th grade

ODE Progressions

4th Grade

- Use the four operations with whole numbers to solve problems (4.OA.1,2,3)
- Generalize place value understanding for multi-digit whole numbers less than or equal to 1,000,000 (4.NBT.1,2,3)
- Use place value understanding and properties of operations to perform multi-digit arithmetic with whole numbers less than or equal to 1,000,000 (4.NBT.4,5,6)

Information obtained from:
Ohio's K-8 Learning Progressions

5th Grade

- Write and interpret numerical expressions (5.OA.1,2)
- Understand the place value system (5.NBT.1,2,3,4)
- Perform operations with multi-digit whole numbers and with decimals to hundredths(5.NBT.5,6,7)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 3: Developing understanding of volume.

Students recognize volume as an attribute of three-dimensional space. They understand that volume can be measured by finding the total number of same-size units of volume required to fill the space without gaps or overlaps. They understand that a 1-unit by 1-unit by 1-unit cube is the standard unit for measuring volume. They select appropriate units, strategies, and tools for solving problems that involve estimating and measuring volume. They decompose three-dimensional shapes and find volumes of right rectangular prisms by viewing them as decomposed into layers of arrays of cubes. They measure necessary attributes of shapes in order to determine volumes to solve real world and mathematical problems.

candy bar. How much will she have left after she gives her brother the amount she promised? They may check their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?".

MP.2 Reason abstractly and quantitatively. Fifth graders should recognize that a number represents a specific quantity. They connect quantities to written symbols and create a logical representation of the problem at hand, considering both the appropriate units involved and the meaning of quantities. They extend this understanding from whole numbers to their work with fractions and decimals. Students write simple expressions that record calculations with numbers and represent or round numbers using place value concepts. For example, students use abstract and quantitative thinking to recognize that 0.5 × (300 ÷ 15) is 1 2 of (300 ÷ 15) without calculating the quotient.

MP.3 Construct viable arguments and critique the reasoning of others. In fifth grade, students may construct arguments using concrete referents, such as objects, pictures, and drawings. They explain calculations based upon models and properties of operations and rules that generate patterns. They demonstrate and explain the relationship between volume and multiplication. They refine their mathematical communication skills as they participate in mathematical discussions involving questions like "How did you get that?" and "Why is that true?" They explain their thinking to others and respond to others' thinking. Students use various strategies to solve problems and they defend and justify their work with others. For example, two afterschool clubs are having pizza parties. The teacher will order 3 pizzas for every 5 students in the math club; and 5 pizzas for every 8 students in the student council. If a student is in both groups, decide

Grade 5 Continued

Critical Skills from 4th Grade that Connect to 5th Grade

ODE Progressions

4th Grade

- Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit (4.MD.3)
- Extend understanding of fraction equivalence and ordering limited to fractions with denominators 2,3,4,5,6,8,10,12,and 100 (4.NF.1,2)
- Build fractions from unit fractions by applying and extending previous understandings of operations on whole numbers limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (4.NF.3,4)
- Understand decimal notation for fractions, and compare decimal fractions limited to fractions with denominators 2,3,4,5,6,8,10,12, and 100 (4NF.5,6,7)

Information obtained from:
Ohio's K-8 Learning Progressions

5th Grade

- Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition. (5.MD.3,4,5)
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (Fractions need not be simplified). (4.NF.4,5)

Information obtained from:
Ohio's K-8 Learning Progressions

Critical Area 4: Modeling numerical relationships with the coordinate plane.

Based on previous work with measurement and number lines, students develop understanding of the coordinate plane as a tool to model numerical relationships. These initial understandings provide the foundation for work with negative numbers, and ratios and proportional relationships in Grade Six and functional relationships in further grades.

Critical Skills from 4th Grade that Connect to 5th Grade

ODE Progressions

4th Grade

- Generate and analyze patterns (4.OA.5)
- Draw and identify lines and angles, and classify shapes by properties of their lines and angles (4.G.1)

Information obtained from:
Ohio's K-8 Learning Progressions

5th Grade

- Analyze patterns and relationships (5.OA.3)
- Graph points on the coordinate plane to solve real-world and mathematical problems (5.G.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

which party he/she should attend. How much pizza will each student get at each party? If a student wants to have the most pizza, which party should he/she attend?

MP.4 Model with mathematics. Students experiment with representing problem situations in multiple ways including numbers, words (mathematical language), drawing pictures, using objects, making a chart, list, or graph, creating equations, etc. Students need opportunities to connect the different representations and explain the connections. They should be able to use all of these representations as needed. Fifth graders should evaluate their results in the context of the situation and whether the results make sense. They also evaluate the utility of models to determine which models are most useful and efficient to solve problems.

MP.5 Use appropriate tools strategically. Fifth graders consider the available tools (including estimation) when solving a mathematical problem and decide when certain tools might be helpful. For instance, they may use unit cubes to fill a rectangular prism and then use a ruler to measure the dimensions. They use graph paper to accurately create graphs and solve problems or make predictions from real-world data.

MP.6 Attend to precision. Students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to expressions, fractions, geometric figures, and coordinate grids. They are careful about specifying units of measure and state the meaning of the symbols they choose. For instance, when figuring out the volume of a rectangular prism they record their answers in cubic units.

MP.7 Look for and make use of structure. In fifth grade, students look closely to

Grade 5 Continued

Critical Area 5: Classifying two-dimensional figures by properties

Students build on their understanding of angle measures and parallel and perpendicular lines to explore the properties of triangles and quadrilaterals. They develop a foundation for classifying triangles or quadrilaterals by comparing the commonalities and differences of triangles or between types of quadrilaterals.

Critical Skills from 4th Grade that Connect to 5th Grade

ODE Progressions

4th Grade

- Draw and identify lines and angles, and classify shapes by properties of their lines and angles (4.G.1,2)

Information obtained from:
Ohio's K-8 Learning Progressions

5th Grade

- Classify two-dimensional figures into categories based on their properties (5.G.3,4)

Information obtained from:
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discover a pattern or structure. For instance, students use properties of operations as strategies to add, subtract, multiply and divide with whole numbers, fractions, and decimals. They examine numerical patterns and relate them to a rule or a graphical representation.

MP.8 Look for and express regularity in repeated reasoning. Fifth graders use repeated reasoning to understand algorithms and make generalizations about patterns. Students connect place value and their prior work with operations to understand algorithms to fluently multiply multi-digit numbers and perform all operations with decimals to hundredths. Students explore operations with fractions with visual models and begin to formulate generalizations.

(NOTE) Resources Created by Organizations from Outside of Ohio

Some resources were created by professional organizations outside of Ohio and are not guaranteed to fully align to the Ohio Learning Standards for Mathematics. When reviewing these resources, educators can use the expectations for learning and content elaborations contained in the Model Curriculum to help make determinations on whether to use the materials with their instruction.

Additional Content/Informational Resources

- ODE Newly Revised Standards (5th Grade) - Provide learning outcomes for the end of the 5th Grade academic year.
- ODE Math Resources Grades PK-5 - Resources packed through ODE specific to mathematics and grade levels.
- Achieve the Core - These guides will help educators understand and implement the mathematics standards. They can use the guides as they observe teachers giving instruction and provide them with feedback that supports their planning and reflection.
    - K - 8 Content Emphases
    - K - 8 Instructional Practice Guide
- Arizona Progressions - These narrative documents describe the typical learning progression of a topic, informed by both research on children's cognitive development and the logical structure of mathematics.
- Equip – Provides educators with tools to identify high-quality materials for use in classrooms and national examples of high-quality materials aligned to the standards
- The Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric provides criteria to measure alignment and overall quality of lessons and units.

Grade 5 Continued

- Illustrative Mathematics – This site illustrates the range and types of mathematical work that students should experience as teachers use Ohio's Learning Standards in Mathematics. It also presents other tools supporting standards-based instruction.
- Depth of Knowledge information posted by ODE
- Progression Videos of "How" students build math knowledge

Instructional Resources

- Teaching Channel - Provides guiding questions to use during planning and instruction. Classroom videos model best practices. Learning activities showcase rigorous problems that deepen conceptual understanding.
- YouCubed – Showcases research-based teaching methods, mathematics tasks, videos and ideas on how to bring about high levels of student engagement.
- National Library of Virtual Manipulatives - The site contains manipulatives and concept tutorials across the grade bands.
- Inside Mathematics - Educators can find exemplary standards-based lesson ideas on this site, as well as classroom videos. Teachers interested in the lessons can search under "performance task" for lesson ideas organized by grade and course.
- Illuminations - This project by the National Council of Teachers of Mathematics provides quality lessons and interactive resources for teaching and learning mathematics.
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Grade 5 Continued

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Grade 6

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems

Students use reasoning about multiplication and division to solve ratio and rate problems about quantities. By viewing equivalent ratios and rates as deriving from, and extending, pairs of rows (or columns) in the multiplication table, and by analyzing simple drawings that indicate the relative size of quantities, students connect their understanding of multiplication and division with ratios and rates. Thus students expand the scope of problems for which they can use multiplication and division to solve problems, and they connect ratios and fractions. Students solve a wide variety of problems involving ratios and rates.

Critical Skills from 5th Grade that Connect to 6th grade

ODE Progressions

5th Grade

- Understand the place value system (5.NBT.1,2,3,4)
- Perform operations with multi-digit whole numbers and with decimals to hundredths (5.NBT.5,6,7)
- Use equivalent fractions as a strategy to add and subtract fractions (Fractions need not be simplified.) (5.NF.1,2)
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (Fractions need not be simplified.) (5.NF.4,5,6,7)

6th Grade

- Understand ratio concepts and use ratio reasoning to solve problems. (6.RP.1,2,3)

Critical Area 2: Completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers

Students use the meaning of fractions, the meanings of multiplication and division, and the relationship between multiplication and division to understand and explain why the procedures for dividing fractions make sense. Students use these operations to solve problems. Students extend their previous understanding of numbers and the ordering of numbers to the full system of rational numbers, which includes negative rational numbers, and in particular negative integers. They reason about the order and absolute value of

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(The big picture of what our students deserve)

Grade 6 Model Curriculum

Instructional Supports for...

Critical Area 1: Ratios
Critical Area 2: The Number System
Critical Area 3: Expressions and Equations
Critical Area 4: Geometry
Critical Area 5: Statistics and Probability

(The links shown above direct teachers to GREAT resources for each critical area! Many examples are shown to give more meaning to standards. And, many links are provided to other resources that can support each standard cluster.)

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(Explore the five dimensions of powerful classrooms)

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(Embedding missed content into current grade level material)

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(Ideas for teaching concepts mathematically to help students learn)

6th Grade Standards for Mathematical Practice

(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In grade 6, students solve problems involving ratios and rates and discuss how they solved them. Students solve real-world problems through the application of algebraic and geometric

Grade 6 Continued

rational numbers and about the location of points in all four quadrants of the coordinate plane.

Critical Skills from 5th Grade that Connect to 6th grade
ODE Progressions

5th Grade

- Understand the place value system (5.NBT.1,2,3,4)
- Perform operations with multi-digit whole numbers and with decimals to hundredths (5.NBT.5,6,7)
- Use equivalent fractions as a strategy to add and subtract fractions (Fractions need not be simplified.) (5.NF.1,2)
- Apply and extend previous understandings of multiplication and division to multiply and divide fractions. (Fractions need not be simplified.) (5.NF.4,5,6,7)

6th Grade

- Apply and extend previous understandings of multiplication and division to divide fractions by fractions. (6.NS.1)
- Compute fluently with multi-digit numbers and find common factors and multiples. (6.NS.2,3,4)
- Apply and extend previous understandings of numbers to the system of rational numbers. (6.NS.5,6,7,8)

Critical Area 3: Writing, interpreting, and using expressions and equations

Students understand the use of variables in mathematical expressions. They write expressions and equations that correspond to given situations, evaluate expressions, and use expressions and formulas to solve problems. Students understand that expressions in different forms can be equivalent, and they use the properties of operations to rewrite expressions in equivalent forms. Students know that the solutions of an equation are the values of the variables that make the equation true. Students use properties of operations and the idea of maintaining the equality of both sides of an equation to solve simple one-step equations. Students construct and analyze tables, such as tables of quantities that are in equivalent ratios, and they use equations (such as 3x = y) to describe relationships between quantities.

Critical Skills from 5th Grade that Connect to 6th grade
ODE Progressions

5th Grade

- Write and interpret numerical expressions. (5.OA.1,2)
- Analyze patterns and relationships. (5.OA.3)

6th Grade

concepts. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?". Students can explain the relationships between equations, verbal descriptions, and tables and graphs. Mathematically proficient students check their answers to problems using a different method.

MP.2 Reason abstractly and quantitatively. In grade 6, students represent a wide variety of real-world contexts through the use of real numbers and variables in mathematical expressions, equations, and inequalities. Students contextualize to understand the meaning of the number or variable as related to the problem and decontextualize to manipulate symbolic representations by applying properties of operations or other meaningful moves. To reinforce students' reasoning and understanding, teachers might ask, "How do you know?" or "What is the relationship of the quantities?".

MP.3 Construct viable arguments and critique the reasoning of others. In grade 6, students construct arguments using verbal or written explanations accompanied by expressions, equations, inequalities, models, and graphs, tables, and other data displays (i.e. box plots, dot plots, histograms, etc.). They further refine their mathematical communication skills through mathematical discussions in which they critically evaluate their own thinking and the thinking of other students. They pose questions like "How did you get that?", "Why is that true?" "Does that always work?" They explain their thinking to others and respond to others' thinking.

MP.4 Model with mathematics. In grade 6, students model problem situations symbolically, graphically, in tables, contextually and with drawings of quantities as needed. Students form expressions, equations, or inequalities from real-world contexts and connect symbolic and graphical representations. Students begin to represent two quantities simultaneously. Students use number lines to compare numbers and represent inequalities. They use measures of center and variability and data displays (i.e. box plots and histograms) to draw inferences about and make comparisons between data sets. Students need many opportunities to connect and explain the connections between the different representations. They should be able to use all of these representations as appropriate and apply them to a problem context. Students should be encouraged to answer questions

Grade 6 Continued

- Apply and extend previous understandings of arithmetic to algebraic expressions. (6.EE.1,2,3,4)
- Reason about and solve one-variable equations and inequalities. (6.EE.5,6,7,8)
- Represent and analyze quantitative relationships between dependent and independent variables. (6.EE.9)

Critical Area 4 : Developing understanding of statistical problem solving

Building on and reinforcing their understanding of numbers, students begin to develop their ability to think statistically. The GAISE model is used as a statistical problem solving framework. Students recognize that a data distribution may not have a definite center and that different ways to measure center yield different values. The median measures center in the sense that it is roughly the middle value. The mean measures center in the sense that it is the value that each data point would take on if the total of the data values were redistributed equally, and also in the sense that it is a balance point. Students recognize that a measure of variability (range and interquartile range) can also be useful for summarizing data because two very different sets of data can have the same mean and median yet be distinguished by their variability. Students learn to describe and summarize numerical data sets, identifying clusters, gaps, peaks, and outliers in a distribution, considering the context in which the data were collected.

Critical Skills from 5th Grade that Connect to 6th grade
ODE Progressions

5th Grade

- None listed

6th Grade

- Develop understanding of statistical problem solving. (6.SP.1, 2, 3)
- Summarize and describe distributions. (6.SP.4, 5)

Critical Area 5: Solving Problems involving area, surface area, and volume

Students in Grade 6 also build on their work with area in elementary school by reasoning about relationships among shapes to determine area, surface area, and volume. They find areas of right triangles, other triangles, and special quadrilaterals by decomposing these shapes, rearranging or removing pieces, and relating the shapes to rectangles. Using these methods, students discuss, develop, and justify formulas for areas of triangles and parallelograms. Students find areas of polygons and surface areas of prisms and pyramids by decomposing them into pieces whose area they can determine. They reason about right rectangular prisms with fractional side lengths to extend formulas for the volume of a right rectangular prism to fractional side lengths. They prepare for work on scale drawings and constructions in Grade 7 by drawing polygons in the coordinate plane.

such as “What are some ways to represent the quantities?” or “What formula might apply in this situation?”

MP.5 Use appropriate tools strategically. Students consider available tools (including estimation and technology) when solving a mathematical problem and decide when certain tools might be helpful. For instance, students in grade 6 may decide to represent figures on the coordinate plane to calculate area. Number lines are used to create dot plots, histograms, and box plots to visually compare the center and variability of the data. Visual fraction models can be used to represent situations involving division of fractions. Additionally, students might use physical objects or applets to construct nets and calculate the surface area of three-dimensional figures. Students should be encouraged to answer questions such as “What approach did you try first?” or “Why was it helpful to use?”

MP.6 Attend to precision. In grade 6, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to rates, ratios, geometric figures, data displays, and components of expressions, equations or inequalities. When using ratio reasoning in solving problems, students are careful about specifying units of measure and labeling axes to clarify the correspondence with quantities in a problem. Students also learn to express numerical answers with an appropriate degree of precision when working with rational numbers in a situational problem. Teachers might ask, “What mathematical language, definitions, or properties can you use to explain ___?”

MP.7 Look for and make use of structure. Students routinely seek patterns or structures to model and solve problems. For instance, students recognize patterns that exist in ratio tables recognizing both the additive and multiplicative properties. Students apply properties to generate equivalent expressions (i.e. $6 + 2nn = 2\ (3 + nn)$ by distributive property) and solve equations (i.e. $2cc + 3 = 15$, $2cc = 12$ by subtraction property of equality; $cc = 6$ by division property of equality). Students compose and decompose two- and three-dimensional figures to solve real-world problems involving area and volume. Teachers might ask, “What do you notice when ___?” or “What parts of the problem might you eliminate, simplify, or ___?”

MP.8 Look for and express regularity in repeated reasoning. In grade 6, students use repeated reasoning to understand

Grade 6 Continued

Critical Skills from 5th Grade that Connect to 6th grade
ODE Progressions

5th Grade

- Graph points on the coordinate plane to solve real-world and mathematical problems (5.G.1, 2)
- Classify two-dimensional figures into categories based on their properties (5.G.3, 4)
- Convert like measurement units within a given measurement system. (5.MD.1)
- Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition. (5.MD.3, 4, 5)

6th Grade

- Solve real-world and mathematical problems involving area, surface area, and volume. (6.G.1, 2, 3, 4)

algorithms and make generalizations about patterns. During multiple opportunities to solve and model problems, they may notice that *aa bb ÷ cc dd = aaaa bbbb* and construct other examples and models that confirm their generalization. Students connect place value and their prior work with operations to understand algorithms to fluently divide multi-digit numbers and perform all operations with multi-digit decimals. Students informally begin to make connections between rates and representations showing the relationships between quantities. Students should be encouraged to answer questions such as, "How would we prove that ___?" or "How is this situation like and different from other situations?"

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Grade 6 Continued

Instructional Resources

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Grade 6 Continued

Assessment Resources

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Grade 7

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Developing understanding of and applying proportional relationships

Students extend their understanding of ratios and develop understanding of proportionality to solve single and multi-step problems. Students use their understanding of ratios and proportionality to solve a wide variety of percent problems, including those involving discounts, interest, taxes, tips, and percent increase or decrease. Students solve problems about scale drawings by relating corresponding lengths between the objects or by using the fact that relationships of lengths within an object are preserved in similar objects. Students graph proportional relationships and understand the unit rate informally as a measure of the steepness of the related line, called the slope. They distinguish proportional relationships from other relationships.

Critical Skills from 6th Grade that Connect to 7th grade

ODE Progressions

6th Grade

- Understand ratio concepts and use ratio reasoning to solve problems. (6.RP.1,2,3)
- Solve real-world and mathematical problems involving area, surface area, and volume. (6.G.1,2,3,4)

7th Grade

- Analyze proportional relationships and use them to solve real-world and mathematical problems. (7.RP.1,2,3)
- Draw, construct, and describe geometrical figures and describe the relationships between them. (7.G.1)

Critical Area 2: Developing understanding of operations with rational numbers and working with expressions and linear equations.

Students develop a unified understanding of numbers, recognizing fractions, decimals (that have a finite or a repeating decimal representation), and percents as different representations of rational numbers. Students extend addition, subtraction, multiplication, and division to all rational numbers, maintaining the properties of operations and the relationships between addition and subtraction, and multiplication and division. By applying these properties, and by viewing negative numbers in terms of everyday contexts, e.g., amounts owed or temperatures below zero, students explain and interpret the rules for adding, subtracting, multiplying, and dividing with negative numbers. They use the arithmetic of rational numbers as they formulate expressions and equations in one variable and use these equations to solve problems.

How to Facilitate Learning

(We believe students should be doing the thinking)

PDF Executive Summary of NCTM's Principles to Actions

(The big picture of what our students deserve)

Grade 7 Model Curriculum

Instructional Supports for…

Critical Area 1: Ratios and Proportional Relationships, Geometry
Critical Area 2: The Number System
Critical Area 3: Geometry, Expressions and Equations
Critical Area 4: Statistics and Probability
Critical Area 5: Statistics and Probability

(The links shown above direct teachers to GREAT resources for each critical area! Many examples are shown to give more meaning to standards. And, many links are provided to other resources that can support each standard cluster.)

Teaching for Robust Learning (Tru) Framework

(Explore the five dimensions of powerful classrooms)

Restarting School: Planning for Acceleration in 20/21

(Embedding missed content into current grade level material)

Nix the Tricks

(Ideas for teaching concepts mathematically to help students learn)

7th Grade Standards for Mathematical Practice

(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In grade 7, students solve problems involving ratios and rates and discuss how they solved them. Students solve real-world problems through the application of

Grade 7 Continued

Critical Skills from 6th Grade that Connect to 7th grade
ODE Progressions

6th Grade

- Apply and extend previous understandings of multiplication and division to divide fractions by fractions. (6.NS.1)
- Compute fluently with multi-digit numbers and find common factors and multiples. (6.NS.2,3,4)
- Apply and extend previous understandings of numbers to the system of rational numbers. (6.NS.5,6,7,8)
- Understand ratio concepts and use ratio reasoning to solve problems. (6.RP.1,2,3)
- Apply and extend previous understandings of arithmetic to algebraic expressions. (6.EE.1,2,3,4)
- Reason about and solve one-variable equations and inequalities. (6.EE.5,6,7,8)
- Represent and analyze quantitative relationships between dependent and independent variables (6.EE.9)

7th Grade

- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers. (7.NS.1,2,3)
- Analyze proportional relationships and use them to solve real-world and mathematical problems. (7.RP.2)
- Use properties of operations to generate equivalent expressions. (7.EE.1,2)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.3, 4)

Critical Area 3: Solving problems involving scale drawings and informal geometric constructions, angles, and working with two- and three-dimensional shapes to solve problems involving area, surface area, and volume.

Students continue their work with area from Grade 6, solving problems involving the area and circumference of a circle and surface area of three-dimensional objects. In preparation for work on congruence and similarity in Grade 8 they reason about relationships among two-dimensional figures using scale drawings and informal geometric constructions, and they gain familiarity with the relationships between angles formed by intersecting lines. Students work with three-dimensional figures, relating them to two-dimensional figures by examining cross-sections. They solve real-world and mathematical problems involving area, surface area, and volume of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. Geometry 7.G Draw, construct, and describe

Critical Skills from 6th Grade that Connect to 7th grade
ODE Progressions

algebraic and geometric concepts. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?". When students compare arithmetic and algebraic solutions to the same problem, they identify correspondences between different approaches.

MP.2 Reason abstractly and quantitatively. In grade 7, students represent a wide variety of real-world contexts through the use of real numbers and variables in mathematical expressions, equations, and inequalities. Students contextualize to understand the meaning of the number or variable as related to the problem and decontextualize to manipulate symbolic representations by applying properties of operations.

MP.3 Construct viable arguments and critique the reasoning of others. In grade 7, students construct arguments using verbal or written explanations accompanied by expressions, equations, inequalities, models, and graphs, tables, and other data displays (i.e. box plots, dot plots, histograms, etc.). They further refine their mathematical communication skills through mathematical discussions in which they critically evaluate their own thinking and the thinking of other students. For example, as students notice when geometric conditions determine a unique triangle, more than one triangle, or no triangle, they have an opportunity to construct viable arguments and critique the reasoning of others. Students should be encouraged to answer questions such as these: "How did you get that?" "Why is that true?" "Does that always work?" They explain their thinking to others and respond to others' thinking.

MP.4 Model with mathematics. In grade 7, students model problem situations symbolically, graphically, in tables, and contextually. Students form expressions, equations, or inequalities from real-world contexts and connect symbolic and graphical representations. Students use experiments or simulations to generate data sets and create probability models. Proportional relationships present opportunities for modeling. For example, for modeling purposes, the number of people who live in an apartment building might be taken as proportional to the number of stories in the building. Students should be

Grade 7 Continued

6th Grade

- Solve real-world and mathematical problems involving area, surface area, and volume. (6.G.1,2,4)
- Reason about and solve one-variable equations and inequalities. (6.EE.5,6,7)

7th Grade

- Draw, construct, and describe geometrical figures and describe the relationships between them. (7.G.1,2,3)
- Solve real-life and mathematical problems involving angle measure, circles, area, surface area, and volume. (7.G.4,5,6)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.4)

Critical Area 4 : Drawing inferences about populations based on samples.

Students build on their previous work with statistical problem solving through the use of the GAISE model framework. They summarize and describe distributions representing one population and informally compare two populations. Students interpret numerical data sets using mean absolute deviation. They begin informal work with sampling to generate data sets: learn about the importance of representative samples for drawing inferences and the impact of bias.

Critical Skills from 6th Grade that Connect to 7th grade

ODE Progressions

6th Grade

- Develop understanding of statistical problem solving. (6.SP.1,2,3)
- Summarize and describe distributions. (6.SP.5)

7th Grade

- Use sampling to draw conclusions about a population. (7.SP.1)
- Broaden understanding of statistical problem solving. (7.SP.2)
- Summarize and describe distributions representing one population and draw informal comparisons between two populations. (7.SP.3)

Critical Area 5: Investigating chance

Students build upon previous understandings as they develop concepts of probability. They investigate relevant chance events and develop models to determine and compare probabilities. They analyze the frequencies of the experimental results against their predictions, justifying any discrepancies. Students extend their investigations with compound events representing the possible outcomes in tree diagrams, tables, lists, and ultimately through designing and using simulations.

Critical Skills from 6th Grade that Connect to 7th grade

ODE Progressions

encouraged to answer questions such as "What are some ways to represent the quantities?" or "How might it help to create a table, chart, or graph?"

MP.5 Use appropriate tools strategically. Students consider available tools (including estimation and technology) when solving a mathematical problem and decide when certain tools might be helpful. For instance, students in grade 7 may decide to represent similar data sets using dot plots with the same scale to visually compare the center and variability of the data. Students might use physical objects or applets to generate probability data and use graphing calculators or spreadsheets to manage and represent data in different forms. Teachers might ask, "What approach are you considering?" or "Why was it helpful to use ___?"

MP.6 Attend to precision. In grade 7, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students define variables, specify units of measure, and label axes accurately. Students use appropriate terminology when referring to rates, ratios, probability models, geometric figures, data displays, and components of expressions, equations or inequalities. Teachers might ask, "What mathematical language, definitions, or properties can you use to explain ___?

MP.7 Look for and make use of structure. Students routinely seek patterns or structures to model and solve problems. For instance, students recognize patterns that exist in ratio tables making connections between the constant of proportionality in a table with the slope of a graph. Students apply properties to generate equivalent expressions (i.e. $6 + 2nn = 2\ (3 + nn)$ by distributive property) and solve equations (i.e. $2cc + 3 = 15$, $2cc = 12$ by subtraction property of equality; $c = 6$ by division property of equality). Students compose and decompose two- and three-dimensional figures to solve real world problems involving scale drawings, surface area, and volume. Students examine tree diagrams or systematic lists to determine the sample space for compound events and verify that they have listed all possibilities. Solving an equation such as $8 = 4\ (nn - 1\ 2\ )$ is easier if students can see and make use of structure, temporarily viewing $(nn - 1\ 2\ )$ as a single entity.

MP.8 Look for and express regularity in repeated

Grade 7 Continued **6th Grade** • None listed **7th Grade** • Investigate chance processes and develop, use, and evaluate probability models. (7.SP.5-8)	**reasoning.** In grade 7, students use repeated reasoning to understand algorithms and make generalizations about patterns. During multiple opportunities to solve and model problems, they may notice that *aa bb = cc dd* if and only if *aaaa = bbbb* and construct other examples and models that confirm their generalization. Students should be encouraged to answer questions such as "How would we prove that ___?" or "How is this situation both similar to and different from other situations using these operations?"

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- Steve Wyborney - Awesome web page for elementary. You will find popular activities (Splat, Hundred Maze, Subitizing, Fraction Splat, Primary Tile, Tile Area, Esti mystery)
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Grade 7 Continued

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Grade 8

What Students Learn (Critical Areas/Big Ideas)

ODE Critical Areas of Focus

Critical Area 1: Formulating and reasoning about expressions and equations, including modeling an association in bivariate data with a linear equation, and solving linear equations and systems of linear equations.

Students use linear equations and systems of linear equations to represent, analyze, and solve a variety of problems. Students recognize equations for proportions ($y/x = m$ or $y = mx$) as special linear equations ($y = mx + b$), understanding that the constant of proportionality (m) is the slope, and the graphs are lines through the origin. They understand that the slope (m) of a line is a constant rate of change, so that if the input or x-coordinate changes by an amount A, the output or y-coordinate changes by the amount $m \cdot A$. Students also use a linear equation to describe the association between two quantities in bivariate data (such as arm span vs. height for students in a classroom). At this grade, fitting the model, and assessing its fit to the data are done informally. Interpreting the model in the context of the data requires students to express a relationship between the two quantities in question and to interpret components of the relationship (such as slope and y-intercept) in terms of the situation. Students strategically choose and efficiently implement procedures to solve linear equations in one variable, understanding that when they use the properties of equality and the concept of logical equivalence, they maintain the solutions of the original equation. Students solve systems of two linear equations in two variables graphically or by simple inspection; these intersect, are parallel, or are the same line. Students use linear equations, systems of linear equations, linear functions, and their understanding of slope of a line to analyze situations and solve problems.

Critical Skills from 7th Grade that Connect to 8th grade

ODE Progressions

7th Grade

- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.4)
- Analyze proportional relationships and use them to solve real-world and mathematical problems. (7.RP.2)

8th Grade

- Understand the connections between proportional relationships, lines, and linear equations. (8.EE.5,6)
- Analyze and solve linear equations and pairs of simultaneous linear equations. (8.EE.7)
- Analyze and solve linear equations and pairs of simultaneous linear equations. (8.EE.8)
- Investigate patterns of association in bivariate data. (8.SP.1-4)

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PDF Executive Summary of NCTM's Principles to Actions

(The big picture of what our students deserve)

Grade 8 Model Curriculum

Instructional Supports for…

Critical Area 1: Expressions and Equations, Statistics and Probability
Critical Area 2: Functions
Critical Area 3: Expressions and Equations, Geometry
Critical Area 4: The Number System, Expressions and Equations

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(Explore the five dimensions of powerful classrooms)

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(Embedding missed content into current grade level material)

Nix the Tricks

(Ideas for teaching concepts mathematically to help students learn)

8th Grade Standards for Mathematical Practice

(Imagine these are your instructional goals; the content standards are the vehicle you use to get students behaving mathematically)

MP.1 Make sense of problems and persevere in solving them. In grade 8, students solve real-world problems through the application of algebraic and geometric concepts. Students seek the meaning of a problem and look for efficient ways to represent and solve it. They may check

Grade 8 Continued

Critical Area 2: Grasping the concept of a function and using functions to describe quantitative relationships.

Students grasp the concept of a function as a rule that assigns to each input exactly one output. They understand that functions describe situations where one quantity determines another. They can translate among representations and partial representations of functions (noting that tabular and graphical representations may be partial representations), and they describe how aspects of the function are reflected in the different representations.

Critical Skills from 7th Grade that Connect to 8th grade
ODE Progressions

7th Grade

- Analyze proportional relationships and use them to solve real-world and mathematical problems. (7.RP.2)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.4)

8th Grade

- Define, evaluate, and compare functions. (8.F.1,2,3)
- Use functions to model relationships between quantities. (8.F.4,5)

Critical Area 3: Analyzing two- and three-dimensional space and figures using distance, angle, similarity, and congruence, and understanding and applying the Pythagorean Theorem.

Students use ideas about distance and angles, how they behave under translations, rotations, reflections, and dilations, and ideas about congruence and similarity to describe and analyze two-dimensional figures and to solve problems. Students show that the sum of the angles in a triangle is the angle formed by a straight line, and that various configurations of lines give rise to similar triangles because of the angles created when a transversal cuts parallel lines. Students understand the statement of the Pythagorean Theorem and its converse, and can explain why the Pythagorean Theorem holds, for example, by decomposing a square in two different ways. They apply the Pythagorean Theorem to find distances between points on the coordinate plane, to find lengths, and to analyze polygons. Students complete their work on volume by solving problems involving cones, cylinders, and spheres.

Critical Skills from 7th Grade that Connect to 8th grade
ODE Progressions

their thinking by asking themselves, "What is the most efficient way to solve the problem?", "Does this make sense?", and "Can I solve the problem in a different way?"

MP.2 Reason abstractly and quantitatively. In grade 8, students represent a wide variety of real-world contexts through the use of real numbers and variables in mathematical expressions, equations, and inequalities. They examine patterns in data and assess the degree of linearity of functions. Students contextualize to understand the meaning of the number(s) or variable(s) as related to the problem and decontextualize to manipulate symbolic representations by applying properties of operations.

MP.3 Construct viable arguments and critique the reasoning of others. In grade 8, students construct arguments using verbal or written explanations accompanied by expressions, equations, inequalities, models, and graphs, tables, and other data displays (i.e. box plots, dot plots, histograms, etc.). They further refine their mathematical communication skills through mathematical discussions in which they critically evaluate their own thinking and the thinking of other students. They pose questions like "How did you get that?", "Why is that true?" "Does that always work?" They explain their thinking to others and respond to others' thinking.

MP.4 Model with mathematics. In grade 8, students model problem situations symbolically, graphically, in tables, and contextually. Working with the new concept of a function, students learn that relationships between variable quantities in the real-world often satisfy a dependent relationship, in that one quantity determines the value of another. Students form expressions, equations, or inequalities from real-world contexts and connect symbolic and graphical representations. Students use scatterplots to represent data and describe associations between variables. Students need many opportunities to connect and explain the connections between the different representations. They should be able to use all of these representations as appropriate to a problem context. Students should be encouraged to answer questions such as "What are some ways to represent the quantities?" or "How might it help to create a table, chart, graph, or ___?"

MP.5 Use appropriate tools strategically. Students consider available tools (including estimation and technology) when solving a mathematical problem and

Grade 8 Continued

7th Grade

- Analyze proportional relationships and use them to solve real-world and mathematical problems. (7.RP.2)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.4)
- Draw, construct, and describe geometrical figures and describe the relationships between them. (7.G.1-2)
- Solve real-life and mathematical problems involving angle measure, circles, area, surface area, and volume. (7.G.5-6)

8th Grade

- Understand the connections between proportional relationships, lines, and linear equations. (8.EE.6)
- Understand congruence and similarity using physical models, transparencies, or geometry software. (8.G.1,2,3,4,5)
- Understand and apply the Pythagorean Theorem. (8.G.6,7,8)
- Solve real-world and mathematical problems involving volume of cylinders, cones, and spheres. (8.G.9)

Critical Area 4 : Working with irrational numbers, integer exponents, and scientific notation

Students explore irrational numbers and their approximations. They extend work with expressions and equations with integer exponents, square and cube roots. Understandings of very large and very small numbers, the place value system, and exponents are combined in representations and computations with scientific notation.

Critical Skills from 7th Grade that Connect to 8th grade

ODE Progressions

7th Grade

- Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers. (7.NS.2-3)
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations. (7.EE.3)

8th Grade

- Know that there are numbers that are not rational, and approximate them by rational numbers. (8.NS.1,2)
- Work with radicals and integer exponents. (8.EE.1,2,3,4)

decide when certain tools might be helpful. For instance, students in grade 8 may translate a set of data given in tabular form to a graphical representation to compare it to another data set. Students might draw pictures, use applets, or write equations to show the between the angles created by a transversal that intersects parallel lines. Teachers might ask, "What approach are you considering?" or "Why was it helpful to use ___?" MP.6 Attend to precision. In grade 8, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to the number system, functions, geometric figures, and data displays. Teachers might ask, "What mathematical language, definitions, or properties can you use to explain ____?"

MP.6 Attend to precision. In grade 8, students continue to refine their mathematical communication skills by using clear and precise language in their discussions with others and in their own reasoning. Students use appropriate terminology when referring to the number system, functions, geometric figures, and data displays. Teachers might ask, "What mathematical language, definitions, or properties can you use to explain ____?"

MP.7 Look for and make use of structure. Students routinely seek patterns or structures to model and solve problems. In grade 8, students apply properties to generate equivalent expressions and solve equations. Students examine patterns in tables and graphs to generate equations and describe relationships. Additionally, students experimentally verify the effects of transformations and describe them in terms of congruence and similarity.

MP.8 Look for and express regularity in repeated reasoning. In grade eight, students use repeated reasoning to understand the slope formula and to make sense of rational and irrational numbers. Through multiple opportunities to model linear relationships, they notice that the slope of the graph of the linear relationship and the rate of change of the associated function are the same. For example, as students repeatedly check whether points are on the line with a slope of 3 that goes through the point (1, 2), they might abstract the equation of the line in the form $(y-2)/(x-1) = 3$. Students should be encouraged to answer questions such as "How would we prove that ___?" or "How is this situation like and different from other situations using these operations?"

Grade 8 Continued

(NOTE) Resources Created by Organizations from Outside of Ohio

Some resources were created by professional organizations outside of Ohio and are not guaranteed to fully align to the Ohio Learning Standards for Mathematics. When reviewing these resources, educators can use the expectations for learning and content elaborations contained in the Model Curriculum to help make determinations on whether to use the materials with their instruction.

Additional Content/Informational Resources

- ODE Newly Revised Standards (8th Grade) - Provide learning outcomes for the end of the 8th Grade academic year.
- ODE Math Resources Grades 6-8 - Resources packed through ODE specific to mathematics and grade levels.
- Achieve the Core - These guides will help educators understand and implement the mathematics standards. They can use the guides as they observe teachers giving instruction and provide them with feedback that supports their planning and reflection.
    - K - 8 Content Emphases
    - K - 8 Instructional Practice Guide
- Arizona Progressions - These narrative documents describe the typical learning progression of a topic, informed by both research on children's cognitive development and the logical structure of mathematics.
- Equip – Provides educators with tools to identify high-quality materials for use in classrooms and national examples of high-quality materials aligned to the standards
- The Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric provides criteria to measure alignment and overall quality of lessons and units.
- Illustrative Mathematics – This site illustrates the range and types of mathematical work that students should experience as teachers use Ohio's Learning Standards in Mathematics. It also presents other tools supporting standards-based instruction.
- Depth of Knowledge information posted by ODE
- Progression Videos of "How" students build math knowledge

Instructional Resources

- Teaching Channel - Provides guiding questions to use during planning and instruction. Classroom videos model best practices. Learning activities showcase rigorous problems that deepen conceptual understanding.
- YouCubed – Showcases research-based teaching methods, mathematics tasks, videos and ideas on how to bring about high levels of student engagement.
- National Library of Virtual Manipulatives - The site contains manipulatives and concept tutorials across the grade bands.
- Inside Mathematics - Educators can find exemplary standards-based lesson ideas on this site, as well as classroom videos. Teachers interested in the lessons can search under "performance task" for lesson ideas organized by grade and course.
- Illuminations - This project by the National Council of Teachers of Mathematics provides quality lessons and interactive resources for teaching and learning mathematics.
- Resources for 3-Act Math Class (Choose appropriateness for your grade level. These are tasks that foster mathematical modeling.

Dan Meyer	Graham Fletcher	Robert Kaplinsky
Andrew Stadel	John Stevens	Michael Fenton
Geoff Krall	Jon Orr	Kyle Pearce

Back to Top

Grade 8 Continued

- MCTM Collection of Cognitively Demanding Tasks - Amazing collection of web resources for finding those rich multidimensional math tasks.
- Number Talks-provide video resources about how to engage students in mathematical conversation using mental math to solve problems.
    - Building Number Sense (Jo Boaler, Ruth Parker, Sherry Parrish)
    - Inside Mathematics Number Talks
- Fraction Talks - Subitize or Don't, but these awesome pictures open up a world of fraction understanding based on the relationship between a numerator/denominator while the students are quantifying the value the entire time.
- Visual Patterns - great site for students to think algebraically and build expression to model the world with mathematics.
- Clothesline Math - if you have not installed your class clothesline, get on it. What an amazing resource.
- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.
- Estimation 180-great site to have students work on estimation skills
- Would You Rather- students are given a prompt and are asked to select a path and justify their response
- Open Middle-problems that allow multiple ways to approach to solve problems, requiring higher Depth of Knowledge
- Numberless Word Problems-numberless word problems are designed to provide scaffolding that allows students the opportunity to develop a better understanding of the underlying structure of word problems
- DESMOS Activities -these activities are designed for playful exploration of mathematical ideas
- DESMOS Graphing Calculator Online math tool for making tables, graphs, and equations
- Geogebra-online math tools for math and geometry
- DESMOS Geometry Online math tool for geometry

Assessment Resources

Assessment data can be collected in many forms. In most cases understanding where students are in their learning pathway is about listening to their thinking during a Number Talk, rich tasks, solution pathways used in curricular work, etc. Understanding student thinking towards a specific goal will be more impactful than focusing on what they know or don't know. A sound use of formative assessment (conversations, observations, written, thinking) in real time can offer much more instructional information than any given assessment.

(Caution, please use assessments that are designed to actually perform the action you are calling on it to provide. For example, do not use a universal screener as a diagnostic. It is important that all stakeholders understand Universal Screeners, Benchmarks, Progress Monitors, Diagnostics, Growth Measures, Adaptive...and the pedagogical consequences of using inappropriately)

- ODE Grade 8 Testing Resources
- Ohio Department of Education Approved Vendor Assessments
- Depth of Knowledge - Website with information on building assessments using Depth of Knowledge
- Cognition-Based Assessment - Assessments used for diagnostic purposes. Used to develop targeted interventions with aligned interventions. Best used as an interview.
- AIMS plus - Universal screener, benchmark and progress monitor
- Math Recovery / Math AddVantage - Diagnostic assessment and targeted activities up through 5th grade

**Struggle is a situation and should not become an identity. We need to ensure mindful, appropriate responses to all assessment.*

Algebra 1

What Students Learn

(Algebra 1 Critical Areas of Focus)

*Identified on the Algebra1 Test Blueprint

Critical Area 1: Relationships Between Quantities and Reasoning with Equations (Number and Quantity, Algebra)*

By the end of eighth grade students have learned to solve linear equations in one variable and have applied graphical methods to analyze and solve systems of linear equations in two variables. Now students build on these earlier experiences by analyzing and explaining the process of solving an equation. Students develop fluency writing, interpreting, and translating between various forms of linear equations and inequalities, and using them to solve problems. They master the solution of linear equations and apply related solution techniques and the laws of exponents to the creation and solution of simple exponential equations. All this work is grounded on understanding quantities and on the relationships between them. Students apply this learning in real-world and modeling situations.

Critical Area 2: Linear and Exponential Relationships (Algebra, Functions)*

In earlier grades, students define, evaluate, and compare functions, and use them to model relationships between quantities. Students will learn function notation and develop the concepts of domain and range. Their understanding moves beyond viewing functions as processes that take inputs and yield outputs and to viewing functions as objects in their own right followed by an informal introduction of inverse functions. They explore many examples of functions, including sequences; they interpret functions given graphically, numerically, symbolically, and verbally, translate between representations, and understand the limitations of various representations. They work with functions given by graphs and tables, keeping in mind that, depending upon the context, these representations are likely to be approximate or incomplete. Their work includes functions that can be described or modeled by formulas as well as those that cannot. When

What Students Do

(Standards for Mathematical Practice)

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MP.1 Make sense of problems and persevere in solving them.

Students learn that patience is often required to fully understand what a problem is asking. They discern between useful and extraneous information. They expand their repertoire of expressions and functions that can be used to solve problems.

MP.2 Reason abstractly and quantitatively.

Quantitative reasoning entails habits of creating a coherent representation of the problem at hand; of considering the units involved; of attending to the meaning of quantities, not just how to compute them; and of knowing and flexibly using different properties of operations and objects.

MP.3 Construct viable arguments and critique the reasoning of others.

Students reason through the solving of equations, recognizing that solving an equation involves more than simply following rote rules and steps. They use language such as "If ___, then ___" when explaining their solution methods and provide justification for their reasoning.

How to Facilitate Learning

Ohio Resources

The ODE provides a **Model Curriculum** with Instructional Supports for Algebra 1.

This document is user-friendly with the Table of Contents serving as a hub to quickly access desired content by providing links to specific pages in the document.

Teachers already comfortable with the standards may go directly to the "Instructional Strategies" for a more thorough description of students' learning progression through content or "Instructional Tools/Resources" for ideas for classroom instruction.

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Algebra 1 Continued

functions describe relationships between quantities arising from a context, students reason with the units in which those quantities are measured. Students build on and informally extend their understanding of integer exponents to consider exponential functions. They compare and contrast linear and exponential functions, distinguishing between additive and multiplicative change. They interpret arithmetic sequences as linear functions and geometric sequences as exponential functions.

Critical Area 3: Descriptive Statistics (Statistics and Probability)*

In middle school, students developed an understanding of statistical problem solving through the format of the GAISE Model. They are expected to display numerical data and summarize it using measures of center and variability. By the end of middle school, students were creating scatterplots and recognizing linear trends in data. Now, they apply those concepts by using the GAISE model in the context of real-world applications. Students develop formal means of assessing how a model fits data. They use regression techniques to describe approximate linear relationships between quantities. Students use graphical representations and knowledge of the context to make judgments about the appropriateness of linear models. In Algebra 2/Mathematics 3, students will look at residuals to analyze the goodness of fit.

Critical Area 4: Expressions and Equations (Algebra)*

Students apply the properties of operations with real numbers, the relationships between the operations, along with the properties of exponents to operations with polynomials. Also, students focus on the structure of expressions, rewriting expressions to clarify and reveal aspects of the relationship they represent. They create and solve equations, inequalities, and systems of equations involving exponential and quadratic expressions.

Critical Area 5: Quadratic Functions and Modeling (Functions)*

In preparation for work with quadratic relationships students explore distinctions between rational and irrational numbers. They consider quadratic functions,

MP.4 Model with mathematics.

Students also discover mathematics through experimentation and by examining data patterns from real-world contexts. They Apply their new mathematical understanding of exponential, linear, and quadratic functions to real-world problems.

MP.5 Use appropriate tools strategically.

Students develop a general understanding of the graph of an equation or function as a representation of that object, and they use tools such as graphing calculators or graphing software to create graphs in more complex examples, understanding how to interpret results. They construct diagrams to solve problems.

MP.6 Attend to precision.

Students use clear definitions in discussion with others and in their own reasoning. They state the meaning of the symbols they choose, including using the equal sign consistently and appropriately. They are careful about specifying units of measure and labeling axes to clarify the correspondence with quantities in a problem. They make use of the definition of function when deciding if an equation can describe a function by asking, "Does every input value have exactly one output value?"

MP.7 Look for and make use of structure.

Students develop formulas such as $(a \pm b)^2 = a^2 \pm 2ab + b^2$ by applying the distributive property. Students see that the expression $5 + (n-2)^2$ takes the form of 5 plus "something squared," and because "something squared" must be positive or zero, the expression can be no smaller than 5

MP.8 Look for and express regularity in repeated reasoning.

Students see that the key feature of a line in the

Ohio's Frequently Updated Resources Page

Additional Instructional Supports

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Supports for Pedagogical Philosophy

(We believe students should be doing the thinking)

PDF Executive Summary of NCTM's Principles to Actions

(The big picture of what our students deserve)

Teaching for Robust Learning (Tru) Framework

(Explore the five dimensions of powerful classrooms)

Algebra 1 Continued comparing the key characteristics of quadratic functions to those of linear and exponential functions. They select from among these functions to model phenomena. Students learn to gather information about quadratic and exponential functions by interpreting various forms of expressions representing the functions. For example, they identify the real solutions of a quadratic equation as the zeros of a related quadratic function. When quadratic equations do not have real solutions, students learn that the graph of the related quadratic function does not cross the horizontal axis.They relate their prior experience with transformations to that of building new functions from existing ones and recognize the effect of the transformations on the graphs. Formal work with complex numbers and more specialized functions—absolute value, step, and piecewise-defined, will occur in Algebra 2/Mathematics 3.	plane is an equal difference in outputs over equal intervals of inputs, and that the result of evaluating the expression $\frac{y_2-y_1}{x_2-x_1}$ for points on the line is always equal to a certain number m. Therefore, if (x,y) is a generic point on this line, the equation $m = \frac{y_2-y_1}{x_2-x_1}$ will give a general equation of that line.	**Restarting School: Planning for Acceleration in 20/21** **(Embedding missed content into current grade level material)** **Nix the Tricks** **(Ideas for teaching concepts mathematically to help students learn)**

Geometry

What Students Learn

(Geometry Critical Areas of Focus)

* Identified on the Geometry Test Blueprint

Critical Area 1: Applications of Probability (Statistics and Probability)*

Building on probability concepts that began in grade 7, students use the languages of set theory to expand their ability to compute and interpret theoretical and experimental probabilities for compound events, attending to mutually exclusive events, independent events, and conditional probability. Students should make use of geometric probability models wherever possible. They use probability to make informed decisions related to real-world situations.

Critical Area 2: Congruence, Proof, and Constructions (Geometry)*

In previous grades, students were asked to draw triangles based on given measurements. They also have prior experience with rigid motions: translations, reflections, and rotations and have used these to develop notions about what it means for two objects to be congruent or to have symmetries of itself, rotational or reflected. Students establish triangle congruence criteria, based on analyses of rigid motions and formal constructions. They use triangle congruence as a familiar foundation for the development of formal and informal proof. Students prove theorems—using a variety of formats—and apply them when solving problems about triangles, quadrilaterals, and other polygons. They apply reasoning to complete geometric constructions and explain why they work. Students will extend prior experience with geometric shapes toward the development of a hierarchy of two-dimensional figures based on formal properties.

Critical Area 3: Similarity, Proof, and Trigonometry (Geometry)*

Students apply their earlier experience with dilations and proportional reasoning to build a formal understanding of similarity. They identify criteria for similarity of triangles, use it as a familiar foundation for the development of informal and formal proofs, problem solving and applications to similarity in right triangles. This will assist in the further

What Students Do

(Standards for Mathematical Practice)

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MP.1 Make sense of problems and persevere in solving them.
Students construct accurate diagrams of geometry problems to help make sense of them. They organize their work so that others can follow their reasoning.

MP.2 Reason abstractly and quantitatively.
Students understand that the coordinate plane can be used to represent geometric shapes and transformations, and therefore they connect their understanding of number and algebra to geometry.

MP.3 Construct viable arguments and critique the reasoning of others.
Students use formal and informal proofs to verify, prove, and justify geometric theorems with respect to congruence and similarity. These proofs can include paragraph proofs, flow charts, coordinate proofs, two-column proofs, diagrams without words, indirect proofs, or the use of dynamic software.

How to Facilitate Learning

Ohio Resources

The ODE provides a **Model Curriculum** with Instructional Supports for Geometry.

This document is very user-friendly with the Table of Contents serving as a hub for quickly accessing desired content by providing links to specific pages in the document.

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Ohio's Frequently Updated Resources Page

Geometry Continued

development of right triangle trigonometry, with particular attention to special right triangles, right triangles with one side and one acute angle given and the Pythagorean Theorem. Students apply geometric concepts to solve real-world, design and modeling problems.

Critical Area 4: Connecting Algebra and Geometry Through Coordinates (Geometry)

Building on their work with the Pythagorean theorem in 8th grade to find distances, students use a rectangular coordinate system to verify geometric relationships, including properties of special triangles and quadrilaterals and slopes of parallel and perpendicular lines.

Critical Area 5: Circles With and Without Coordinates (Geometry)*

Students prove basic theorems about circles, such as a tangent line is perpendicular to a radius, inscribed angle theorem, and theorems about chords, secants, and tangents dealing with segment lengths and angle measures. They study relationships among segments on chords, secants, and tangents as an application of similarity. Students use the distance formula to write the equation of a circle when given the radius and the coordinates of its center. Given an equation of a circle, they draw the graph in the coordinate plane, and apply techniques for solving quadratic equations, which relates back to work done with systems of equations in the first course to determine intersections between lines and circles. Students model and solve real-world problems applying these geometric concepts.

Critical Area 6: Extending to Three Dimensions (Geometry)

Students' experience with two-dimensional and three dimensional objects is extended to include informal explanations of circumference, area and volume formulas. Students develop the understanding of how changes in dimensions result in similar and non-similar shapes and how scaling changes lengths, areas and volumes. Additionally, students apply their knowledge of two-dimensional shapes to consider the shapes of cross-sections and the result of rotating a two-dimensional object about a line. They solve real-world problems applying these geometric concepts.

MP.4 Model with mathematics.
Students apply their new mathematical understanding to real-world problems. They learn how transformational geometry and basic trigonometric functions can be used to model the physical world.

MP.5 Use appropriate tools strategically.
Students make use of visual tools for representing geometry, such as simple patty paper, transparencies, or dynamic geometric software.

MP.6 Attend to precision.
Students develop and use precise definitions of geometric terms. They verify that a particular shape has specific properties and justify the categorization of the shape, e.g., a rhombus versus a quadrilateral.

MP.7 Look for and make use of structure.
Students construct triangles in quadrilaterals or other shapes and use congruence criteria of triangles to justify results about those shapes.

MP.8 Look for and express regularity in repeated reasoning.
Students explore rotations, reflections, and translations, noticing that some attributes of shapes (e.g., parallelism, congruency, orientation) remain the same. They develop properties of transformations by generalizing these observations.

Additional Instructional Supports

The Resources for High School portion of this document, below, contains links to many valuable resources that support teachers as they construct classrooms where students can be curious, thoughtful, and persistent as they grow in their mathematical understanding.

While many of these resources are referenced in Ohio's Model Curriculum, these resources were created by professional organizations outside of Ohio and are not guaranteed to fully align to the Ohio Learning Standards for Mathematics. When reviewing these resources, educators can use the expectations for learning and content elaborations contained in the Model Curriculum to help make determinations on whether to use the materials with their instruction.

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Nix the Tricks
(Ideas for teaching concepts mathematically to help students learn)

Algebra 2

What Students Learn
(Algebra 2 Critical Areas of Focus)

Critical Area 1: Inferences and Conclusions from Data (Statistics and Probability)

Students see how the visual displays and summary statistics they learned in earlier grades relate to different types of data and to probability distributions. They identify different ways of collecting data—including sample surveys, experiments, and simulations—and the role that randomness and careful design play in the conclusions that can be drawn.To model the relationships between variables, students fit a linear function to data and analyze residuals to assess the appropriateness of fit. Building on prior experiences associated with the notion of a correlation coefficient, students learn how to distinguish a statistical relationship from a cause-and-effect relationship.

Critical Area 2: Polynomials, Rational and Radical Relationships (Number and Quantity, Algebra)

Students build on their previous work with rational numbers and integer exponents to develop understanding of rational exponents. They apply this new understanding of numbers to seeing the structure in exponential expressions.Students develop the structural similarities between the system of polynomials and the system of integers. Theydraw on analogies between polynomial arithmetic and base ten computation, focusing on properties of operations, particularly the distributive property. Students connect multiplication of polynomials with multiplication of multi-digit integers, and division of polynomials with long division of integers. Students identify zeros of
polynomials and make connections between zeros of polynomials and solutions of polynomial equations. This learning culminates with applying the Fundamental Theorem of Algebra. A central

What Students Do
(Standards for Mathematical Practice)

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MP.1 Make sense of problems and persevere in solving them.
Students apply their understanding of various functions to real-world problems. They approach complex mathematics problems and break them down into smaller problems, synthesizing the results when presenting solutions.

MP.2 Reason abstractly and quantitatively.
Students deepen their understanding of transformations of graphs by changing the form of rational function $f(x) = \frac{a(x)}{b(x)}$ where $a(x)$ and $b(x)$ represent polynomials and $b(x)$ is not 0, to reveal and interpret the key features of the function.

MP.3 Construct viable arguments and critique the reasoning of others.
Students continue to reason through the solution of an equation and justify their reasoning to their peers. Students defend their choice of a function when modeling a

How to Facilitate Learning

Ohio Resources

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The Instructional Supports for Algebra 2 should be updated in the Model Curriculum soon. In the meantime, teachers may use the resources here to support instruction.

Ohio's Frequently Updated Resources Page

Outside Resources for Algebra 2

While these resources are referenced in Ohio's Model Curriculum for other courses, these resources were created by professional organizations outside of Ohio and are not guaranteed to fully align to the Ohio Learning

Algebra 2 Continued

theme of the arithmetic of rational expressions is governed by the same rules as the arithmetic of rationalnumbers.Students realize that rational numbers extend the arithmetic of integers by allowing division by all numbers except 0. Similarly, they learn that rational expressions extend the arithmetic of polynomials by allowing division by all polynomials except the zero polynomial. In addition, students will extend their experience with solving systems of two linear equations in two variables to solving systems of three linear equations in three variables algebraically.

Critical Area 3: Trigonometry of General Triangles and Trigonometric Functions (Geometry, Functions)

Building on students' previous work with functions, trigonometric ratios,and circles in Geometry or Mathematics 2, students now use the coordinate plane and the unit circle to extend trigonometry to general angles and to model periodic phenomena.This leads to the conclusion that trigonometry is applied beyond the right triangle—that is, at least to obtuse angles. Concurrently, students develop the notion of radian measure for angles and extend the domain of the trigonometric functions to all real numbers. They also develop an understanding that theLaws of Sines and Cosines can be used to find missing measures of general (not necessarily right) triangles. This allows students to distinguish whether three given measures (angles or sides) define 0, 1, 2, or infinitely many triangles.

Critical Area 4: Modeling with Functions (Algebra, Functions)

Students synthesize and generalize what they have learned about a variety of function families. They extend their work with exponential functions to include solving exponential equations with logarithms. They explore the effects of transformations on graphs of diverse functions, including functions arising in an application, in order to abstract the general principle that transformations on a graph always have the same real-world situation.

MP.4 Model with mathematics.

Students apply their new mathematical understanding to real-world problems, making use of their expanding repertoire of functions in modeling. Students also discover mathematics through experimentation and by examining patterns in data from real-world contexts.

MP.5 Use appropriate tools strategically.

Students continue to use graphing technology to deepen their understanding of the behavior of polynomial, rational, square root, and trigonometric functions.

MP.6 Attend to precision.

Students make note of the precise definition of complex numbers, understanding that real numbers are a subset of complex numbers. They pay attention to units in real-world problems and use unit analysis as a method for verifying their answers.

MP.7 Look for and make use of structure.

Students see the operations of complex numbers as extensions of the operations for real numbers. They understand the periodicity of sine and cosine and use these functions to model periodic phenomena.

MP.8 Look for and express regularity in repeated reasoning.

Students observe a pattern that powers of the imaginary number i cycles through the same four outcomes, i, -1, $-i$ and 1, since $i^4 = 1$ and any power of i with an integer exponent that is a multiple of 4 has a value 1.

$i = i$ $\qquad$ $i^5 = i$

Standards for Mathematics. Review the resources carefully for alignment with your course standards.

Algebra 2 Illustrative Mathematics Curriculum is one of the highest rated curricula by EdReports. It is meant to be done online. It has resources for students, families, and educators.

Algebra 2 EngageNY is a full curriculum that is rated highly by EdReports. The lessons are in-depth and aligned to the standards. It has printable student worksheets and teacher answer keys.

Algebra 2 Mathematics Vision Project has a full curriculum of lessons. There are also teacher notes available.

Additional Instructional Supports

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Algebra 2 Continued effect regardless of the type of the underlying functions. They Identify appropriate types of functions to model a situation, they adjust parameters to improve the model, and they compare models by analyzing appropriateness of fit and making judgments about the domain over which model is a good fit. The description of modeling as "the process of choosing and using mathematics and statistics to analyze empirical situations, to understand them better, and to make decisions" is at the heart of this unit. The narrative discussion and diagram of the modeling cycle should be considered when knowledge of functions, statistics, and geometry is applied in a modeling context.	$i^2 = -1$ $\quad i^6 = -1$ $i^3 = -i$ $\quad i^7 = -i$ $i^4 = 1$ $\quad i^8 = 1$ students use this observation to make a conjecture about any power of i.	**Nix the Tricks** **(Ideas for teaching concepts mathematically to help students learn)**

Resources for High School Instruction

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** Referenced in the Model Curriculum with Instructional Supports

- 3-Act Math Tasks
  - Dan Meyer** - blog contains lots of thought-provoking information as well as 3-act tasks by topic
  - Robert Kaplinsky**- lessons easily identified by course
  - Tap Into Teen Minds** - search for lessons by standard or topic
  - When Math Happens** - tasks by course up through Calculus
  - Yummy Math** - tasks by conceptual category
- Achieve the Core** - provides lessons and tasks for teachers to use in the classroom
- Debate Math with Chris Luzniak - supports MP3, among others by using a debate format to encourage student discussion and critical thinking
- Desmos Classroom Activities** - includes many activities that are classroom-ready.
- DESMOS Graphing Calculator Online math tool for making tables, graphs, and equations
- DESMOS Geometry Online math tool for geometry
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- Math Bits Notebook - lessons for building procedural fluency
- MCTM Collection of Cognitively Demanding Tasks - Amazing collection of web resources for finding those rich multidimensional math tasks.
- National Library of Virtual Manipulatives** - The site contains manipulatives and concept tutorials across the grade bands.
- Number Talks-provide video resources about how to engage students in mathematical conversation using mental math to solve problems.
  - Building Number Sense (Jo Boaler, Ruth Parker, Sherry Parrish)
  - Inside Mathematics Number Talks

- Numberless Word Problems-numberless word problems are designed to provide scaffolding that allows students the opportunity to develop a better understanding of the underlying structure of word problems
- Open Middle-problems that allow multiple ways to approach to solve problems, requiring higher Depth of Knowledge
- Pleacher Math - lessons for building procedural fluency
- Teaching Channel - Provides guiding questions to use during planning and instruction. Classroom videos model best practices. Learning activities showcase rigorous problems that deepen conceptual understanding.
- Visual Patterns** - great site for students to think algebraically and build expression to model the world with mathematics.
- Which one does not belong- Great resource with low floor and high ceiling. Getting the reluctant math student to contribute early. Kids love these.
- Would You Rather- students are given a prompt and are asked to select a path and justify their response
- YouCubed** – Showcases research-based teaching methods, mathematics tasks, videos and ideas on how to bring about high levels of student engagement

Resources for High School Assessment

Assessment data can be collected in many forms. In most cases understanding where students are in their learning pathway is about listening to their thinking during a Number Talk, rich tasks, solution pathways used in curricular work, etc. Understanding student thinking towards a specific goal will be more impactful than focusing on what they know or don't know. A sound use of formative assessment (conversations, observations, written, thinking) in real time can offer much more instructional information than any given assessment.

(Caution, please use assessments that are designed to actually perform the action you are calling on it to provide. For example, do not use a universal screener as a diagnostic. It is important that all stakeholders understand Universal Screeners, Benchmarks, Progress Monitors, Diagnostics, Growth Measures, Adaptive...and the pedagogical consequences of using inappropriately)

- Achieve the Core Assessments contains mini assessments to gauge student understanding of specific standards.
- Depth of Knowledge Sample Problems by Conceptual Category for High School
- Mathematics Assessment Project provides resources for both formative and summative assessment
- ODE Testing Resources
- ODE Instructional Strategies for Mathematics supports assessment using Depth of Knowledge

Closing Thoughts

This document offers many amazing resources for understanding content and how to deliver content in a mathematics classroom. We are encouraged and hopeful by the progress our state has made in mathematics instruction, but our work is far from complete! We need to move from knowledge to deep understanding of the Ohio Learning Standards and how they interact with each other to create a wonderful connected web of learning. We need to learn and reflect on how students learn mathematics developmentally and how building agency and identity are just as important as content. Please consider avenues to "sharpen your saw" and grow in your craft. No one person has all the answers or has reached the pinnacle of understanding on how to deliver the content from their discipline. This work is hard, and is a slow metamorphosis. We encourage a process of building beliefs and visions of what students deserve and learning how to align practices with those beliefs. It ensures we are doing what the research suggests is best for students, not what is easiest for adults. Although we are proud and pleased to be embedded in Ohio's math community, we also know we have lots of understanding and growth to do as a professional community. This document was prepared to help educators post Covid-19, but we view it also as a document and calling to continue improving our discipline. This document and appropriate professional development will be an impetus for both. Please remember when planning instruction to focus on Mathematical Practices and work diligently to ensure the students are doing the thinking.

"What we learn today does not make yesterday wrong; it only makes tomorrow better." *Unknown*

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