Moving Mathematics Education Forward

Oregon Department of Education
Introductions

Please share:
- Your name
- Your grade level
- Your school
- Your favorite math vocabulary word
Workshop Goals

Participants will:

- increase understanding of the Oregon Mathematics Core, Content, and Process Standards;
- increase understanding of the Elements of Effective Mathematics Instruction; and
- develop knowledge and skills for developing implementation action plans.
Housekeeping

- Logistics
- Expectations
- Bike rack
- Credit information
- Notebook overview
- Group Agreements
Agenda – Day 1

8:00-11:25
- Welcome and Overview
- Introductions
- Workshop Goals
- Norms/Expectations
- Logistics
- Engaging in Mathematics
- Oregon Diploma
- Oregon K-8 and H.S. Math Content Standards
- Vertical Mapping to Understand Learning Progressions

11:25-12:10 Lunch

12:10-4:00
- Elements of Effective Instruction: Mathematics
- Instructional Practices for Mathematics
- Reaching All Students - Learning Preferences
- Closure
Agenda – Day 2

8:00-11:40
   Welcome and Overview
   Analyzing Cognitive Demand of Tasks
   Formative Assessment

11:40-12:25  Lunch

12:25- 4:00
   Design A Math Task for Lesson
   Lesson Planning With Content Standards
   Action Planning
   Closure and Evaluation
Resources and References

- Acronyms
- Websites of resources and references
- ODE staff information:
  - Tanya Frisendahl
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MMEF
Moving Math Education Forward
Engaging in Mathematics
Penny’s mother told her that several of her great-great-great grandparents fought in the Civil War. Penny thought this was interesting, and she wondered how many great-great-great-grandparents that she actually had. When she found that number, she wondered how many generations back she’d have to go until she could count more than 100 ancestral grandparents or 1000, or 10,000, or even 100,000. When she found out, she was amazed and pretty glad she had a calculator. How do you think Penny might have figured out all this information? Explain and justify your method as clearly and completely as possible.
Problem Solving Activity

- Solve the problem on your own using a method that would be appropriate at (or near) the grade level you teach.
- Move to your assigned grade band group.
- Discuss solutions to the problem.
- Create a visual to demonstrate a solution to this problem.
- Select a reporter to present your visual.
Clock Partner Activity

- Draw a circle on a blank piece of paper. Label the 12, 3, 6, and 9 o'clock times on the clock face.
- Find four people to share something you know about the Oregon Diploma.
- Have each of the four sign a different time on your clock. These will be your clock partners for the workshop.
The Oregon Diploma

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What have you heard about the new Oregon Diploma requirements?
OREGON DIPLOMA 2012

Credit Requirements/Standards

4- English/LA
3- Math
3- Science
3- Social Sciences
3- Arts/CTE/Second Language
1- Health
1- PE
6- Electives

24- Total

Essential Skills Proficiency

☐ Reading

Personalized Learning

☐ Education Plan & Profile
☐ Extended Application
☐ Career-Related Learning Experiences

www.ode.state.or.us/go/diploma
OREGON DIPLOMA

Essential Skills Proficiency Requirements are as Follows:

For the Graduating Class of 2012:
☐ Read and comprehend a variety of text

For the Graduating Class of 2013:
☐ Read and comprehend a variety of text
☐ Write clearly and accurately

For the Graduating Class of 2014:
☐ Read and comprehend a variety of text
☐ Write clearly and accurately
☐ Apply mathematics in a variety of settings

www.ode.state.or.us/go/diploma
Diploma Changes

Math Credits

- 3 credits required starting with the 2010 graduates
- 3 credits at Algebra I and above required starting with the 2014 graduates
- Courses/credits aligned to content standards
- Credit may be earned through applied academics
What is the connection between the Oregon Diploma requirements and Oregon’s content standards?
Oregon Content Standards

Oregon Educational Act (ORS 329.045)

- **State Board of Education (SBE)**
  - shall regularly and periodically review and revise its ...rigorous academic content standards in mathematics, science, English, history, geography, economics, civics, physical education, health, the arts and second languages.

- **School districts**
  - shall maintain control over course content, format, materials, and teaching methods.
  - shall offer students instruction in mathematics, science, English, history, geography, economics, civics, physical education, health, the arts and second languages that meets the academic content standards ...and requirements adopted by the SBE...
Oregon Content Standards

Define what students are expected to know and be able to do.
Reflection

Turn to your elbow partner and for one minute discuss:

What did you learn about the Oregon Diploma requirements?
Oregon K-8 and High School Mathematics Content Standards
Oregon's Core Standards Structure

- Fewer, more focused and coherent content standards
- Built around “big ideas” for each grade level and subject area (core standards statement)
- Articulates learning progressions within and between grade levels
- Allows for more effective lesson design, focused instruction, and creation of formative assessments
- Endurance, Leverage, and Success
Grade 4

It is essential that these standards be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations.

4.1 Number and Operations: Develop an understanding of decimals, including the connections between fractions and decimals.

4.1.1 Extend the base-ten system to read, write, and represent decimal numbers (to the hundredths) between 0 and 1, between 1 and 2, etc.
4.1.2 Use models to connect and compare equivalent fractions and decimals.
4.1.3 Determine decimal equivalents or approximations of common fractions.
4.1.4 Compare and order fractions and decimals.
4.1.5 Estimate decimal or fractional amounts in problem solving.
4.1.6 Represent money amounts to $10.00 in dollars and cents, and apply to situations involving purchasing ability and making change.

4.2 Number and Operations and Algebra: Develop fluency with multiplication facts and related division facts, and with multi-digit whole number multiplication.

4.2.1 Apply with fluency multiplication facts to 10 times 10 and related division facts.
4.2.2 Apply understanding of models for multiplication (e.g., equal-sized groups, arrays, area models, equal intervals on the number line), place value, and properties of operations (commutative, associative, and distributive).
4.2.3 Select and use appropriate estimation strategies for multiplication (e.g., use benchmarks, overestimate, underestimate, round) to calculate mentally based on the problem situation when computing with whole numbers.
4.2.4 Develop and use accurate, efficient, and generalizable methods to multiply multi-digit whole numbers.
4.2.5 Develop fluency with efficient procedures for multiplying multi-digit whole numbers and justify why the procedures work on the basis of place value and number properties.

4.3 Measurement: Develop an understanding of area and determine the areas of two-dimensional shapes.

4.3.1 Recognize area as an attribute of two-dimensional regions.
4.3.2 Determine area by finding the total number of same-sized units of area that cover a shape without gaps or overlaps.
4.3.3 Recognize a square that is one unit on a side as the standard unit for measuring area.
4.3.4 Determine the appropriate units, strategies, and tools to solving problems that involve estimating or measuring area.
4.3.5 Connect area measure to the area model used to represent multiplication and use this to justify the formula for area of a rectangle.
4.3.6 Find the areas of complex shapes that can be subdivided into rectangles.
4.3.7 Solve problems involving perimeters and areas of rectangles and squares.
4.3.8 Recognize that rectangles with the same area can have different perimeters and that rectangles with the same perimeter can have different areas.
Grade 3

3.1 Fractions

3.2 Develop an understanding of multiplication and division

3.3 Two-dimensional shapes

Grade 4

4.1 Decimals

4.2 Develop fluency with multiplication and division

4.3 Area
High School

Guiding Principles and Goals:

- Content Standards - Algebra; Geometry and Measurement; and Probability and Statistics are the essential content for all students.

- Process Standards, which support the Apply Mathematics Essential Skill, must be taught throughout K-12 mathematics.

- High school standards address a wide range of depth of knowledge levels to encourage mathematical fluency, deep conceptual knowledge, and mastery of the Apply Mathematics Essential Skill.

- Advanced mathematics knowledge and essential skills offer opportunities for differentiated instruction.
# Mathematics Standards Framework

<table>
<thead>
<tr>
<th>Algebra</th>
<th>Geometry &amp; Measurement</th>
<th>Probability &amp; Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Numbers</td>
<td>Geometric Reasoning</td>
<td>Data Analysis</td>
</tr>
<tr>
<td>Equivalent Expressions</td>
<td>Similarity and Transformations</td>
<td></td>
</tr>
<tr>
<td>Linear Equations and Functions</td>
<td>Two and Three Dimensional Geometry</td>
<td>Probability</td>
</tr>
<tr>
<td>Systems of Equations</td>
<td>Right Triangle Trigonometry</td>
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<tr>
<td>Quadratic and Exponential</td>
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<tr>
<td>Equations and Functions</td>
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- Problem Solving
- Reasoning
- Communication
- Making Connections
- Designing and Analyzing Representations
- Reflection on One's Solution (H.S.)
National Mathematics Advisory Panel Report

- Published in March 2008
- Reviewed over 16,000 research publications
- Developed 45 recommendations
- Focused on algebra - preparation and content
- Emphasized “the best available scientific evidence.”
Main Findings and Recommendations

- Curricular Content
- Learning Processes
- Teachers and Teacher Education
- Instructional Practices
- Instructional Materials
- Assessment
- Research Policies and Mechanisms
Curricular Content

- Focused, coherent progression of mathematics learning, with an emphasis on proficiency with key topics
- Major Topics of School Algebra
- Goal to develop proficiency with fractions, decimals, and percents
National Council of Teachers of Mathematics

Focal Points

- Directs the focus of mathematics instruction and learning at particular K-8 grade levels in effort to:
  - Develop consistency in mathematics across the U.S.
  - Teach important concepts in depth
  - Align math curriculum with Trends in International Mathematics and Science Study (TIMSS) recommendations.
  - Support an emphasis on accountability testing
  - Alleviate affects of high levels of student mobility
  - Reduce costs of curriculum development
# Curriculum Focal Points and Connections for Grade 3

The set of three curriculum focal points and related connections for mathematics in grade 3 follow. These topics are the recommended content emphases for this grade level. It is essential that these focal points be addressed in contexts that promote problem solving, reasoning, communication, making connections, and designing and analyzing representations.

<table>
<thead>
<tr>
<th>Grade 3 Curriculum Focal Points</th>
<th>Connections to the Focal Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number and Operations</strong> and <strong>Algebra</strong>: Developing understandings of multiplication and division and strategies for basic multiplication facts and related division facts</td>
<td><strong>Algebra</strong>: Understanding properties of multiplication and the relationship between multiplication and division is a part of algebra readiness that develops at grade 3. The creation and analysis of patterns and relationships involving multiplication and division should occur at this grade level. Students build a foundation for later understanding of functional relationships by describing relationships in context with such statements as, “The number of legs is 4 times the number of chairs.”</td>
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<tr>
<td>Students understand the meanings of multiplication and division of whole numbers through the use of representations (e.g., equal-sized groups, arrays, area models, and equal “jumps” on number lines for multiplication, and successive subtraction, partitioning, and sharing for division). They use properties of addition and multiplication (e.g., commutativity, associativity, and the distributive property) to multiply whole numbers and apply increasingly sophisticated strategies based on these properties to solve multiplication and division problems involving basic facts. By comparing a variety of solution strategies, students relate multiplication and division as inverse operations.</td>
<td><strong>Measurement</strong>: Students in grade 3 strengthen their understanding of fractions as they confront problems in linear measurement that call for more precision than the whole unit allowed them in their work in grade 2. They develop their facility in measuring with fractional parts of linear units. Students also develop measurement concepts and skills through experiences in analyzing attributes and properties of two-dimensional objects. They form an understanding of perimeter as a measurable attribute and select appropriate units, strategies, and tools to solve problems involving perimeter.</td>
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<tr>
<td><strong>Number and Operations</strong>: Developing an understanding of fractions and fraction equivalence</td>
<td><strong>Data Analysis</strong>: Addition, subtraction, multiplication, and division of whole numbers come into play as students construct and analyze frequency tables, bar graphs, picture graphs, and line plots and use them to solve problems.</td>
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<tr>
<td>Students develop an understanding of the meanings and uses of fractions to represent parts of a whole, parts of a set, or points or distances on a number line. They understand that the size of a fractional part is relative to the size of the whole, and they use fractions to represent numbers that are equal to, less than, or greater than 1. They solve problems that involve comparing and ordering fractions by using models, benchmark fractions, or common numerators or denominators. They understand and use models, including the number line, to identify equivalent fractions.</td>
<td><strong>Number and Operations</strong>: Building on their work in grade 2, students extend their understanding of place value to numbers up to 10,000 in various contexts. Students also apply this understanding to the task of representing numbers in different equivalent forms (e.g., expanded notation). They develop their understanding of numbers by building their facility with mental computation (addition and subtraction in special cases, such as 2,500 + 6,000 and 9,000 − 5,000), by using computational estimation, and by performing paper-and-pencil computations.</td>
</tr>
<tr>
<td><strong>Geometry</strong>: Describing and analyzing properties of two-dimensional shapes</td>
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<tr>
<td>Students describe, analyze, compare, and classify two-dimensional shapes by their sides and angles and connect these attributes to definitions of shapes. Students investigate, describe, and reason about decomposing, combining, and transforming polygons to make other polygons. Through building, drawing, and analyzing two-dimensional shapes, students understand attributes and properties of two-dimensional space and the use of those attributes and properties in solving problems, including applications involving congruence and symmetry.</td>
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Oregon Math Standards Resources

- Assessment Resources:  
  www.ode.state.or.us/search/results/?id=239

- Standards Resources:  
  www.ode.state.or.us/search/page/?id=1527
Vertical Mapping for Understanding Learning Progressions
Vertical Mapping Directions

- Move to K-12 assigned groups.
- Solve the problem in your table group.
- Highlight the standards at your grade level.
- Create a conceptual map.
Groups that solved the Jose problem:
- Discuss questions 1, 3, and 5.

Groups that solved the Shane problem:
- Discuss questions 11 and 13.

Whole group discussion.
Elements of Effective Instruction: Mathematics
Introduction to Elements of Effective Instruction

- List components of an effective lesson
- Discuss your list in table groups
- Whole group discussion
The following elements of effective instruction are derived largely from the learning theory described in:

Engage Students with the Mathematics Content

- Effective lessons provide students with opportunities to grapple with important mathematics content in meaningful ways.
- Effective lessons engage students with concepts so they come away with the understanding that mathematics is a dynamic body of knowledge generated and enriched by investigation.
- Effective lessons take into account what students already know and can do, and challenge them to learn more.
Create an Environment Conducive to Learning

Effective lessons are **both** rigorous and respectful of students.
Ensure Access for All Students

- Effective lessons ensure that all students are able to participate in learning important mathematics content.
- Engaging all students in a given lesson can be difficult with heterogeneous classes.
- Different learners can learn the same concepts via differentiated instruction.
- Extensive efforts are often required to ensure that all students had access to the lesson.
Use Questioning to Monitor and Promote Understanding

- Effective lessons use questions strategically
  - to assess where students are in their understanding
  - to encourage students to think more deeply about mathematics content

- Teachers who teach effective lessons...
  - Pose questions that elicit, engage, and challenge each student’s thinking.
  - Listen carefully to students’ ideas.
  - Ask students to clarify and justify their ideas.
  - Decide what student ideas to pursue in depth and how to pursue them.
  - Monitor students’ participation to ensure each student shares in the discussion.
Help Students Make Sense of the Mathematics Content

- Effective lessons include opportunities for students to apply reasoning and sense-making to mathematics.
Review of Oregon’s Process Standards

- Problem Solving
- Reasoning
- Communication
- Making Connections
- Designing and Analyzing Representations
In the next activity, you will review a math vignette and discuss these elements of effective mathematics instruction.

Please take your binder.
Clock Partner Meeting

- Find your 9 o’clock partner.
- Discuss:
  - What did you learn about Elements of Effective teaching that might help you the most in the classroom?
  - How have the math content standards changed?
  - How does effective mathematics instruction prepare students for the new diploma requirements?
Instructional Practices for Mathematics

Research-Based Effective Practices
Instructional Practices for Mathematics

- In groups of 3-5 decide in which light group the practice belongs.
- Whole group discussion.
Criteria for Placing Mathematical Instructional Practices

**Effective (Green)** - This practice contributes to the development or understanding of mathematical concepts.

**Not Enough Known (Yellow)** - This practice may or may not contribute to the development or understanding of mathematical concepts.

**Ineffective (Red)** - This practice does not contribute to the development or understanding of mathematical concepts.
Instructional Practices for Mathematics

- Comments on students’ oral and written work
- Using formative assessments to individualize instruction
- Engaging students to interact purposefully with mathematics content
- Including development of automatic recall of subtraction and addition facts
Instructional Practices for Mathematics

- Teaching number facts, standard arithmetic procedures, and core concepts
- Helping students make sense of the mathematics content
- Developing a student's sense of efficacy
Instructional Practices for Mathematics

- Differentiated instruction
- Asking students to justify their answer
- Using explicit instruction to improve performance with word problems and computation with students who have difficulty with mathematics
Reaching All Students: Learning Styles

the way each person begins to concentrate on, process, internalize, and retain new information.
Teaching through learning styles produced significantly higher gains than teaching traditionally.

—Dunn & Dunn, 1999

Learning styles-based instruction has been effective at every academic level, including in-service.

—Taylor, 1999; Raupers, 1999; Dunn, Dunn & Freeley, 1985 in Dunn & Dunn, 1999
Four Target Audiences

**Inventors**
These people want to adapt, modify, extend, explore, and create. They want to rearrange the information into new and different arrangements.

Engage them with **Flights of Fancy**

**Scientists**
These people want to understand and comprehend. They want to reason with the information that is being presented.

Engage them with **Formulating Ideas**

**Professors**
These people want mastery and competence. They want to be able to remember the information and to perform the skills that are represented.

Engage them with **Facts**

**Friends**
These people want involvement and engagement with other participants. They want to respond to the topic through interpersonal relations. Feeling tone is important to them.

Engage them with **Feelings**

**Inventors**
These people want to adapt, modify, extend, explore, and create. They want to rearrange the information into new and different arrangements.

Engage them with **Flights of Fancy**

Adapted from the Thoughtful Education Model developed by Hanson, Silver Strong Associates, Morristown, NJ.
Professors want mastery and competence. They want to be able to remember the information and to perform the skills that are represented.

Presentation Tips
Provide facts, lecture, citations, quotes, exam demonstrations, practice, feedback, drill, sequence, detail, overt organization, and a detailed bibliography.
Friends want involvement and engagement with other participants. They want to respond to the topic through interpersonal relations. Feeling tone is important to them.

**Presentation Tips**

Provide emotional hooks, personal stories, metaphors, inventories, opportunities for sharing, choosing and relating the topic to oneself and others through hands-on and group activities.
Scientists want to understand and comprehend. They want to reason with the information that is being presented.

**Presentation Tips**

Provide concepts, ideas, data, opportunities to examine and process the data, formulate explanations, make judgments, and inquire. They like structure and organization.

*Engage Them with Formulating Ideas*
Inventors want to adapt, modify, extend, explore, and create. They want to reorganize the information into new and different arrangements.

**Presentation Tips**

Provide opportunities for creative self-expression, and individual and group exploration, where they can reorganize what is known to make new connections and original creations.
Reaching ALL Students

- How do you learn best?
- How do you test best?
- What did you like most about school?
Table Group Activity: Strategy Sort

- Review the strategies printed on the slips of paper.
- Sort according to the type of learner best supported by a given strategy.
- Find 2-3 strategies that BEST support each type of learner.
- Discuss those that might support more than one type of learner and why.
Closing

- OCTM Bling
- Bike Rack
- Goals
- Expectations
- Pluses/Wishes
Moving Mathematics Education Forward

Day 2

Oregon Department of Education
Workshop Goals

Participants will:

- increase understanding of the Oregon Mathematics Core, Content, and Process Standards;
- increase understanding of the Elements of Effective Mathematics Instruction; and
- develop knowledge and skills for developing implementation action plans.
Housekeeping

- Pluses and Wishes
- Bike Rack
Agenda – Day 2

8:00-11:40
Welcome and Overview
Analyzing Cognitive Demand of Tasks
Formative Assessment

11:40-12:25 Lunch

12:25-4:00
Design A Math Task for Lesson
Lesson Planning With Content Standards
Action Planning
Closure and Evaluation
Analyzing the Cognitive Demand of Mathematical Tasks
Analyzing the Cognitive Demand of Mathematical Tasks Activity

- Work individually to solve both tasks.
- Work in pairs in your grade band group. Address the following:
  - Share strategies and process standards used.
  - Identify the math concepts embedded in the tasks.
  - Identify the similarities and differences between the two tasks.
- Whole group discussion.
Analyzing the Cognitive Demand of Mathematical Tasks Activity: Task Sorting

- Pairs sort task cards using categories they determine. Prepare to share an explanation of your categories.

- Identify the criteria for each category.

- Whole group discussion.
Analyzing the Cognitive Demand of Mathematical Tasks Activity: Task Analysis Guide

- Memorization
- Procedures without connections to understanding, meaning, or concepts
- Procedures with connections to understanding, meaning, or concepts
- Doing math
Analyzing the Cognitive Demand of Mathematical Tasks Activity: Re-Sorting Activity

- Pairs use Features of Cognitive Demand Recording Chart and Task Analysis Guide to re-categorize the tasks.

- Whole group discussion.
Analyzing the Cognitive Demand of Mathematical Tasks Activity: Summarize

Discuss the following questions:

- Does a particular feature (e.g., writing an explanation as part of your answer, drawing a picture to explain what you did, using manipulatives to solve the task) indicate that the task has a certain level of cognitive demand?
- Is there a difference between “level of cognitive demand” and “difficulty”?
- What effect does context (e.g., setting in which the task is used, students’ prior experience, grade level) have on the level of cognitive demand required by the task?
Clock Partner Meeting

- Find your 6 o’clock partner.
- Discuss:
  - What was one of your “a-ha’s” during this activity?
  - What will you take back to share with your peers?
  - What will you implement in your classroom?
Formative Assessment

How Do We Know Our Students Got There?
Formative Assessment Activity

- Move into your assigned grade band groups.
- Groups go to break out rooms.
- Take your binder.
- Facilitator will provide additional directions in grade band groups.
Clock Partner Meeting

- Find your 3 o’clock partner.
- Discuss:
  - How does formative assessment help students?
  - What is it that you read about that you are already doing?
  - What is new and you will try implementing in your classroom?
Lesson Planning with Content Standards

Designing a Mathematical Lesson to Address a Content Standard in Depth

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Create a Worthwhile/Rich Mathematical Task

- The teacher of mathematics should pose tasks that are based on:
  - Sound and significant mathematics;
  - Knowledge of students' understandings, interests, and experiences;
  - Knowledge of the range of ways that diverse students learn mathematics;

AND THAT...
Create a Worthwhile/Rich Mathematical Task

- Engage students’ intellect;
- Develop students’ mathematical understandings and skills;
- Stimulate students to make connections and develop a coherent framework for mathematical ideas;
- Call for problem formulation, problem solving, and mathematical reasoning;

AND THAT...
Create a worthwhile/rich mathematical task

- Promote communication about mathematics;
- Represent mathematics as an ongoing human activity;
- Display sensitivity to, and draw on, students’ diverse background experiences and dispositions;
- Promote the development of all students’ dispositions to do mathematics.
Create a Worthwhile/Rich Mathematical Task

- Share math task with partner/group.
- Provide feedback for revisions or additions.
- Small group discussion/sharing.
- Gather back as a whole group in main room.
Lesson Planning Activity

- Work with a partner or on your own to develop a lesson.
- Use lesson template or your own lesson format.
- Review instructional materials or personal math unit.
- Create a lesson and share with partner.
- Whole group sharing.
Closing

- Resources Binder
- Bike Rack
- Goals
- Expectations
- Complete evaluations
- Certificates/Credit
Action Planning

- Teams develop action plan for when they go back to their school/district for implementation of the Moving Math Education Forward workshop.

- Fill out post card with three personal next steps.

- Complete online evaluation.