Effective Differentiation in Mathematics

presented by
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ISBE Math Content Specialists
Session Objectives

✓ Define Differentiation

✓ Explore DI strategies for math.
  • Math Talks
  • Open Questions
  • Multiple Access Points
  • Student Choice

✓ Considerations
Differentiation refers to a wide variety of teaching techniques and lesson adaptations that educators use to instruct a diverse group of students, with diverse learning needs, in the same course, classroom, or learning environment.

Differentiation is modifying the content, process, or product of a learning experience based on individual students’ needs and/or interests.
Why is differentiation so important?

• Our classrooms are full of diverse learners
• Teaching everyone one way will alienate someone
• Meeting students needs and interests will help alleviate many discipline issues
• Meeting students needs and interests will help them achieve at a higher level
• Connections to Danielson
Roadblocks to Differentiation

What obstacles keep us from differentiating?
Strategies for Differentiating:

There are MANY different ways to differentiate math instruction to meet the needs of all the learners in your classroom. Today we are going to look at these 4 methods. Our focus is on “inclusive” differentiation strategies.

1. Math Talks
2. Open Questioning
3. Multiple Access Points
4. Student Choice
**Math Talks**

- The teacher poses a purposeful problem.
- Students signal when they are ready to share a solution.
- The teacher collects answers orally.
- Students explain or defend their answers.
- The teacher records student strategies and asks questions to facilitate mathematical discourse.
- Finally, the class comes to a consensus.

[ilteachandtalk.org](http://ilteachandtalk.org)
If I bought a computer for $150 and used a 75% off coupon, what was the original price of the computer?

http://www.ilteachandtalk.org/
Why it works...

• Students become more active listeners, eager to hear the different strategies shared.

• Emphasis is on the solution path or strategy not the answer.

• Deeper conceptual understanding due to the analysis of the mathematical reasoning behind the strategies.

• Students use the math skills they are most comfortable with to approach the problem.
Open Problems

Open refers to a problem which has more than one correct answer and more than one strategy to obtain an answer.
Robert Kaplinsky shared this example...

Kaplinsky is looking for student work examples for these problems. If you are interested in trying this out with your students, here is the form to share your results:
https://goo.gl/forms/xr3fQIBUsPE7vvUQ2

**PROBLEM ONE**

Solve for $x$.

$$4x + 3 = 2x + 7$$

**PROBLEM TWO**

Using the digits 1 to 9, at most one time each, place a digit in each box to create two equations: one where $x$ has a positive value and one where $x$ has a negative value.

$$oxed{x} + oxed{ } = oxed{ } x + oxed{ }$$
How could you organize 27 skittles to make them easier to count?
Grade 3 -

Using the digits 1 through 9, at most one time each, fill in the blanks to make the following problem true.

Sarah planted ___ ___ carrots in her garden. 
She planted them in ___ rows. Each row had ___ carrots.

Grade 5 -

Using the digits 1 through 9, exactly once each, so that each expression is simplified to a different odd number.

5.OA.1  http://www.openmiddle.com/order-of-operations-5/
Grade 6 -

74 is ____% of ___.

6.RP.3
Grade 8 -

Find 3 positive integers that add up to 10.
Use them to fill in the blanks in this expression.
Find the largest possible result.

\[( ___ ) \times ( ___ ) \]
Using the whole numbers 0 through 9, no more than once, fill in the following boxes to make one function to have one real root and the last function have two real roots.

\[
\begin{align*}
y &= \square x^2 + \square x + \square \\
y &= \square x^2 + \square x + \square \\
y &= \square x^2 + \square x + \square \\
y &= \square x^2 + \square x + \square 
\end{align*}
\]
Why it works...

• Students are exposed to many different ways of thinking.

• All students can approach the problem using the skills they are personally comfortable with.

• Many different ways of thinking are acknowledged and validated.

• Students reach a deeper level of conceptual understanding.
Problems with Multiple Access Points

• Engaging students with problems that can be solved in multiple ways

• Approached with different skill sets
Consider a collection of pennies with the following constraints:

When the pennies are put in groups of 2 there is one penny left over. When they are put in groups of three, five and six there is also one penny left over. But when they are put in groups of seven there are no pennies left over.

How many pennies could there be?

4.OA and 4.NBT

From Jo Boaler’s (youcubed.org) Week of Inspirational Maths 4
“My ideal oreo cookie would be a triple double. What would be the nutritional information of a triple double?”
Why it works...

• Again, students are approaching the problem with the math that they are most comfortable with.

• The problem is grade level appropriate.

• Students see connections between the various strategies.
Student Choice

• Engage students with Variety and Choice.
• Provide your students with a variety of contexts in which they can apply the math.
• Provide different ways for them to explore the math - hands on manipulatives, technology, drawings, etc.
How can we make this easy to implement?

• Come up with a template or pattern that you follow.

• Find resources that you can easily use as a choice
  - ISBE Choice Board Examples (Grades 2-7)
  - Choice Board Examples (Grade 8 and Algebra 1)
    - Thank you, Trish DeFino and Sarah Wentworth for creating and sharing these with us!
<table>
<thead>
<tr>
<th>Task 1</th>
<th>Task 2</th>
<th>Task 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.MD.8</td>
<td>2.NBT.7</td>
<td>2.OA.1</td>
</tr>
<tr>
<td>Making Change</td>
<td>Math Riddle</td>
<td>Jelly Belly</td>
</tr>
<tr>
<td>Fun Fact: There are 293 ways to make change for a dollar.</td>
<td>Solve Mentally See Handout</td>
<td>Visit the Jelly Belly website and write down three numerical facts. For example, there are 50 original flavors. Use these facts to create 3 start unknown word problem.</td>
</tr>
<tr>
<td>List three ways to make change for a dollar</td>
<td>Source: Braingle</td>
<td><a href="https://www.jellybelly.com/">https://www.jellybelly.com/</a></td>
</tr>
<tr>
<td><a href="https://www.braingle.com/brainteasers/1308/math-in-your-head.html">Image 254x16 to 706x540</a></td>
<td><a href="https://www.jellybelly.com/">Image 254x16 to 706x540</a></td>
<td></td>
</tr>
<tr>
<td>Task 4</td>
<td>Task 5</td>
<td>Task 6</td>
</tr>
<tr>
<td>2.NBT.7</td>
<td>2.NBT.6</td>
<td>2.NBT.5</td>
</tr>
<tr>
<td>Magic Squares</td>
<td>Phone Number Math</td>
<td>Solve using both addition and subtraction</td>
</tr>
<tr>
<td>Find Magic Square activity and choose 2 squares. <a href="https://www.k-5mathteachingresources.com/2nd-grade-number-activities.html">https://www.k-5mathteachingresources.com/2nd-grade-number-activities.html</a></td>
<td>Find a phone number where the sum of all the digits is greater than 30</td>
<td>Josh has 112 pencils. He gives some pencils to his friends. Now, he has 27 left. How many pencils did he give away? Solve using a model.</td>
</tr>
<tr>
<td>Task 7</td>
<td>Task 8</td>
<td>Task 9</td>
</tr>
<tr>
<td>2.MD.1</td>
<td>2.MD.8 and 2.NBT.5</td>
<td>2.NBT.6</td>
</tr>
<tr>
<td>Do the Write Thing!</td>
<td>A Jar of Coins</td>
<td>Magic Square</td>
</tr>
<tr>
<td>Write these words and measure their length to the nearest centimeter. Choose 3 words to write and measure. Then add the total length of all three words.</td>
<td>See the attached activity. Feel free to use a real jar of coins to help you.</td>
<td>If the Magic number is 15, fill in the missing squares.</td>
</tr>
<tr>
<td><a href="https://www.illustrativemathematics.org/content-standards/2/MD/C/8/tasks/1071">Image 254x16 to 706x540</a></td>
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<tr>
<td>Task</td>
<td>3.OA.1 &amp; 2</td>
<td>Task 2</td>
</tr>
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</tr>
<tr>
<td>Subitizing Flash Cards</td>
<td>Color in Multiplication Facts</td>
<td>Tic Tac Toe Products Game</td>
</tr>
<tr>
<td>Practice multiplication with the subitizing cards and a partner. <a href="https://gifetchy.files.wordpress.com/2014/03/multiplication-subitizing-cards.pdf">Link</a></td>
<td>Handout below</td>
<td>Play with a partner. <a href="https://www.youcubed.org/tasks/tic-tac-toe-products/">Link</a></td>
</tr>
<tr>
<td>Source: Graham Fletcher</td>
<td>Source: EngageNY</td>
<td>Source: YouCubed at Stanford University</td>
</tr>
</tbody>
</table>
| Task 1  
6.RP.1 | Task 2  
6.RP.2 | Task 3  
6.RP.1 |
|---|---|---|
| **Given the Tape Diagram, write a ratio and a word problem to go along with the picture.**

**apple juice:**

![apple juice tape diagram]

**grape juice:**

![grape juice tape diagram]

**Source:** Progressions for the CCSSM  

| **Yellow and blue paint were mixed in a ratio of 5 to 3 to make green paint. After 14 liters of blue paint were added, the amount of yellow and blue paint in the mixture was equal. How much green paint was in the mixture at first?**  
**Represent this multi-step problem with two pairs of tape diagrams.**

**Source:** Progressions for the CCSSM  

| **Engage NY Lesson Module 1 Lesson 7**  
**Example 1 and 2**  
**Handout Below**

**Source:** EngageNY  

| Task 4  
6.RP.3 | Task 5  
6.RP.1 | Task 6  
6.RP.3 |
|---|---|---|
| **Solve each problem and describe how the problems are similar and different.**

1. **After a 20% discount, the price of a SuperSick skateboard is $140. What was the price before the discount?**

2. **A SuperSick skateboard costs $140 now, but its price will go up by 20%. What will the new price be after the increase?**

**Source:** Progressions for the CCSSM  

| **Slimy Gloopy mixture is made by mixing glue and liquid laundry starch in a ratio of 3 to 2. How much glue and how much starch is needed to make 85 cups of Slimy Gloopy mixture? Use a Tape Diagram to solve.**

**Source:** Progressions for the CCSSM  

| **A credit card company charges 17% interest on any charges not paid at the end of the month. Make a ratio table to show how much the interest would be for several amounts. If your bill totals $450 for this month, how much interest would you have to pay if you let the balance carry to the next month? Show the relationship on a graph and use the graph to predict the interest charges for a $300 balance.**  
**Source:** Kansas Department of Education  
[https://community.ksde.org/LinkClick.aspx?fileticket=J4xYrFOUWGMP%3d&tabid=5646&mid=15542](https://community.ksde.org/LinkClick.aspx?fileticket=J4xYrFOUWGMP%3d&tabid=5646&mid=15542)
<table>
<thead>
<tr>
<th>Choice Board Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create a table showing the first ten digits of the following graphs:</strong></td>
</tr>
<tr>
<td>1. ( y = 3x - 2 )</td>
</tr>
<tr>
<td>2. ( y = -5x + 8 )</td>
</tr>
<tr>
<td>3. ( y = 2x + 3 )</td>
</tr>
<tr>
<td>4. ( y = -6x - 9 )</td>
</tr>
<tr>
<td>5. ( y = 7x )</td>
</tr>
<tr>
<td><strong>Using the current calculator you have for this class, create a function button sheet consisting of 5 essential buttons for graphing. Explain what each button functions is and how to get to that button.</strong></td>
</tr>
<tr>
<td><strong>Track the temperature for 10 days in this month. Make a chart to show your data. Create a line graph to show the pattern over the ten days. Under your graph, find the mean, median, mode, and range.</strong></td>
</tr>
<tr>
<td><strong>Create a HOW-To worksheet or POSTER for linear equations. Have the sheet explain to students how to make an equation from a table. Show the difference between the slope(pattern) and the y-intercept(starting point)</strong></td>
</tr>
<tr>
<td><strong>Create a Wanted Poster for the People of Folcroft. Pretend you are an equation looking for your matching table and/or graph.</strong></td>
</tr>
<tr>
<td><strong>Create a practice worksheet for the class using ten patterns you make up. Attach an answer key.</strong></td>
</tr>
<tr>
<td><strong>Copy/write 5 linear tables down one column of loose leaf. In the column next to it, write the equation for the table. Then write a statement under each equation telling how to find the m and b given the table.</strong></td>
</tr>
<tr>
<td><strong>Find a worksheet online that you can print out and complete. The worksheet should have you plot points and/or find the coordinates for given points. There should be at least 20 questions.</strong></td>
</tr>
<tr>
<td><strong>Create a powerpoint of at least 5 slides reteaching a topic we learned this month. Include vocab, examples and practice problems with answers. Print out the slides or email them to me.</strong></td>
</tr>
</tbody>
</table>
Why it works...

• Students feel ownership of their learning and are therefore more engaged.

• Students are given opportunities to demonstrate their talents while exploring math concepts. Very empowering!
A few things to consider...

• Facilitate productive struggle.
  ○ I do... We do... You do... trains students to wait for the teacher

• Differentiate within the grade level.

• Empower students to reach their full potential.

• Provide opportunities for students to identify with context/content.
<table>
<thead>
<tr>
<th>Common Misstep</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blindly adhering to a pacing guide/calendar</td>
<td>Use <strong>formative data</strong> to gauge student understanding and inform pacing</td>
</tr>
<tr>
<td>Halting instruction for a broad review</td>
<td>Provide <strong>just-in-time</strong> support within each unit or during intervention</td>
</tr>
<tr>
<td>Trying to address every gap a student has</td>
<td><strong>Prioritize most essential prerequisite</strong> skills and understanding for upcoming content</td>
</tr>
<tr>
<td>Trying to build from the ground up or going back too far in the learning progression</td>
<td><strong>Trace the learning progression, diagnose, and go back just enough</strong> to provide access to grade-level material</td>
</tr>
<tr>
<td>Re-teaching students using previously failed methods and strategies</td>
<td><strong>Provide a new experience</strong> for students to re-engage, where appropriate</td>
</tr>
<tr>
<td>Disconnecting intervention from content students are learning in math class</td>
<td><strong>Connect learning experiences</strong> in intervention and universal instruction</td>
</tr>
<tr>
<td>Choosing content for intervention based solely on students’ weakest areas</td>
<td><strong>Focus on Major Work</strong> clusters from current or previous grades as it relates to upcoming content</td>
</tr>
<tr>
<td>Teaching all standards in intervention in a step-by-step, procedural way</td>
<td>Consider the aspect of <strong>Rigor</strong> called for in the standards when designing and choosing tasks, activities, or learning experiences</td>
</tr>
<tr>
<td>Over-reliance on computer programs in intervention</td>
<td><strong>Facilitate rich learning experiences</strong> for students to complete unfinished learning from previous or current grade</td>
</tr>
</tbody>
</table>

Annie Perkins

The Mathematicians Project: Mathematicians Are Not Just White Dudes

https://arbitrarilyclose.com/2016/08/21/the-mathematicians-project-mathematicians-are-not-just-white-dudes/
Need support with any of the materials included here? Reach out to one of our Math Content Specialists!

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