Dana Center
Mathematics
PATHWAYS

Differentiated Instruction Techniques

Joan Zoellner, Course Program Specialist

Frank Savina, Course Program Specialist

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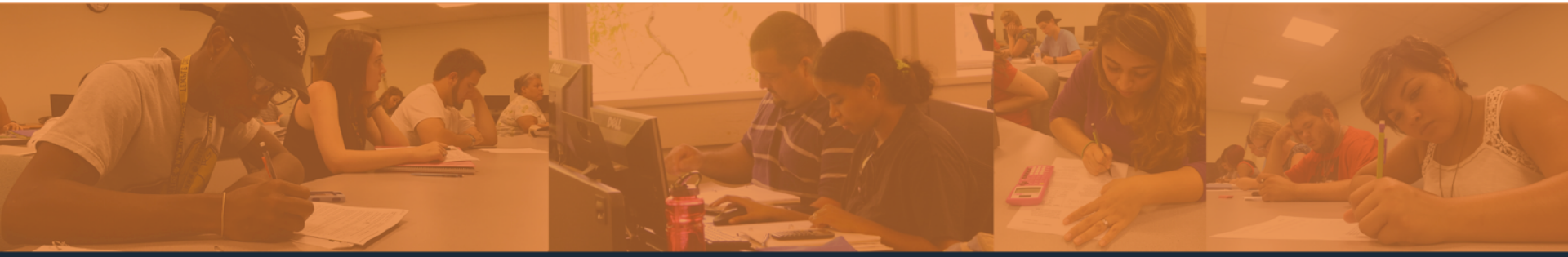


Session Outcomes

Participants will:

- Understand the purpose of differentiated instruction.
- Discuss and experience several strategies for differentiated instruction.

Breakout #1: Thoughts About Differentiated Instruction

Choose a reporter and a timekeeper.

In your breakout, discuss:

- *What classroom issues are you hoping to resolve by using differentiated instruction?*
- *When do you plan to use differentiated instruction (main course, support course, other)?*

Share-out #1: Thoughts About Differentiated Instruction

Reporter:

- *What classroom issues are you hoping to resolve by using differentiated instruction?*
- *When do you plan to use differentiated instruction (main course, support course, other)?*

Other participants:

If there is anything else you want to share that has not been shared, please share in the chat box.

What is Differentiated Instruction?

- A process through which teachers can increase access to content by considering unique characteristics of students as they plan instructional experiences.
- Provides all students with opportunities to engage in productive struggle.
- Considers both the characteristics of students who struggle and those working at above-course-level expectations.
- Provides a variety of opportunities for students to access and engage with the content, and to demonstrate understanding and mastery.

Productive Struggle for All: Differentiated Instruction, by Lynch, Hunt, and Lewis

Related Considerations

- Prep time required
- In-class time required
- Course content coverage
- Classroom set-up
- Establishing a classroom culture that supports collaboration

Low-Floor, High-Ceiling Activities

- Concept Checks
- Equivalence Justifications
- Novice to Expert Card Sort

Important Considerations for Each Activity

- What is it?
- What makes it low-floor, high-ceiling?
- How is it implemented?
- How do you create them?
- How can it be modified?
- How can it help you make instructional decisions?

Concept Checks

- **What are they?**
  - A combination of the formative assessment strategy of Voting Questions and the think-pair-share protocol
  - A quick way to identify student familiarity with a concept, understanding, and misconceptions
  - Can be used at the beginning, middle, or end of instruction of a concept

Concept Checks

- **What makes them low-floor, high-ceiling?**
  - Low floor: All students can participate in making a choice and justifying their response.
  - High-ceiling: All students can improve their justifications.

Concept Checks

- **How are they implemented?**

1. Establish the rules for participation.

Concept Checks

- **How are they implemented?**

1. Establish the rules for participation.
2. Ask students to vote.

Which of the following is the deepest lake in the USA?

a) Lake Superior

b) Crater Lake

c) Lake Pend Oreille

d) Lake Tahoe

e) none of the above

Concept Checks

- **How are they implemented?**

1. Establish the rules for participation.
2. Ask students to vote.
3. Ask students to discuss their answers with their classmates and make the case for their answer.

Concept Checks

- **How are they implemented?**

1. Establish the rules for participation.
2. Ask students to vote.
3. Ask students to discuss their answers with their classmates and make the case for their answer.
4. Ask students to vote again.

Concept Checks

- **How are they implemented?**

1. Establish the rules for participation.
2. Ask students to vote.
3. Ask students to discuss their answers with their classmates and make the case for their answer.
4. Ask students to vote again.
5. Ask for volunteers to explain why their answer is correct.

Concept Checks

- **How do you create them?**
  - Use multiple choice questions from the book as a starting point.
  - Try to ensure that the wrong answers correspond to common misconceptions.
  - This website has many classroom voting question libraries for math classes: http://mathquest.carroll.edu/

Concept Checks

- **How can they be modified?**

M091 – Concept Test *Polynomials*

Which of the following shows a pair of like terms?

a) $3x^2$ and $3x$
b) $3x^2$ and $4x^2$
c) $3x^2$ and $2x^3$
d) $3x^2$ and 3
e) None of the above.

M093 – Concept Test *Radicals*

Alice, Bob, and Cindy are asked to evaluate $\sqrt{16}$. Alice says the answer is 4, Bob says it is -4, and Cindy says both are correct. Who is right?

1) Alice
2) Bob
3) Cindy

M091 – Concept Test *Factoring*

What two integers c_1 and c_2 have a product of 12 and a sum of -7?

(a) $c_1 = -2$ and $c_2 = -6$
(b) $c_1 = 3$ and $c_2 = -4$
(c) Integers not listed here
(d) There are no such integers.

M093 – Concept Test *Functions*

All quadratic functions have at least one *x*-intercept.

a) True, and I am very confident
b) True, but I am not very confident
c) False, but I am not very confident
d) False, and I am very confident

Concept Checks

- **How can they help you make instructional decisions?**
  - If all students pick the right answer right away, you can move on quickly.
  - If students know the answer to a pre-instruction concept test you may be able to decrease the amount of background or introductory material you spend time on.
  - If many students vote for a common wrong answer, you have an idea of an important misconception to address.
  - If voting is all over the place, you may need to go back and re-cover the topic for clarity.

Equivalence Justifications

- **What are they?**
  - A template asking students to decide if several expressions are or are not equivalent to a given expression, and a space to provide justification.

- **What makes them low-floor, high-ceiling?**
  - Low floor: All students can participate in making true/false decisions and justifying their responses.
  - High-ceiling: All students can improve their justifications.

Equivalence Justifications

- **How are they implemented?**
  - Have students spend time individually deciding if the expressions are equivalent, and providing justifications. (Think)
  - Have students compare their answers with those of their group members and decide on the “correct” answer, and a justification. (Pair/Small group)
  - Discuss answers and compare justifications as a class. (Share)

Equivalence Justifications

- **How do you create them?**

Determine whether the following expressions are equivalent to $-8(x+2)$. Provide a justification in the space provided.

Expression	Equivalent? Yes/No	Why or Why Not?
$-8x+2$		
$-8x-16$		
$(x+2)-8$		
$(x+2)(-8)$		
$0-8(x+2)$		

Equivalence Justifications

- **How can they be modified?**
  - Ask if equations have the same solutions.

- **How can they help you make instructional decisions?**
  - Based on the types of justifications given you can revisit important concepts that may have been missed.

Equivalence Justifications – Individual Reflection

- **Think of a course where you might want to use an equivalence justification activity.**
  - What topic would lend itself to this kind of analysis?
  - What are some common misconceptions that you could highlight using this activity?
- **Do you have any other questions about this type of activity and how to use it?**

Novice to Expert Card Sort

- **What are they?**
  - A type of attribute activity where students identify "like" objects by defining categories.
    *Categorization and Representation of Physics Problems by Experts and Novices**, by Chi, Feltovich, and Glaser
- **What makes them low-floor, high-ceiling?**
  - Low floor: All students can participate, and there are correct sorting schemes that only require a superficial level of understanding.
  - High ceiling: Students can identify multiple sorting schemes based on deeper levels of conceptual understanding.

Novice to Expert Card Sort

Cumin

Turnip

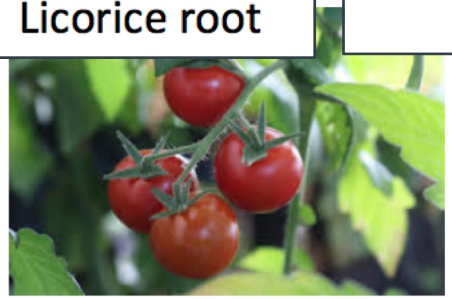
Licorice root

Parsley

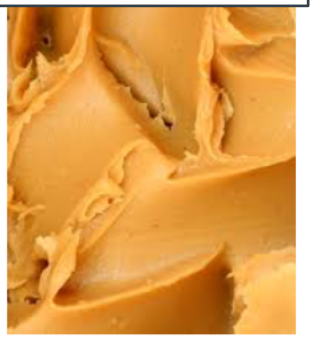
Horseradish

Brussels sprouts

Black eyed peas



Tomato



Peanut butter

Cayenne

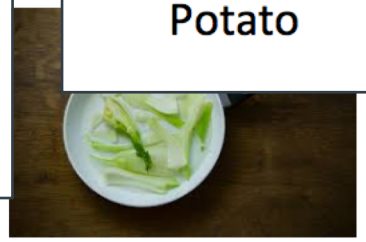
Roasted red pepper spread (Ajvar)

Potato

Cauliflower curry

Green beans

Carrot



Sautéed fennel

Breakout #2: Card Sort

Choose a reporter and a timekeeper.

In your breakout, discuss:

- *What categories did you make?*
- *What cards were in each category?*
- *Do you think you have a "novice" or "expert" sorting scheme?*

Share-out #2: Card Sort

Reporter:

- *What categories did you make?*
- *What cards were in each category?*
- *Do you think you have a "novice" or "expert" sorting scheme?*

Other participants:

If there is anything else you want to share that has not been shared, please share in the chat box.

Novice to Expert Card Sort

- **How are they implemented?**
  - Create a card-sort activity using the novice/expert scheme (more details later)
  - Give cut-out sets of cards to pairs of students and ask them to sort them.
  - If a pair finishes early, there are several possible follow-up questions that can be asked.
  - Remember: there are no “wrong” groupings – just ones that represent different levels and ways of understanding the material

Novice vs. Expert Card Sort

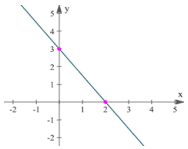
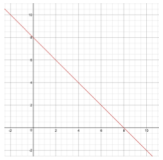
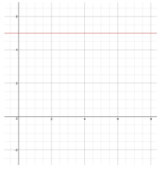
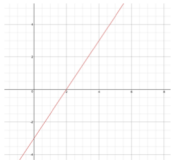
- **How do you create them?**
  - Create a grid, identify the categories you want to use for "novice" (usually involves surface characteristics) and the categories you want for "expert" (usually involves deeper characteristics).
  - Identify appropriate entries for each intersection of categories.

Novice to Expert Card Sort

	Root	Cooked	Plant	Spice
Nightshade	 Potato	 Roasted red pepper spread (Ajvar)	 Tomato	 Cayenne
Mustard	 Turnip	 Cauliflower curry	 Brussels sprouts	 Horseradish
Parsley	 Carrot	 Sautéed fennel	 Parsley	 Cumin
Pea	 Peanut	 Black eyed peas	 Green beans	 Licorice

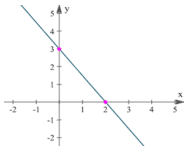
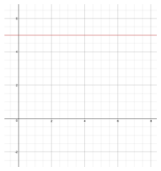
Novice vs. Expert Card Sort

- **Example 1**

	Novice Category 1: Graph	Novice Category 2: Table	Novice Category 3: Equation	Novice Category 4: Verbal Description
Expert Category 1: Line 1		x, y 1, 2 2, 0 3, -1	$y - 2 = -\frac{3}{2}(x - 1)$	A line perpendicular to , with the same y-intercept as
Expert Category 2: Line 2		x, y 1, 7 -1, 9 3, 5	$x = 8 - y$	The sum of and is 8
Expert Category 3: Line 3		x, y 0, 5 -1, 5 2, 5	$y = 5$	A line with slope zero and -intercept
Expert Category 4: Line 4		x, y 1, -1.5 -1, -4.5 4, 3	$3x - 2y = 6$	A line with intercepts and

Novice vs. Expert Card Sort

- **Example 1, more challenging**

	Novice Category 1: Graph	Novice Category 2: Table	Novice Category 3: Equation	Novice Category 4: Verbal Description
Expert Category 1: Line 1			$y - 2 = -\frac{3}{2}(x - 1)$	A line perpendicular to , with the same y-intercept as
Expert Category 2: Line 2		x, y 1, 7 -1, 9 3, 5	$x = 8 - y$	The sum of and is 8
Expert Category 3: Line 3		x, y 0, 5 -1, 5 2, 5	$x = 5$	A line with slope zero and -intercept
Expert Category 4: Line 4		x, y 1, -1.5 -1, -4.5 4, 3	$3x - 2y = 6$	

Novice vs. Expert Card Sort

- **Example 2**

	Novice Category 1: Money problem	Novice Category 2: Mixture problem	Novice Category 3: Population problem	Novice Category 4: Number problem
Expert Category 1: Linear				
Expert Category 2: Quadratic				
Expert Category 3: Exponential				
Expert Category 4: Logarithmic				

Novice vs. Expert Card Sort

- **How can they be modified?**
  - The type of instructions you give students.
  - Leave blanks (one per each sorting scheme) and ask students to fill in the blank with the appropriate information.
  - Can include intentional “error” cards so that students can’t identify a group as “all the ones that are left”.

Novice vs. Expert Card Sort

- **How can these help you make instructional decisions?**
  - If students are consistently using the “novice” scheme, may need to go back and help them make explicit connections that would lead to the “expert” scheme.
  - If students are consistently using the “expert” scheme, it is probably appropriate to move on to the next topic.
  - Warning: in research the “novice” and “expert” schemes are heavily tested for validity. Remember that your students may not be sorting according to your preconceived schemes not because they don’t understand, but because of ineffective card and category design.
    Rigging the Deck, by Wolf, Dougherty, and Kortemeyer

Making Time for Differentiated Instruction

- **The strategies discussed in this session are all intended to be incorporated into a standard class period.**
  - Concept Check: ~5 minutes
  - Equivalence Justifications: ~30 minutes
  - Novice to Expert card sort: ~20 minutes
- **Creating the activities is where the big time commitment exists**
  - Start small
  - Collaborate and share activities

Department Support for Differentiated Instruction

- Faculty Learning Groups
- Peer observation
- Repository of faculty-generated activities

Differentiated Instruction – Individual Reflection

- What type of support would you need to incorporate differentiated learning strategies in your classes?
- Which activity seems most appealing to try first?
- Do you have any other questions about using any of these activities for differentiated instruction?

Contact Information

- General information about the Dana Center
  www.utdanacenter.org

- DCMP Resource Site
  www.dcmathpathways.org

- To receive monthly updates about the DCMP, contact us at
  dcmathpathways@austin.utexas.edu

- Joan Zoellner, joan.zoellner@austin.utexas.edu

Links and Citations

- Lynch, Hunt, and Lewis. 2018. “Productive Struggle for All: Differentiated Instruction” *Mathematics Teaching in the Middle School* 23, no. 4 (January/February):194-201.
- Chi, M. T., Feltovich, P. J. and Glaser, R. (1981), Categorization and Representation of Physics Problems by Experts and Novices*. *Cognitive Science*, no. 5: 121-152.
- Wolf, Steven & Dougherty, Daniel & Kortemeyer, Gerd. (2012). Rigging the deck: Selecting good problems for expert-novice card-sorting experiments. *Physics Review Special Topics - Physics Education Research* 8(2)

About the Dana Center

The Charles A. Dana Center at The University of Texas at Austin works with our nation's education systems to ensure that every student leaves school prepared for success in postsecondary education and the contemporary workplace.

Our work, based on research and two decades of experience, focuses on K–16 mathematics and science education with an emphasis on strategies for improving student engagement, motivation, persistence, and achievement.

We develop innovative curricula, tools, protocols, and instructional supports and deliver powerful instructional and leadership development.

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