Dana Center **Mathematics** PATHWAYS

Differentiated Instruction: Active Formative Assessment Strategies that Engage All Students

Paula Talley, Manager, Professional Learning, Higher Education Strategy, Policy, and Systems Lesha Smith, Department Chair Academic Foundations, Associate Professor of English April 24, 2019





www.dcmathpathways.org





Group Norms

Make equity central.

Focus on fulfilling our charge.

Seek clarification in language and ideas to increase understanding.

Understand that those who work, learn.

Look for solutions, not blame.

Focus on systems, not people.

Recognize that everyone has expertise.

Be honest.

Share talk time.

Dana Center Mathematics PATHWAYS

- 1. Mapping pathways to student end goals
- 2. Helping students choose and enter a program pathway
- 3. Keeping students on path
- 4. Ensuring students are learning

Ensuring Students are Learning Essential Practices

- Program learning outcomes aligned with employment & education
- Active learning activities embedded into coursework
- Program learning outcomes assessed across curriculum
- Assessment results used to improve teaching & learning
- Students document learning beyond transcript
- College offers targeted professional development

Ensuring Students are Learning Equity Considerations

- Participation of underrepresented students in active learning
- Pedagogical changes to support underrepresented students
- Equity-minded teaching and advising
- Disaggregated student outcome data

Participants will:

- Understand the purpose of differentiated instruction.
- Discuss and experience several strategies for differentiated instruction.
- Discuss how to use formative assessment techniques to support differentiated instruction.
- Do all of the above with a vision toward scale.

https://tinyurl.com/TPIDI-2019

Who is in Attendance?

Please stand up if you are ...

Dana Center Mathematics PATHWAYS Spend a few minutes writing down your response to the following prompts:

- 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)?

"Differentiation could be the difference between academic success and failure for many students. A professional mindset of differentiation includes a learner-centered, constructivist model that will meet the needs of all learners at every level."

> Dosch, M., & Zidon, M. (2014). "The Course Fit Us": Differentiated Instruction in the College Classroom. *International Journal of Teaching and Learning in Higher Education*, *26*(3), 343–357. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=eric&A N=EJ1060829&site=ehost-live&scope=site



Culturally Responsive Differentiated Instruction: Foregrounding Equity



People who are considered different by those in the majority have a long history of exclusion & denied access.

Differentiated Instruction= Equitable opportunities & access to information & participation



What is Differentiated Instruction?

Which of the following statements about Differentiated Instruction is not true?

- 1) Differentiated instruction provides students with greater access to content.
- 2) Differentiated instruction provides all students with opportunities to engage in productive struggle.
- 3) Differentiated instruction does not mean that some students are held to a lower standard.
- 4) Differentiated instruction only supports students who are underprepared.
- 5) Differentiated instruction provides a variety of opportunities for students to demonstrate understanding.

- 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

Differentiated Learning is most effective when combined with the following classroom behaviors:

- Formative Assessment Techniques
- A Culture of Student Discourse and Collaboration
- Active and Collaborative Learning Strategies

"Formative assessment is used to inform students and teachers of students' needs in order to improve mastery of the material, rather than penalize or rank students."

"Formative assessment has the 'flexibility to incorporate attention to context, [so] it can more easily address issues of cultural validity."

Pamela Burdman,

The Mathematics of Opportunity: Rethinking the Role of Math in Educational Equity, Just Equations, November 2018, https://justequations.org/resource/the-mathematics-of-opportunity-report/



Assessments

"If faculty are unlikely to use assessments of learning other than grades, then they are unlikely to be able to assess, discuss, and improve the achievement of learning outcomes by students – not only within courses but across courses in a program."



Bailey, T. R., Jaggars, S. S., & Jenkins, D. (2015). *Redesigning Americas community colleges: A clearer path to student success*. Cambridge, MA: Harvard Univ. Press.



Children need to develop a broad range of writing skills (Cole, 2002; 2006) — more than can be measured on such tests. In addition, knowledgeable teachers use day- by - day formative assessments that consider a broader range of writing products. Conclusions drawn from such analyses have greater utility; they lead to targeted instruction.

Writers need *differentiated instruction* that's responsive to where they are. "Let them write, and only then teach at the point of revealed need" (Walshe, 1982, 11). That's differentiation. Teaching in the moment and for the moment yields efficient forward growth.

Shea, Mary. "Differentiating Writing Instruction: Meeting the Diverse Needs of Authors in a Classroom." *Journal of Inquiry and Action in Education*, vol. 6, no. 2, Jan. 2015, pp. 80–118. *EBSCOhost*, search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ1133583&site=ehost-live&scope=site.

Dana Center Mathematics PATHWAYS

The Power of Collaboration

Students working on complex problems in groups, with thoughtful and appropriate scaffolding, can often reach a deeper and more lasting understanding than can students working independently.

Groups can often arrive at better solutions by working collaboratively than can individuals working alone.

Collaboration is not a simple sharing of knowledge from more skilled to less skilled students. Explaining is an opportunity to learn. All who participate actively benefit.

Collaborative and Active Learning



Guided Inquiry Cooperative Learning Formal group-work Informal group-work Problem based learning Project based learning Inquiry based learning Case studies Simulations Peer teaching Peer editing Small group discussion Jigsaw Think-Pair-Share

Dana Center Mathematics PATHWAYS

Characteristics of Effective Activities

- Allow for multiple problem-solving strategies
- Allow for different ways of demonstrating understanding
- Low-Floor, High-Ceiling

Multiple Problem-Solving Strategies

Problems that require Multiple Problem-Solving Strategies can:

- Be open-ended or open-middle and require complex problem solving.
- Have multiple paths to solutions.
- Have multiple entry points and multiple opportunities to demonstrate competence.
- Have multiple interpretations.

Multiple Problem-Solving Strategies

When students are exposed to, discuss, and present multiple solutions to a problem, they:

- 1) See that everyone's thought process is respected and valued.
- 2) Extend their reasoning and learn new techniques.
- 3) Consider different ways of thinking about or solving a problem.
- 4) Compare solution strategies for accuracy, utility, and efficiency.
- 5) Make explicit connections between different representations.
- 6) Practice and develop their ability to use correct notation and terminology to talk about and solve mathematics problems.

Learning Assessment Techniques

ELIZABETH F. BARKLEY CLAIRE HOWELL MAJOR





Another Formative Assessment Resource





Constructive Alignment



A <u>constructively aligned course</u> builds 'links between course intended learning outcomes, teaching and learning activities, and assessment tasks so that [students] understand why they needed to take the course and how the course was related to other courses and even the program goals' (Wang, et al., 2013 p. 487)."

Biggs, J. (1996). Enhancing teaching through constructive alignment. *Higher education*, 32(3), 347-364. Wang, X., Su, Y., Cheung, S., Wong, E., & Kwong, T. (2013). An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. *Assessment & Evaluation in Higher Education*, 38(4), 477–491.



Low-Floor, High-Ceiling Activities

- Concept Checks
- Equivalence Justifications
- Novice to Expert Card Sort
- One Minute Summaries

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?

What are they?

- A combination of the formative assessment strategy of Voting Questions and the thinkpair-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

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.

1. Establish the rules for participation.



- 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

- 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.

- 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.

- 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.

Should states adopt presumed consent organ donation systems automatically registering everybody as an organ donor unless a person opts out?



"Organ Donation: Should States Adopt Presumed-consent Organ Donation Systems, Automatically Registering Everybody as an Organ Donor unless a Person Opts Out?" *Issues & Controversies,* Infobase Learning, 28 June 2010,http://icof.infobaselearning.com/recordurl.aspx?ID=2502. Accessed 21 Apr. 2019.

Dana Center Mathematics PATHWAYS
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: <u>http://mathquest.carroll.edu/</u>
- Intriguing active learning concept checks for multiple disciplines. <u>https://blog.polleverywhere.com/active-learning-strategies/</u>

Who is the only person to have served as both US Vice President and President without being elected to either office?

- a) George Washington
- b) Lyndon B. Johnson
- c) Gerald Ford
- d) Harry Truman
- e) None of the above

Dana Center Mathematics PATHWAYS

Ice-cubes are added to a glass of water. What happens to the level of the water as the ice cubes melt?

- A. The level of the water drops.
- B. The level of the water stays the same.
- c. The level of the water rises.
- D. You need more information to be sure.



M091 – Concept Test Polynomials

Which of the following shows a pair of like terms?

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

Dana Center Mathematics PATHWAYS

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



You were once exactly 3 feet tall.

- 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

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.

Kahoot and Quizlet

- Kahoot!
 - Use multiple choice questions from the book as a starting point.
 - Easy to ensure that the wrong answers correspond to common misconceptions.
 - Student is responsible for his/her answer.
- Quizlet

 Group activity with group help; high-level peer-to-peer interaction

Kahoot.it

Dana Center Mathematics PATHWAYS Think of one of the classes in which you would like to use differentiated instruction. Create a Concept Check for one of the commonly confusing topics in that course.

Concept Checks – Sample 1

Question

- 1) Answer 1
- 2) Answer 2
- 3) Answer 3
- 4) Answer 4
- 5) Answer 5

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)		

Dana Center Mathematics PATHWAYS

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.

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)

How do you create them?

• Look for common, thought provoking, or unusual errors and misconceptions, perhaps from old exams or homework assignments.

 $_{\odot}$ 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.



Think of one of the classes in which you would like to use differentiated instruction. Create an Equivalence Justification for one of the commonly confusing topics in that course. Work in pairs to sort your cards.

- 1) It is possible to create four categories.
- 2) Each category should have four cards.

Write down the names of your categories.

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.

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

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

Dana Center Mathematics PATHWAYS

Novice to Expert Card Sort



Dana Center Mathematics PATHWAYS Novice:

- Mask
- Саре
- Weapon
- Armor

Expert:

- Justice League
- Avengers
- X-Men
- The Champions

Novice vs. Expert Card Sort

	Novice Category 1: Graph	Novice Category 2: Table	Novice Category 3: Equation	Novice Category 4: Verbal Description
Expert Category 1: Line 1	5 4 y 4 3 2 1 -2 -1 -2 -1 -2 -2 -1 -2 -2 -1 -2 -2 -2 -2 -2 -2 -2 -2 -2 -2	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		х у 0 5 -1 5 2 5	<i>y</i> = 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

Dana Center Mathematics PATHWAYS

Novice vs. Expert Card Sort

	Novice Category 1: Graph	Novice Category 2: Table	Novice Category 3: Equation	Novice Category 4: Verbal Description
Expert Category 1: Line 1	$\begin{array}{c} 5 & 4 \\ & 4 \\ & 3 \\ 2 \\ 1 \\ -2 \\ -1 \\ -2 \\ -2 \\ -2 \\ -2 \\$		$y - 2 = -\frac{3}{2}(x - 1)$	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	<i>x</i> = 5	A line with slope zero and - intercept
Expert Category 4: Line 4	Notice Category 1 1: Graph Dept Notice Category 1 both Notice Category 4 Equation Notice Category 4 Hold Decayton Expert Category 1 Uint 1 +1-2-2-1 Notest category 4 Hold Networkshows Expert Category 2 Uint 2 x = 8 - yr Notest cet 1 Hold Networkshows Expert Category 2 Uint 2 x = 8 - yr Notest cet 2 Hold Networkshows Expert Category 2 Uint 2 x = 8 - yr Notest cet 2 Hold Networkshows Expert Category 4 Lint 4 3z - 2y = 6 Set on America	x y 1 -1.5 -1 -4.5 4 3	3x - 2y = 6	

Dana Center Mathematics PATHWAYS

Novice vs. Expert Card Sort

	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				

- $_{\odot}$ 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".

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.

How can these help you make instructional decisions?

 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

Think of one of the classes in which you would like to use differentiated instruction. Identify possible "novice" and "expert" categories for one of the commonly confusing topics in that course.

If you have time, start identifying entries for your card sort.

What are they?

 A simple technique to answer the questions "Who does what to whom, when, where, how, and why?" about a given topic.

 Students "synthesize those answers into a single informative, grammatical, and long summary sentence."

Angelo, T. A. and Cross, K. P. (1993). *Classroom Assessment Techniques. A Handbook for College Teachers. Second Edition*. San Francisco: Jossey-Bass.



An Example from Classroom Research

- o Who? teacher
- o Does what? Assess
- o To What or Whom? Their students' learning
- When? Regularly during the semester
- Where? In their own classrooms

Angelo, T. A. and Cross, K. P. (1993). Classroom Assessment Techniques. A Handbook for

College Teachers. Second Edition. San Francisco: Jossey-Bass.



An Example from Classroom Research

- How? Using classroom assessment techniques and any other appropriate tools and methods of inquiry
- Why? So they can understand and improve teaching effectiveness and the quality of student learning

Angelo, T. A. and Cross, K. P. (1993). *Classroom Assessment Techniques. A Handbook for College Teachers. Second Edition*. San Francisco: Jossey-Bass.


In sentence form:

 Teachers assess their students' regularly during the semester in their own classrooms, by using Classroom Assessment Techniques and any other appropriate tools and methods of inquiry, so that they can understand and improve teaching and effectiveness and quality of student learning.

Angelo, T. A. and Cross, K. P. (1993). Classroom Assessment Techniques. A Handbook for College

Teachers. Second Edition. San Francisco: Jossey-Bass.



What makes them low-floor, high-ceiling?

- Low floor: All students can participate in making summaries.
- High-ceiling: All students can improve their summaries.

What is it?

- A writing method that allows students to contextualize the new information they are acquiring.
- "Students are able to ask questions, admit confusion, make connections, and grow ideologically."

Cisero, C. A. (2006). Does Reflective Journal Writing Improve Course Performance? *College Teaching*, *54*(2), 231–236. https://doi.org/10.3200/CTCH.54.2.231-236

What makes them low-floor, high-ceiling?

- Low floor: All students can write a journal entry that discusses their analysis of an assignment from their perspective or of the course.
- High-ceiling: All students can work to improve their writing, critical thinking, and metacognitive skills.

Write a reflective journal entry about this course. In some textbooks, reflection is a step in the writing process where the writers go back and examines at your writing creations after you have been away from the work for a while. How have you grown as a writer this semester? What was your favorite assignment? Why? Which writing piece is your least favorite? Why? What words of wisdom would you want to impart to the students next semester to help them? In what way are you proud of yourself for the work you completed this semester?

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
 - One Minute Summaries: ~15 minutes

Making Time for Differentiated Instruction

- Creating the activities is where the big time commitment exists
 - Start small
 - Collaborate and share activities

Department Support

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

Differentiated Instruction

- 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?

- 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)

- Paula Talley, Manager, Professional Learning for Higher Education paula.talley@austin.utexas.edu
- Lesha Smith, Department Chair, Academic Foundations Temple College
- General information about the Dana Center <u>lesha.smith@templejc.edu</u>
- DCMP Resource Site
 <u>www.dcmathpathways.org</u>
- To receive monthly updates about the DCMP, contact us at <u>dcmathpathways@austin.utexas.edu</u>

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.

2017

