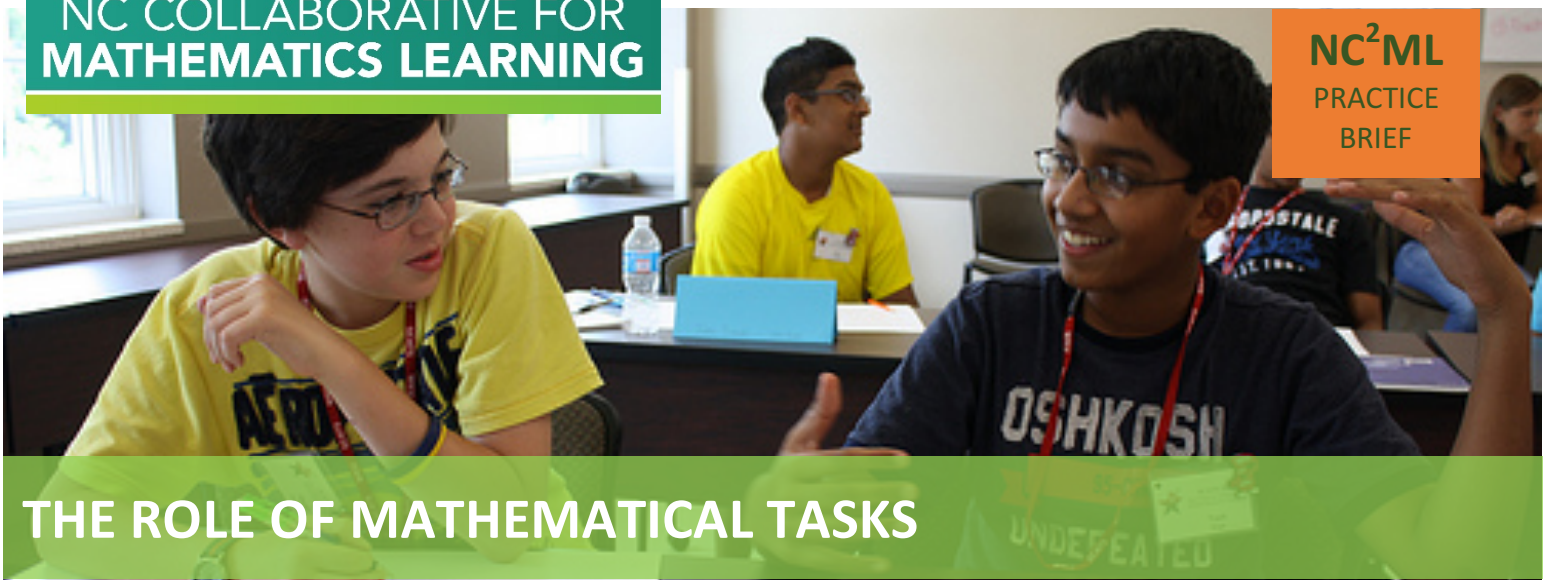
NC COLLABORATIVE FOR MATHEMATICS LEARNING

NC²ML PRACTICE BRIEF



THE ROLE OF MATHEMATICAL TASKS

WHY DO THE TASKS WE CHOOSE MATTER?

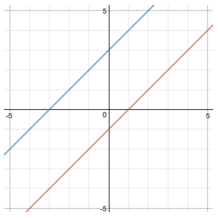
The mathematical tasks you pose during class determine the nature of the mathematics your students will engage in. Selecting "good" tasks is not a trivial act, it greatly impacts your students' learning and their development of mathematical habits of mind. Tasks that require students to memorize a formula or practice a particular skill leads to a different type of learning than tasks that require students to consider multiple solution strategies and convince others that their strategies are valid.

Questions for Discussion

1. In what ways might using low floor - high ceiling – wide wall tasks create a more equitable mathematics learning environment?
2. What are the instructional challenges you face when you use higher cognitive demand tasks? How might you mitigate those challenges?
3. How do you determine what tools you might make available to your students to help create a "wide wall" environment for a particular task?

WHAT IS A "GOOD" MATH TASK?

The different types of thinking required of students to respond to a task is referred to as *cognitive demand*. Stein and Smith (1998) developed a framework for characterizing the cognitive demand of a task. This framework can be very helpful when selecting or revising tasks to meet your learning goals. In the framework there are two types of high cognitive demand tasks: *procedures with connections* and *doing mathematics*. Generally, high cognitive demand tasks are non-routine, requiring students to think conceptually about mathematical ideas. In contrast, low cognitive demand tasks require students to remember facts and procedures and apply them to familiar situations. There are two types of low cognitive demand tasks in the framework: *memorization* and *procedures without connections*. Brief examples of each type of task are provided in the figure below.

Low cognitive demand tasks	High cognitive demand tasks
Memorization Example. Describe the system as: a) Consistent and Independent b) Consistent and Dependent c) Inconsistent 	***Procedures with connections*** Example. Paul has 100 dimes and quarters in his piggy bank. The total amount of money in his piggy bank is $15.25. How many quarters and dimes does he have?
Procedures without connections Example. Solve using elimination. $3x + 5y = 6$ $3x - 5y = 18$	***Doing mathematics*** *Example.* Allison's parents have agreed to let her get a cell phone. However, before doing so, she must find the best cell phone plan and convince her parents why it is the best. After doing some research, she was able to narrow her choices down to two companies, Horizon Wireless and B-Mobile. Horizon Wireless charges a $20 fee and then $10 for every gigabyte of data used each month. B-Mobile charges $40 and then $2 for every gigabyte of data used each month. Prepare an argument for Allison to convince her parents that she has the best plan.

PROVIDING "LOW FLOOR – HIGH CEILING – WIDE WALL" OPPORTUNITIES

While all levels of tasks are appropriate at different times based on your learning goals, ideally students should experience more high cognitive demand tasks than not. A synthesis of research has shown that curricular materials that contain high cognitive demand tasks are successful in improving students' conceptual understanding of important mathematics, in improving students' abilities to reason, communicate, problem-solving and make mathematical connections, and improving their performance on state and national achievement tests (Boston & Wolf, 2006). So, not only is it important for students that we incorporate more high cognitive demand tasks, but also that we identify "good" ones. Really "good" mathematical tasks are those that have entry points for every student in your class and allow space for extensions to keep all students mathematically engaged. We often use the phrase "low floor, high ceiling, and wide walls" to describe such tasks. (Low floor = anyone can access the task; high ceiling = there are lots of possibilities for taking things even further; wide walls = space to explore multiple pathways).

YOU DON'T HAVE TO REINVENT THE WHEEL

While there many low floor – high ceiling – wide wall tasks available in existing resources (e.g., the NC^{2}ML canvas site and the MRI documents), they are not always easy to find. As a result, students are often presented low cognitive demand tasks even when they do not match the learning goals for the lesson. However, many tasks can be easily adapted. By providing less direction and asking broader questions a task can be transformed into a low floor – high ceiling – wide walls type task. When considering how you might adapt a task it is important to consider its intended purpose? Do you plan to use the task to introduce a new mathematical idea? To apply or practice a mathematical concept? Or for assessment of some kind? Identifying the purpose of the task will help you make decisions about adaptation.

LOWER COGNITIVE DEMAND TASK

Jeremy has been on his parents' cell phone plan, but now as he heads out after graduating from college, he needs to get his own plan. He has a particular smartphone that only works with one company, but the company has multiple options for plans. Jeremy is considering two different monthly cell phone plans:
Cell phone plan #1: no flat fee, $0.16 per min
Cell phone plan #2: flat fee of $20 + $0.10 per min
Write an equation and generate a graph to represent each cell phone plan. Use your equation and graph to determine which plan is the better deal if he typically talks 45 minutes per month?

HIGH COGITIVE DEMAND ADAPTATION

Jeremy has been on his parents' cell phone plan, but now as he heads out after graduating from college, he needs to get his own plan. He has a particular smartphone that only works with one company, but the company has multiple options for plans.

The first two monthly plans are fairly "basic" in Jeremy's mind and are listed below.
Cell phone plan #1: no flat fee, $0.16 per min
Cell phone plan #2: flat fee of $20 + $0.10 per min

Which is the better cell phone plan? How do you know?

(McCulloch, Lee, & Hollebrands, 2015, CH2, p. 29-30)

FINAL THOUGHTS

It is important to note that using high cognitive demand tasks takes careful planning. Beyond selecting tasks that are appropriate for the mathematical goals of your lesson, you must also carefully consider both how you will support students work on the task and how you will facilitate a discussion that is focused on your learning goals. See Smith, Bill, & Hughes (2008) for a useful planning protocol as you get used to implementing these tasks in your lessons.

References

Boston , M., & Wolf , M.K. (2006). Asssessing academic rigor in mathematics instruction: The development of the Instructional quality assessment toolkit. CSE Technical Report 672. Center for the Study of Evaluation, Standards and Student Testing, UCLA

McCulloch, A.W., Lee, H.S., & Hollebrands, K.F. (2015). Preparing to teach mathematics with technology: An integrated approach to algebra (1st Edition). NC State Uiiversity, Raleigh, NC. Available at: https://ptmt.fi.ncsu.edu

Smith, M.S., Bill, V., & Hughes, E.K. (2008). Thinking through a lesson: Successfully implementing high-level tasks. Matheamtics Teaching in the Middle School, 14(3), 132-138.

Stien , M.K. & Smith, M.S. (1998). Selecting and creating matheamtical tasks: From research to practice. Mathematics Teaching in the Middle School, 3(5), 344-350.

LEARN MORE

Join us as we journey together to support teachers and leaders in implementing mathematics instruction that meets needs of North Carolina students.

NC^{2}ML MATHEMATICS ONLINE

For more information and resources please visit the NC DPI math wiki for instructions on accessing our Canvas page created in partnership with the North Carolina Department of Public Instruction at http://maccss.ncdpi.wikispaces.net/

North Carolina Collaborative for Mathematics Learning

www.nc2ml.org