

NORTH CAROLINA ASSOCIATION FOR MIDDLE LEVEL EDUCATION  
**JOURNAL**

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James Davis, Ph.D., Editor  
Coastal Carolina University

Fall 2017, Volume 30, Number 1

**Engaging your students into math with performance tasks and project-based learning**

By

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## Overview

The adoption of the Common Core State Standards in Mathematics ([CCSS-M]; Common Core State Standards Initiative, 2011) has resulted in a lot of discussion about whether the Standards mandate and require specific strategies and pedagogies. This discussion has led to a negative backlash on social media and in the media. One of the benefits of the Common Core Mathematics Standards which has been overlooked is the potential for teachers to go deeper with these Standards that are intended to be taught through the use of tasks and projects that are grounded in real-world examples and relevant to students' lives. In this article, we share about two specific types of activities that can be used to engage students more deeply in middle grades mathematics classrooms- performance tasks and project-based learning scenarios.

## Rationale for Performance Tasks and Project-Based Learning

The National Council for Teachers of Mathematics (NCTM) published a synthesis of research in 2014 that calls for mathematics teachers to focus more on mathematical reasoning and the real-world application of mathematics concepts (NCTM, 2014). These recommendations align with the CCSSM Standards for Mathematical Practice which state characteristics of mathematically proficient students. Table 1 describes a few of the Mathematical Practices in CCSSM.

Table 1: Selected Standards for Mathematical Practice from CCSSM

Mathematical Practice	Description of Student Actions
MP 1: Make sense of problems and persevere in solving them.	Read or hear a problem and determine a way to explore and/or solve it. Persevere in using various strategies while solving the problem.
MP 4: Model with mathematics.	Represent mathematical situations with representations including equations, pictures, or real-world scenarios.
MP 6: Attend to Precision	Use mathematically precise language to communicate about mathematical ideas in writing and discussions.

## Mathematics Performance Tasks

Performance tasks are real-world, authentic opportunities for students to apply their understanding of specific concepts (Wiggins & McTighe, 2011). Grounded in the idea that learners need to have relevant situations to demonstrate what they have learned, performance tasks in mathematics are intended to connect mathematics concepts that students are learning real-life scenarios and authentic situations. In this section, we describe an example of a performance task created for and used with Grade 6 students.

The Garden Design Task was created by the Smarter Balanced Assessment Consortium (Smarter Balanced, n.d.) to allow students to solve a multi-step real-world problem (MP 1) that involved modeling with mathematics (MP 6). Table 2 shows the parts of the Garden Design task.

Table 2: Parts of the Garden Design Task

Part	Description of the part of the task
Part A	Students design different sections of a garden.
	Section 1 must be shaped like a square.
	Section 1 must have an area between 26 square feet and 50 square feet.
	Section 2 must be shaped like a rectangle but must not be a square.
	Section 2 must be exactly twice the area of Section 1.
Part B	Students are given two sizes of wooden boards and their prices. Students must decide how many boards and how much they will spend to build borders around the two sections of the garden.
Part C	Students decide how many tomato and carrot plants they need to buy in order to fill both sections of the garden with plants.
Part D	Students choose a type of soil, determine how much soil is needed, and how much money they will spend on soil for their sections of the garden.
Conclusion	Students must write a justification about whether or not they can complete the project using their budget of \$450 or less.

As you can see in Table 1, the parts of the task vary in terms of the mathematics work that students are expected to do as well as the difficulty. The multiple aspects of the performance task heavily address the Common Core Standard for Mathematical Practice (SMP) 1: *Make sense of problems and persevere in solving them*, when students decide how to explore and solve the task. Further, SMP 4: *Model with mathematics*, is addressed as students represent the situation by creating rectangular sections of the garden and use various strategies to solve the multiple parts of the task. Lastly, SMP 6: *Attend to precision*, is addressed when students have to explain and write about their strategies. SMP 6 is also integrated into the task if teachers have students collaborate on this task or discuss their strategies as a class.

When considering implications of performance-based tasks here are some suggestions for implementing performance tasks, such as the Garden Design, in classrooms.

**Dealing with open-ended tasks.** Part A is open-ended, meaning that there are multiple correct answers, and the work in subsequent parts is based on Part A, it is typical that a whole class of students would have multiple solutions to this performance task. This means that whole class discussions should be about the strategies used to solve the different aspects of the task and not answers since everyone's answers will be different. Further, as a teacher when you observe students as they work your questions should focus more on their strategies and decisions on how to solve the task.

**Promote collaboration and work in pairs or small groups.** These tasks are rigorous and the multiple parts can be very demanding on students. Students should be put into pairs or small groups to collaborate on these types of tasks in order to gain experience discussing aspects of the task with others and choosing appropriate strategies to solve the task. While there is a time for students to be held independently accountable for solving cognitively-demanding problems, performance tasks tend to be best explored with peers.

**Encourage the use of pictorial representations and equations.** While students explore and solve aspects of performance tasks, students should be encouraged or required to use pictorial representations and equations to represent the mathematical situations. Some students may be apt to simply provide calculations without any representation, the generation of mathematical representations is an important foundation of students' conceptual understanding.

### **Project-Based Learning in Mathematics**

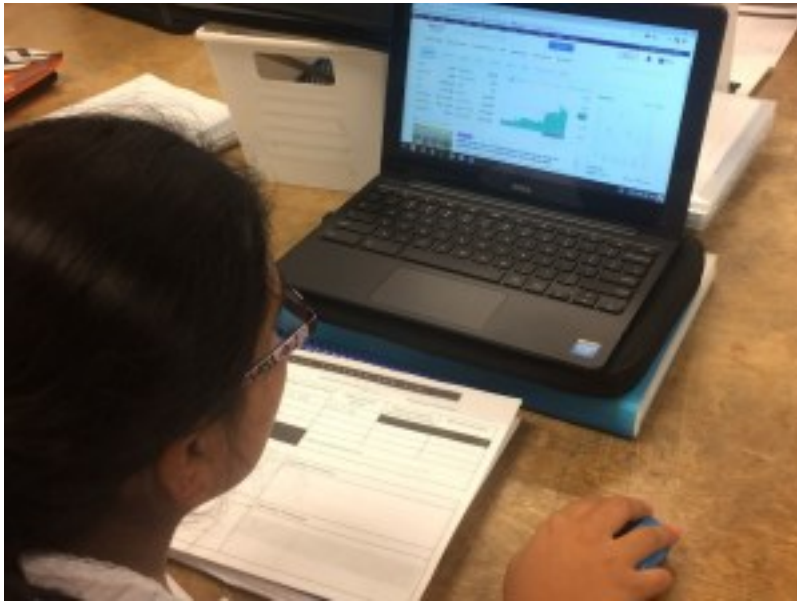
One way to effectively teach cognitively-demanding math tasks is to incorporate project-based learning in the classroom. Project-based learning (PBL) is a teaching method that engages students in a series of tasks to solve an authentic or real-world problem. According to the Buck Institute for Education (2016), research shows that PBLs naturally develop a deeper learning in students that help them become more prepared for college and beyond. In addition, PBLs allow teachers to differentiate the levels of cognitively-demanding tasks for students based on their current levels of ability, reaching and engaging more learners at one time.

The stock market is an intriguing process for middle school students to study as it lends itself to an enticing real-world exploration of positive and negative integers, decimal operations, and graphing. The fast pace and tumultuous rise and fall of stock prices capture students' interests, especially when they analyze the stock prices of companies of which they are regular consumers. Students can easily engage in several cognitively-demanding tasks by analyzing the daily operations of the stock market. Some of the cognitively-demanding tasks that teachers can incorporate into this PBL are:

- Choose five companies and compare their stock prices. Graph their prices over the course of one week, two weeks, one month, etc. Based on your graph, analyze which companies' stocks are most successful. Justify your reasoning.
- Examine the price fluctuation of two companies' stocks over the past year. Which company's stock prices fluctuated more? Describe any patterns you notice. What could be the potential cause of that fluctuation? Support your answer with mathematical evidence.
- Closely observe your record of stocks' prices. Did your company's stock have more positive (gain) or negative (loss) days? Create a table to illustrate why this would become more significant as a person increased the number of stock shares they owned.

To amplify student engagement within this PBL, teachers can assign students the role of investors, requiring them to purchase shares of stocks and compete for the greatest profits. This provides

teachers with an excellent opportunity to differentiate the level of tasks among their different ability-levels of learners. Advanced students, for example, may be given the role of an investor who must purchase stocks of eight different companies and invest at least 90% of their investment budget. Students on grade level may be required to invest in five companies and invest at least 50% of their investment budget. Meanwhile, the teacher may choose to assist his or her lower level learners invest their money in fewer companies' stocks, focusing on investing instead of staying within a given budget. Despite the students' levels of learning, they can all take part in this enriching real-world lesson and strengthen their range of mathematical skills.



*Figure 1. Sixth-grade student analyzes stocks.*

### **Concluding Thoughts**

The Common Core State Standards for Mathematics as well as leaders in mathematics education call for students to be engaged in solving tasks and problems embedded in real-life and are rigorous. The use of performance tasks and project-based learning can provide real-life mathematical situations for students to explore. Specifically, teachers need to look for situations that foster and develop students in regards to the Common Core Standards for Mathematical Practice, especially those identified in Table 1.

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