

Integrating Math, Science, and the Common Core into Career and Technical Education

ST. LANDRY
PARISH SCHOOLS

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About me...

- ▶ B.S. in Agricultural Engineering from University of Nebraska-Lincoln
 - ▶ Minors in Business and Computer Science
- ▶ Taught Math & Science at North Central High School for 8 years
- ▶ M.S. Natural Science (Physics Education) from Arizona State University

Agenda

- ▶ CCSS Math and Science Standards
- ▶ Math-Integrated Tasks
- ▶ Project-Based Learning
- ▶ Task & Project Development

Objectives

- ▶ Understand how CCSS Math and Science standards/practices can be integrated into CTE courses.
- ▶ Learn principles of performance tasks and project-based learning.
- ▶ Develop content-area specific tasks/projects that incorporate CCSS Math and Science standards/practices.

Why?

- ▶ All students should be mathematically fluent, no matter their career path.
- ▶ Scientific reasoning and the importance of understanding and using evidence in decision-making is necessary for citizens of the 21st century.

Workshop Norms

- ▶ I can share about CCSS practices, science standards, performance tasks, and project-based learning; but...
- ▶ YOU are the experts in your content areas!
- ▶ Make the workshop work for you!

CCSS Math Practices

1. Make sense of problems and persevere in solving them
2. Reason abstractly and quantitatively
3. Construct viable arguments and critique the reasoning of others
4. Model with mathematics
5. Use appropriate tools strategically
6. Attend to precision
7. Look for and make use of structure
8. Look for and express regularity in repeated reasoning

CCSS Math Standards – Middle School

► **Grade 7**

- Use ratios and proportional relationships to solve real-world problems; perform operations with fractions.
- Solve real-life and mathematical problems using numerical and algebraic expressions and equations.
- Solve problems involving angle measure, area, surface area, and volume.
- Compare and draw inferences about populations using statistics and probability models.

CCSS Math Standards – Middle School

► **Grade 8**

- Use radicals (square roots) and integer exponents.
- Use functions to model relationships between quantities; relate proportional relationships with linear equations.
- Analyze and solve linear equations and systems of equations.
- Apply the Pythagorean Theorem; solve problems involving volume of cylinders, cones, and spheres.

CCSS Math Standards – High School

▶ **Number and Quantity**

- ▶ Use the real number system (rational and irrational numbers with exponents) to reason quantitatively with units to solve problems.
- ▶ Perform operations on vectors, matrices, and with complex numbers.

CCSS Math Standards – High School

▶ **Algebra & Functions**

- ▶ Write functions/equations that describe relationships and situations.
- ▶ Perform operations on linear, quadratic, exponential, and polynomial functions.
- ▶ Represent and solve equations, inequalities, and systems of equations (algebraically and graphically) to solve problems.
- ▶ Interpret the structure and meaning of mathematical expressions; explain the reasoning used to solve equations in the problem-solving process.
- ▶ Interpret functions (equations) that arise in applications in terms of the context.
- ▶ Analyze functions in different representations.

CCSS Math Standards – High School

▶ **Geometry**

- ▶ Make geometry constructions and experiment with transformations in the plane.
- ▶ Use trigonometric ratios and solve problems involving right triangles and angles.
- ▶ Apply arc lengths and areas of circles; explain volume formulas and use them to solve problems.

CCSS Math Standards – High School

▶ Statistics & Probability

- ▶ Summarize, represent, and interpret data and interpret linear models.
- ▶ Make inferences and justify conclusions from surveys, experiments, and observational studies.
- ▶ Use probability models to determine likelihood of events and evaluate outcomes of decisions.

Next-Generation Science & Engineering Practices

1. Asking questions and defining problems
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Take a few minutes

- ▶ Consider the course(s) you teach:
 - ▶ What topics in those courses have elements of the mathematical standards?
 - ▶ Which topics are best suited to incorporating these math and science practices?
- ▶ After you've made your own list, work with other teachers in your content area to put down a few ideas on your whiteboard to share.

So...

- ▶ How do we better integrate math into CTE courses?

What is a Performance Task?

- ▶ An activity that **supplements** a lesson
 - ▶ One to three class periods in length
- ▶ Requires **higher-order thinking** and problem-solving skills
- ▶ Grounded in **real-world** practice, by applying knowledge/skills to a new situation
- ▶ Not a unit or a complete lesson
- ▶ Not intended to replace curriculum



A High-Quality Task Should:

- ▶ Be standards-based
- ▶ Reflect strong instructional practices
- ▶ Assess knowledge and skill
- ▶ Prepare students for college and careers
- ▶ Support continuous improvement
- ▶ Elicit complex demonstrations or applications
- ▶ Assess all students



Let's Try...

- ▶ With the teachers at your table, choose one of the provided example tasks.
- ▶ Work together to come up with a solution.
- ▶ Show your work on a whiteboard.
- ▶ In 10 minutes, you will share...



Evaluate the Task...

- ▶ Was it **aligned** to standards?
- ▶ Did it **assess** student knowledge and skill effectively?
- ▶ Was your **understanding** deepened by engaging with the problem?
- ▶ Could it assess **all** students?



Tasks

- ▶ Resources: <http://achieve.org/ccss-cte-classroom-tasks>
 - ▶ Several states worked with achieve.org to produce sample tasks in:
 - ▶ Architecture/Pre-Design
 - ▶ Agribusiness/Food Products & Processes
 - ▶ Health Sciences
 - ▶ Many more tasks are available.
- ▶ You will have an opportunity to explore and develop an application task later.

More Task Sources

- ▶ NYC Searchable Task Database:
<http://schools.nyc.gov/Academics/CommonCoreLibrary/TasksUnitsStudentWork/default.htm>
- ▶ Inside Mathematics:
<http://www.insidemathematics.org/index.php/mathematical-content-standards>
- ▶ MARS Tasks:
<http://map.mathshell.org/materials/index.php>
- ▶ Many others available by searching Google.

Project-Based Learning



Project-Based Learning

- ▶ **Authentic**, real-world, or perplexing problems, differentiated according to student interests
- ▶ Provokes students to **grapple** with the key concepts of a topic or discipline
- ▶ Driven by **student** research, production, and presentation of information
- ▶ Allows **reflection** upon decisions and outcomes during the learning process

Many teachers assign projects,

- ▶ but not all projects lead to learning

Doing Projects
vs.
Project Based Learning

What is Project-Based Learning? (bie.org)

- ▶ Focus on Significant **Content**
 - ▶ The project imparts important, standards-based knowledge and skills
- ▶ Develop **21st Century Skills**
 - ▶ Critical thinking, problem-solving, collaboration & communication

What is Project-Based Learning? (bie.org)

- ▶ Engage Students in **In-Depth Inquiry**
 - ▶ Rigorous, extended process of asking questions, using resources, and developing answers
- ▶ Organized Around a **Driving Question**
 - ▶ Focused by an open-ended question that captures the task and is explored by students

What is Project-Based Learning? (bie.org)

- ▶ Establish a **Need to Know**
 - ▶ Students see the need to gain knowledge, understand concepts, and apply skills
- ▶ Encourage **Voice & Choice**
 - ▶ Students are allowed to make choices about how they work and the products they create

What is Project-Based Learning? (bie.org)

- ▶ Incorporate **Revision and Reflection**
 - ▶ Use feedback to consider additions and changes; think about what and how they are learning
- ▶ Include a **Public Audience**
 - ▶ Present their work to other people, beyond their classmates and teacher

Successful CCSS Projects

- ▶ **Rigorous**: build content knowledge
 - ▶ Require students to have a thorough understanding of key instructional objectives in order to complete the project
- ▶ Involve **reasoning**, critiquing, reflecting, and evaluating evidence
- ▶ Use **technology** appropriately and effectively

Project-Based Learning

- ▶ **Example:** Opening a New Restaurant
 - ▶ Nutrition: Plan a menu
 - ▶ Math: Determine costs (food, labor, supplies) and revenues for the business plan
 - ▶ Business: Determine startup costs, financing, and breakeven/payoff period
 - ▶ Marketing: Create advertisements
 - ▶ Students present their projects to "investors" or community members

Types of Projects

- ▶ **Investigation of a Historical Event or Natural Phenomenon**
 - ▶ Should the U.S. have dropped the atomic bomb on Japan?
 - ▶ How might animals evolve in a changing climate?
 - ▶ How has the national debt been affected by wars?

Types of Projects

- ▶ **Problem-Solving Situation**
 - ▶ How can a family eat for a week on a strict budget?
 - ▶ What temperatures are appropriate to store food to prevent food-borne illness?
 - ▶ When is the best time to harvest apples to maximize starch content?

Types of Projects

- ▶ **Examination of a Controversial Issue**
 - ▶ Should the government subsidize production of ethanol?
 - ▶ Should the Fed continue its policy of economic stimulus?
 - ▶ Should companies and scientists receive patents for genes and crop varieties?

Types of Projects

- ▶ **Challenge to Design, Plan, Build, or Create Something**
 - ▶ Design and build _____.
 - ▶ Create a business plan for a new fashion line.
 - ▶ Develop a way to evaluate methods of reducing coastal or soil erosion.

Think about a project you assign...

- ▶ Rate your project based on the provided criteria

		
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Project Upgrade

- ▶ Consider one of the projects you assign in your classes. Think about how you can...
- ▶ Make a "dessert" project into a "main course" project
- ▶ Integrate more math and science skills and practices into the project (and assess them)
- ▶ Guide students toward a product that demonstrates understanding
- ▶ Be ready to share in 10 minutes...

Work Time...

- ▶ Work in content-area teams.
- ▶ Consider a topic you'll be teaching in the next couple months.
- ▶ Design a task or project that integrates CCSS math standards and practices with this topic.
- ▶ Use the '**Project/Task Design Worksheet**' handout as a guide.
- ▶ Be prepared to share your project idea.

Sharing

- ▶ Each team, please take a few moments to share your project ideas.
 - ▶ How will you engage your students in this project?
 - ▶ What will students be required to do?
 - ▶ How is math/science integrated?
 - ▶ Is it rigorous? Can students complete the project without understanding the key math ideas?
 - ▶ How do you assess students? What is/are the deliverable(s)?

Note: Whiteboarding

- ▶ I use whiteboarding often in my classes.
 - ▶ Presentations require students to share their reasoning and justify their claims
 - ▶ Allow students to ask questions of each other (critiquing) and respond logically
 - ▶ Active, peer-driven learning process
 - ▶ Formative assessment – gets students talking to each other about the content
 - ▶ COMPASS

Thank You!
