

Career Academy Blended Mathematics

A NEW SERIES OF SUPPLEMENTARY LESSONS THAT WILL ENHANCE ALL STUDENTS' MATHEMATICAL LEARNING EXPERIENCES.

Career Academy Blended Mathematics (CABM) is a series of exciting projects that include advanced material and supplement existing Talent Development and general curricula. CABM presents mathematics in an engaging manner while corresponding with state and district mathematics standards. These projects provide extensive real-world applications embedded with career themes to equip students with the critical thinking abilities to prosper beyond high school. CABM's in-depth, multi-day projects align with geometric, algebraic, and trigonometric topics found in every high school mathematics class.



A Baltimore Talent Development High School student team works on the initial phase of the CABM Staircase Design project.

Current CABM Lessons

- **Auto Racing** (*Geometry & Trigonometry*)
- **Cocoa Production** (*Data Analysis & Representation*)
- **Difference Boxes** (*Mathematical Analysis*)
- **Square Law** (*Proportions & Quadratic Equations*)
- **Puff Pastry Layers** (*Exponential Functions*)
- **Census Estimation** (*Data Analysis & Representation*)
- **Staircase Design** (*Slope & Trigonometry*)
- **Tree Height** (*Linear Equations*)
- **West Nile Virus** (*Data Analysis & Representation*)
- **Sports Jump!** (*Health & Fitness/Sports*)



Here, the student team works on the second phase of the Staircase Design project – constructing the staircase.

Each CABM Project Contains. . .

Collaborative Student Research Teams

- Builds mathematical/scientific communication between peers
- Promotes teamwork

Background Information Reading

- Provides relevance
- Promotes career knowledge
- Presents global picture of topic
- Provides context for mathematical derivations

Experiment/Construction Activity

- Builds links between tactile objects and high level mathematics

Mathematics Investigation/Data Analysis

- Links representations and translations between representations

Students will:

- Collect data, tabulate, graph, calculate, determine mathematical functions from graphs and data, make predictions

Class Presentations

- Promote mathematical and scientific communication
- Show multiple aspects of overall problem



Construction complete!
The student team proudly displays the completed staircase.

Description

Career Academy Blended Mathematics Projects (CABM) are designed as applied mathematics supplemental materials for the upper grades. The projects align with Career Academies offered through Talent Development Secondary. The mathematical levels of these projects are high school **Geometry, Algebra II, Pre-Calculus, and Trigonometry**. The projects are non-trivial in nature and provide in-depth analysis of mathematical ideas and statistical analysis.

CABM projects are designed to

- provide collaborative learning activities,
- allow for mathematical communication,
- promote background knowledge,
- provide relevance,
- make real-world connections,
- tie to career themes,
- promote conceptual understanding and adaptive reasoning, and
- encourage the use of advanced mathematical tools.

The projects generally begin with an in-class experiment. These experiments are designed to build background knowledge and provide relevance. The experiment leads to in-depth analysis of sophisticated mathematical concepts. Students learn the mathematics that describe real-world phenomena.

Most projects have students give class presentations in order to share results. The class presentations and the collaborative nature of these projects provide students the opportunity to communicate mathematically with their peers. When collaborating with their peers, students work together in research and production groups. Within these groups, each student assumes a particular career role. The “roles” the group members play are related to the particular career path.

The CABM projects are organized according to career academy themes and by mathematical topics. Several projects cover multi-career topics. A brief description of each mathematics lesson and project, the mathematics necessary for the lesson and project, and the career academy theme follow.

Career Academy Blended Mathematics Projects by Career Academy

CABM Projects		Academies							
Project Title	Number of Lessons	Arts	Business	Culinary Arts	Environmental Earth Science	Engineering Mathematics	Health Fitness	Law Enforcement	Travel Hospitality
Auto Racing	2							√	
Cocoa Production	2		√	√					√
Credit Card Debt	3		√						√
Difference Boxes	1					√			
Jump Height and Force	3						√		
Luminosity and The Inverse Square Law	6	√				√			
Puff Pastry Layers	2			√					
Staircase Design	2	√				√			
Tree Height	2				√				
West Nile Virus	2				√		√		√

Career Academy Blended Mathematics Projects by Mathematics Topic

CABM Projects		Mathematics Topics						
Project Title	Number of Lessons	Data Analysis	Geometry Trigonometry	Linear Relationships	Exponential Functions	Quadratic Functions	Cubic Functions	Functional Analysis
Auto Racing	2		√					
Cocoa Production	2	√						
Credit Card Debt	3				√			
Difference Boxes	1							√
Sports Jump Height and Force	3			√	√			
Properties of Light Inverse Square Law	6		√			√		
Puff Pastry Layers	2				√			
Staircase Design	2		√	√				
Tree Height	2	√	√					√
West Nile Virus	2	√						

1) Auto Racing – Geometry and Proportions

- i. These two lessons have students work in racing teams to analyze several types of raceway corners, determine the best path to drive through a corner and determine the fastest speeds and times that can be driven around the corners.
 - a. Students descriptively analyze a hairpin (180°) turn on a race track and create a team logo, design the team race car, and share the team designs with the class.
 - b. In Racing Teams, students analyze a 90° corner on a race track, determine the radius of curvature of the best path to drive through the corner, find the maximum speeds through the corner, and determine the fastest times through the corner.
- ii. Career Fields – Law Enforcement and Engineering.
- iii. Mathematical Topics – Geometry/Trigonometry.

2) Cocoa Production

- i. This project contains two lessons. Students work together in five different production groups.
 - a. Each group analyzes a different aspect of cocoa production. The cocoa growers group analyzes world cocoa production data. The cocoa buyers group analyzes world pricing data. The cocoa processors group analyzes cocoa processing data. The two market research groups conduct chocolate taste test surveys. The surveys are modeled after actual testing methods conducted by cocoa professionals at each step of the cocoa production process. The data is from the International Cocoa Organization.
 - b. Students use various methods to represent the cocoa data – on time-lines, with histograms, and on world maps.
- ii. Career Fields – Culinary Arts, Business and Travel/Hospitality.
- iii. Mathematical Topics – Data Analysis.

3) Credit Card Debt

- i. This project contains three consecutive lessons. Students work together in credit card groups. The credit cards for all groups have the same balance and APR. The differences between groups comes from the monthly payments and other factors
 - a. The monthly payment amount for each group's credit card is different. Each group determines the time it takes to pay off the credit card, the total amount paid and the total interest paid.
 - b. For this lesson, the parameters of the credit card in the first lesson are altered. For example, one group makes a late payment and receives a late fee and increase in interest rate.
 - c. Using the results from the first two lessons, students in their credit card groups design a new credit card, determine rates, fees, etc. and create a marketing advertising campaign.
- ii. Career Fields – Business, Banking, Finance and Social Services.
- iii. Mathematical Topics – Exponential Functions.

4) Difference Boxes

- i. For this one lesson, students experiment with difference boxes and learn what it is for a box to be monotone and non-monotone and discuss ideas of convergence to zero. To make a difference box draw a large square on a piece of paper. Choose four integers. Label each corner of the square with one of the integers. Place a point at the midpoint

of each side. Take the absolute value of the difference between the endpoints of a side. Write that number at the midpoint of the side. Complete for all sides. Continue the process until you get all zeros.

- ii. Career Fields – Engineering, Science and Mathematics.
- iii. Mathematical Topics – Functional Analysis.

5) Sports – Jump Height and Force

The Sports Jump Height and Force projects are independent projects. They are for a Health/Fitness Academy.

- i. These three lessons have student working in groups of four. Students perform jumping experiments that relate deepness of knee bend to the height of the jump. Forces exerted on the floor by the jumps and the times spent in the air for each jump are determined. The collected data is graphed and analyzed.
- ii. Career Fields – Health/Fitness.
- iii. Mathematical Topics – Linear Equation, Quadratic and Square Root Functions.

6) Inverse Square Law and Quadratic Equations - Luminosity

- i. This project has six lessons. Students work in production teams with a gaffer, best boy electric, key grip, and best boy grip. The first two lessons are prerequisites for lessons three through five. These five lessons start with a simple experiment and end with students solving systems of non-linear equations and quadratic equations.
 - a. The first two lessons provide substantial background information on the properties of light and the inverse square law and involve students in a simple lighting experiment. In modeling the inverse square law, students use flashlights and measuring tape and record their data and observations.
 - b. The third lesson uses results from the flashlight experiment to determine geometrical relationships.
 - c. Lessons four and five have students analyzing lighting requirements for a movie set. Students progress from solving lighting questions using the inverse square to graphing the inverse square to solving systems of non-linear and quadratic equations.
- ii. Career Fields – Visual Media, Dramatic Arts and Engineering.
- iii. Mathematical Topics – Inverse Square Law, Proportions, Systems of Equations and Quadratic Equations.

7) Puff Pastry Layers

- i. This project has two lessons. Students work in bakery groups of two as a pastry chef and assistant baker. Using parchment paper and rolling pins, students make paper “puff pastry.” At each stage of folding and rolling, a thin strip of “pastry” is cut off and the number of layers counted. Students graph their results and determine the exponential function for the number of layers. The first lesson describes 2^x , the second describes 3^x .
- ii. Career Fields – Culinary Arts.
- iii. Mathematical Topics – Exponential Functions.

8) Staircase Design

- i. This project contains two lessons. Working in design teams with two students each, students learn the building codes for constructing public and residential staircases. They are given staircase design parameters from an architect and must determine whether or not the architect's design is appropriate and, if not, what measures need to be taken to create a workable staircase and still please the architect. Students then design their own cardboard staircase.
- ii. Career Fields – Architecture, Engineering, and Building Trades.
- iii. Mathematical Topics – Geometry/Trigonometry and Linear Relationships.

9) Tree Height

- i. There are two lessons in this project. Tree descriptions, heights, and price data are provided for students. Working in landscaping teams, students graph the data to determine the relationship between tree height and price.
 - a. For the first lesson, students construct inclinometers. The inclinometers will be used to determine the heights of various objects around the school yard. The heights are recorded in a table for use in the second lesson.
 - b. The second lesson has students analyzing the height and price tree data for several landscaping trees. The data is graphed and equations are fitted to the curves. For the final part of the lesson, the Landscape Teams each create a landscape design for the school yard incorporating all of the trees listed in the lesson. The heights of objects around the school yard listed in the first lesson must be considered when creating the landscape design. The designs are shared with the entire class.
- ii. Career Fields – Environmental Science, Earth Science and Landscape Design.
- iii. Mathematical Topics – Data Analysis, Geometry/Trigonometry and Functional Analysis.

10) West Nile Virus

- i. This project contains two lessons. Working in medical teams, students investigate West Nile Virus (WNV) data collected by the Center for Disease Control and the United States Department of Agriculture.
 - a. Four different medical teams will analyze different collections of WNV data from 1999 to 2005. One group will analyze reported human cases of WNV. Another group will analyze reported horse cases of WNV. Another group will analyze bird cases of WNV reported for crows and other birds. The final group will analyze positive WNV mosquito pools reported by year and mosquito species.
 - b. Time-lines, US maps, pie charts and histograms are created to provide a detailed representation of the WNV data. The medical teams report their results to the entire class for further discussions about infectious diseases
- ii. Career Fields – Medicine, Health/Fitness and Travel/Hospitality.
- iii. Mathematical Topics – Data Analysis.