STEM Curriculum Planning Guide

This instructional design guide serves as the template for the design and development of STEM units of instruction at the Dayton Regional STEM Center in Dayton, Ohio. The guide is anchored to the *STEM Education Quality Framework* also developed at the Dayton Regional STEM Center.

STEM Unit Title	**Engineer a Ball Launcher**
Economic Cluster	Advanced Manufacturing & Materials
Targeted Grades	8
STEM Disciplines	Science Technology Engineering Math
Non-STEM Disciplines	English Language Arts Service Learning

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Section I: STEM Unit Overview

Unit Overview

Given specific constraints, students investigate and apply knowledge of forces of motion, expressions, and analyzed data to design a ball launching mechanism. Teams of students collaborate to help enable a quadriplegic owner like to "throw" the ball to his or her service animal. Students employ the engineering design process as they design a ball launching mechanism prototype that achieves a desired distance and accuracy. After building and testing their design, students complete a simulated ball launching exercise, a basic technical report, and a brief oral presentation.

Essential Question

How can forces and motion as well as collected and interpreted data be utilized to predict the distance a ball will travel when launched?

Enduring Understanding

Data need to be collected in an organized manner and then analyzed to make future predictions.

Understand how multiple forces act on an object.

Engineering Design Challenge

Canine service animals provide a tremendous amount of support for their human companions. Although the majority of a service animal's day is spent working, they also like to have fun, too. Every dog requires exercise to maintain proper weight and health; however, many service dogs' quadriplegic companions struggle to throw balls or play fetch due to their limited arm functionality.

Teams design a ball launching mechanism that will enable a quadriplegic owner to "throw" the ball to his or her service animal. This mechanism should be easy to use, lightweight, and must be able to launch a ball anywhere within a 30 ft. x 20 ft. backyard. The ball launcher must also cost less than twenty dollars. A sketch of the backyard is included.

Time and Activity Overview

Day	Time Allotment	Actvities
1	50 minutes	Pre-test Video http://www.youtube.com/watch?v=BMhAguzWZjk (11m) Determine Teams, Roles, and Code of Cooperation Introduce Engineering Design Challenge (EDC) Homework: Article Analysis

2	50 minutes	Continue Discussing EDC "Force" Lesson Homework: Logbook Continue Discussing EDC Group Brainstorm on prototype Homework: Complete Sketches and Logbook Activity
3	50 minutes	Discuss Logbook Homework Introduce Decision Analysis Matrix Develop Goals for Decision Analysis Matrix Homework: Logbook
4	50 minutes	Discuss Logbook Homework Score Designs Using Decision Analysis Matrix Begin Constructing Prototype Homework: Logbook
5	50 minutes	Discuss Logbook Homework Continue Prototype Construction, Testing, and Begin Redisgn Homework: Logbook
6	50 minutes	Discuss Logbook Homework Test Prototype and Collect Data Homework: Logbook
7	50 minutes	Discuss Logbook Homework Conclude Testing and Data Collection Homework: Logbook

8	50 minutes	Discuss Logbook Homework Ball Launcher Challenge Introduce Brief Technical Report and Presentation Requirements Begin Report and Presentation Homework: Logbook
9	50 minutes	Discuss Logbook Homework Continue Report and Presentation Homework: Logbook
10	50 minutes	Discuss Logbook Homework Collect Presentations and Brief Technical Report Post-Test Post-Unit Survey

Pre-requisite Knowledge & Skill

-Students know and can apply the Pythagorean theorem.
-Students know how to graph data on the coordinate plane.
-Students can determine if data in a scatter plot is linear or non-linear.
-Students can generate a linear equation by calculating the slope and y-intercept from a graph.
-Students can determine the line of best fit for a scatter plot.
-Students understand a force is a push or pull.
-Students comprehend that the greater the force the greater the motion.
-Students understand the amount of change is based on the mass and the amount of force.
-Students understand motion is described by speed and direction.

Academic Content Standards

Add Standard	Mathematics	Ohio
Grade/Conceptual Category	8	
Domain	Expressions and Equations	
Cluster	Understand the connections between proportional relationships, lines, and linear equations	
Standards	5. Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways. For example, compare a distance-time graph to a distance-time equation to determine which of two moving objects has greater speed.	

Add Standard	Mathematics	Ohio
Grade/Conceptual Category	8	
Domain	Functions	
Cluster	Define, evaluate, and compare functions	
Standards	1. Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.	

Add Standard	Mathematics	Ohio
Grade/Conceptual Category	8	
Domain	Functions	
Cluster	Use functions to model relationships between quantities	
Standards	5. Describe qualitatively the functional relationship between two quantities by analyzing a graph (e.g., where the function is increasing or decreasing, linear or nonlinear). Sketch a graph that exhibits the qualitative features of a function that has been described verbally.	

Add Standard	**Mathematics**	Ohio
Grade/Conceptual Category	8	
Domain	Geometry	
Cluster	Understand and apply the Pythagorean Theorem	
Standards	7. Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions.	

Add Standard	**English Language Arts**	Ohio
Grade	6-8	
Strand	English and Language Arts Standards in Science and Technical Subjects	
Topic	Key Ideas and Details	
Standard	1. Cite specific textual evidence to support analysis of science and technical texts. 2. Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions. 3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.	

Add Standard	**English Language Arts**	Ohio
Grade	6-8	
Strand	English and Language Arts Standards in Science and Technical Subjects	
Topic	Craft and Structure	
Standard	4. Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics. 5. Analyze the structure an author uses to organize a text, including how the major sections contribute to the whole and to an understanding of the topic. 6. Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text.	

Add Standard	English Language Arts	Ohio
Add Standard	English Language Arts	Ohio
Grade	6 - 8	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Texts Types and Purpose	
Standard	1. Write arguments focused on discipline-specific content. a. Introduce claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically. b. Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. c. Use words, phrases, and clauses to create cohesion and clarify the relationships among claim(s), counterclaims, reasons, and evidence. d. Establish and maintain a formal style. e. Provide a concluding statement or section that follows from and supports the argument presented. 2. Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. a. Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information into broader categories as appropriate to achieving purpose; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension. b. Develop the topic with relevant, well-chosen facts, definitions, concrete details, quotations, or other information and examples. c. Use appropriate and varied transitions to create cohesion and clarify the relationships among ideas and concepts. d. Use precise language and domain-specific vocabulary to inform about or explain the topic. e. Establish and maintain a formal style and objective tone. f. Provide a concluding statement or section that follows from and supports the information or explanation presented.	

Add Standard	English Language Arts	Ohio
Grade	6 - 8	
Strand	Writing Standards for Literacy in History/Social Studies, Science and Technical Subjects 6–12	
Topic	Productions and Distribution of Writing	
Standard	4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. 5. With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed. 6. Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas clearly and efficiently.	

Add Standard	Social Studies	Ohio
Grade		
Theme		
Strand (pk-8 only)		
Topic		
Content Standard		

Add Standard	Science	Ohio
Grade	8	
Theme	Order and Organization	
Topic	Forces and Motion	
Content Standard	The motion of an object is always measured with respect to a reference point. Forces can be added. The net force on an object is the sum of all of the forces acting on the object. The net force	

Add Standard	Science	Ohio
Strand		
Course Content		
Content Elaboration		

Add Standard	**Fine Arts**	
Grade		

Add Standard	**Fine Arts**	
Subject		
Standard		
Benchmark		
Indicator		

Add Standard	**Technology**	
Grade	8	
Standard	7: Designed World	
Benchmark	A: Develop an understanding of, and be able to, select and use physical technologies.	
Indicator	Construction: 11. Describe how the selection of designs for structures is based on factors such as building laws and codes, including Americans with Disabilities Act concerns, style, convenience, cost, climate and function.	

Assessment Plan

What evidence will show that students have acquired the enduring understandings for this STEM unit?

Performance Task, Projects	Ball Launcher Prototype Brief Technical Report
Quizzes, Tests, Academic Prompts	Pre-Test Post-Test Engineering Logbook
Other Evidence (e.g. observations, work samples, student artifacts, etc.)	Decision Analysis Matrix Individual Sketches of Prototypes Post-Unit Survey
Student Self- Assessment	Engineering Logbook Self-Reflection

Technology Integration

ADISC Technology Integration Model*

	Type of Integration	Application(s) in this STEM Unit
A	Technology tools and resources that support students and teachers in ***adjusting, adapting, or augmenting*** teaching and learning to meet the needs of individual learners or groups of learners.	Smartboard and/or LCD Projector Youtube Video
D	Technology tools and resources that support students and teachers in ***dealing effectively with data***, including data management, manipulation, and display.	Data Table Coordinate Plane Excel or Graphing Calculator (optional) Clinometer (homemade option or digital)
I	Technology tools and resources that support students and teachers in conducting ***inquiry***, including the effective use of Internet research methods.	Internet Research
S	Technology tools and resources that support students and teachers in ***simulating*** real world phenomena including the modeling of physical, social, economic, and mathematical relationships.	Excel (optional) YouTube video

C	Technology tools and resources that support students and teachers in ***communicating and collaborating*** including the effective use of multimedia tools and online collaboration.	Brief Technical Report Presentation Logbook
	**The ADISC Model was developed by James Rowley PhD, Executive Director of the Institute for Technology-Enhanced Learning at the University of Dayton*	

Career Connections

Career Description

Social Worker:
A job for people that desire to greatly improve the quality of other peoples' lives. Social workers provide support to people, and they assist them with coping with and solving problems in daily life. Relationships, family, and personal problems cause stress for many people; social workers are helpful in suggesting solutions for these problems. Many times people just need someone else to help them brain storm a situation. This is more productive and helpful to them. (http://www.jobdescriptions.net)

Mechanical Engineer:
One of the most expansive engineering disciplines, and accordingly the specific job descriptions of individual mechanical engineers are highly variable. However, there is commonality among the various mechanical engineering jobs out there – mechanical engineers are the engineers who design, test, build, and maintain engines, equipment, vehicles, and tools; if it relies on the principles of force and motion to do its job, a mechanical engineer was probably involved in its creation. (http://www.jobdescriptions.net)

Industrial Engineer:
Tasked with formulating the most effective ways of using people, machines, materials, information, and energy to produce a product or provide a service. Industrial engineers strive to balance management goals with operational performance. They meet the objectives through effective management of people, methods of business organization, and use of technology. Typically, industrial engineers work in manufacturing industries. However, many industrial engineers are employed by consulting firms, healthcare services, and the communications industry. (http://www.jobdescriptions.net)

Section II: STEM Lesson Plan

Title of Lesson

Day 1: Introduction to Project

Time Required

50 minutes

Materials

Pre-test (Appendix A) (1 per student)
Pre/Post Test Answer Key (Appendix A)
"Service Dogs for People with Limited Mobility" video (11m22s):
http://www.youtube.com/watch?v=BMhAguzWZjk
Computer with Internet Capabilities (1 per class)
LCD Projector to Project Video (1 per class)
Engineering Logbook (Appendix B) (1 per student)

Materials to Make Available Throughout the Unit:

Suggested Basic Construction Tools Per Team
Hammer
Screw Driver
Scissors

Suggested Materials Per Team (or use similar materials available to you; quantities and size of each material are not set and can be determined by the teacher):
Dowel Rod
Rubber Bands
PVC Piping
Duct Tape
Scrap Wood Piece
Metal Tubing
String
Tape
Cardboard
Straws
Pencils
Pipe Cleaners

Objectives

Students will demonstrate prior knowledge by completing a pretest.

Students will be able to analyze a nonfiction article, video, and class discussion in order to create a need for begin brainstorming a solution to the engineering design challenge.

Students will discuss and for by completing the Team Careers document.

After working together to assign individual careers and create a team code of cooperation students will be able to utilize these as resources for effective collaboration.

Instructional Process

1. Administer Pre-Test (allow 15 minutes for completion).
2. Place students into predetermined groups of four students each.
3. Distribute Engineering Logbook and have them turn to Team Careers document.
4. Allow students time to discuss roles with their teams and collaborate to choose individual roles and complete Code of Cooperation.
5. Show the hook video, "Service Dogs for People with Limited Mobility," (11m22s):
   http://www.youtube.com/watch?v=BMhAguzWZjk
6. Introduce the engineering design challenge and discuss available materials and budget.
   Two Options for building materials:
   a. Provide a budget of $10 with a 'store' of teacher provided supplies. Allow teams to purchase materials for a determined price. If have outside materials are allowed by the teacher, a price will need to be determined allotted for in the budget. For this option, refer to "Material Cost List" in Appendix A.
   b. Task students with bringing materials from home. Provide a budget of $10, but encourage them to use materials around their house. Items from home are considered donations, and are not included in the cost.
7. Instruct students to read the "Canine Companion" article and complete the Article Analysis page for homework.

Differentiation

The pre-test may be modified according to educational goals per individual student.

Assessments

Use pretest to determine students' current level of understanding (formative)
Observation of team dynamics
Engineering Logbook

Section II: STEM Lesson Plan

Title of Lesson

Day 2: Forces

Time Required

50 minutes

Materials

Engineering Logbook

Instructional Videos (choose any from the list below based on your particular students prior knowledge of forces):
-One-Dimensional Kinematics (10m2s): http://www.youtube.com/watch?v=UefWw5k4G0U
-Newton's Laws of Motion and Forces (11m38s): http://www.youtube.com/watch?v=NYVMlmL0BPQ
-Four Forces of Flight Song (3m31s): http://www.youtube.com/watch?v=_iV65AjEoCM
-The Force Physics Song – Newton's Laws of Motion (4m19s): http://www.youtube.com/watch?v=2OJjbztWitk

Engineering Logbook

Objectives

Students will be able to explain that the motion of an object is always measured with respect to a reference point.

Students will be able to explain that a force is described by its strength and direction. They will be able to use arrows depicting direction and strength to illustrate forces acting on an object.

Instructional Process

1. Discuss "Canine Companion" article and analysis completed for homework.
2. Provide instructions regarding forces and motions by choosing from the following list of videos based on your particular students prior knowledge.
   -One-Dimensional Kinematics (10m2s): http://www.youtube.com/watch?v=UefWw5k4G0U
   -Newton's Laws of Motion and Forces (11m38s): http://www.youtube.com/watch?v=NYVMlmL0BPQ
   -Four Forces of Flight Song (3m31s): http://www.youtube.com/watch?v=_iV65AjEoCM
   -The Force Physics Song – Newton's Laws of Motion (4m19s): http://www.youtube.com/watch?v=2OJjbztWitk
3. Discuss how forces are related to the engineering design challenge and how their newly gained knowledge will be useful for completing the challenge effectively. Assign day 2 questions in the Logbook. This may also be completed for homework.
4. Introduce the Brief Technical Report and Presentation requirements and discuss the importance of writing and presenting in engineering. Instruct teams to work on these throughout the challenge. Presentations will be on day 9 and reports are due on day 10.
5. Display and discuss the steps of the Engineering Design Process. Explain that teams will be following this process throughout the engineering design challenge just as engineers follow a design process.

Differentiation

Provide additional ideas and guidance during individual brainstorming.

Assessments

Observation
3 Sketches of possible prototypes
Engineering Logbook

Section II: STEM Lesson Plan

Title of Lesson

Day 3: Prepare Goals for a Decision Analysis Matrix, Brainstorm and Sketch Individual Plan

Time Required

50 minutes

Materials

Engineering Logbook
Decision Analysis Matrix Teacher Instructions (Appendix A)

Objectives

Students will be able to collaborate with a team to reach consensus regarding the team's design goals and final design plan. They will be able to complete an individual design plan based on the chosen goals.

Instructional Process

1. Discuss homework.
2. Model the use of a Decision Matrix (Appendix A: Teacher Instructions - it may be helpful to provide students with a copy).
3. Refer to "Preparing Goals for a"Decision Analysis Matrix" in logbook. Instruct teams to discuss and begin preparing their goals based on the engineering design challenge (to save time, this may be completed either ahead of time by the teacher or together as a class). The Matrix itself will be completed another day.
4. Instruct students to create an individual design plan based on their team's goals by completing day 3. Have them complete all of day 3 for homework.

Differentiation

Aide students in determining their constraints and objectives.
Help students calculate the Matrix.
Complete the goals section of the Matrix for students.

Assessments

Engineering Logbook
Decision Analysis Matrix

Section II: STEM Lesson Plan

Title of Lesson

Days 4 and 5: Choose and Build a Team Prototype

Time Required

100 minutes (50 minutes per day)

Materials

Engineering Logbook

Objectives

Students will share their individual brainstorm ideas based on given constraints and objectives.

Students will collaborate in order to employ the use of an analysis matrix for choosing, building, and troubleshooting their team prototype.

Instructional Process

1. Explain that each team will use the Decision Analysis Matrix as a guide for choosing a team design plan after scoring individual plans.
2. Have teams score individual design plans on the "Decision Analysis Matrix" as each team member shares his or her individual design plan with the team. Once complete, they should analyze the matrix and collaborate in order to choose and sketch a team design plan idea.
3. Tell teams that once they have teacher approval, they may being building their prototype.
4. Monitor student construction of prototype.
5. Instruct students to complete homework in Engineering Logbook each night.
6. Remind teams to continue working on Brief Technical Report and Presentations.

Differentiation

Assist with construction needs (e.g. sawing wood, measuring materials)

Assessments

Prototype
Engineering Logbook

Section II: STEM Lesson Plan

Title of Lesson

Days 6: Initial Testing and Data Collection

Time Required

50 minutes

Materials

Balls (tennis, whiffle, rubber, ping-pong, or foam)
Engineering Logbook
Large Outdoor Area or Gymnasium
Rope / Spray Paint (to map off "backyard")
Hula Hoops (targets)
Rulers
Meter Sticks or Tape Measures
Pencils
Graphing Paper
Prototypes
Card stock
Wheelchair as Launching Platform (optional, a chair could be used)

Clinometer (homemade by copying on card stock or digital) Materials per Team for Homemade:
Protractor (may use card stock template provided)
Washer
String (6 inches)

Objectives

Students will be able to collect, utilize, and graph data based on their trials.

Students will be able to analyze graphs for linearity and use collected results to make predictions for future launches.

Instructional Process

1. Prior to class, use rope or spray paint to map off the dimensions of the "backyard" as shown on the Engineering Design Challenge rope off or paint
2. Have each team test their prototype, record data on tables provided in "Prototype Testing Data Tables,." Time permitting, allow them to make modifications based on the results.
3. Assign homework in Engineering Logbook.
4. Extension: Have students input their data into a graphing calculator or Excel spreadsheet to create a scatter plot (in addition to or in place of graphs in the Logbook).
4. Remind teams to continue working on Brief Technical Report and Presentations.

Differentiation

Aid students in setting up data tables.
Create data tables ahead of time for students.

Assessments	Data collection Data analysis Engineering Logbook completion

Section II: STEM Lesson Plan

Title of Lesson

Day 7:Competitive Challenge

Time Required

50 minutes

Materials

Calculators
'Backyard Simulation Area'
Prototype
Wheelchair (optional, a chair may be used)
Computers (at least one per team)
Engineering Logbook

Objectives

Students will be able to use their acquired data and apply the use of their prototype in various situations.

Students will be able to evaluate the effectiveness of their design and suggest a possible redesign.

Instructional Process

1. Set up the Backyard Simulation Area prior to the beginning of class.
2. Place three hula hoops randomly in the backyard. Have each team launch six balls, attempting to hit inside the hula hoops.
3. Award points to each team according to the hula hoop in which their ball lands.
   Suggested points system: Closest Hula Hoop (one point), Middle Hula Hoop (two points), Furthest Hula Hoop (three points). If a ball is launched into all three hula hoops, award five bonus points to that team.
4. Instruct students to complete homework in Engineering Logbook.
5. Remind teams to continue working on Brief Technical Report and Presentations.

Differentiation

Change the point system for teams.
Provide students with a scaffold for the technical report.

Assessments

Brief Technical Report
Engineering Logbook

Section II: STEM Lesson Plan

Title of Lesson

Days 8, 9, 10: Mini-Presentations, Brief Technical Reports, Post-Test, Unit Survey

Time Required

150 minutes (50 minutes each day)

Materials

Engineering Logbook
Brief Technical Reports
Computers (at least 1 per team)
Printer
Post-Test (Appendix A) (1 per student)
Pre/Post Test answer key (Appendix A)
Post-unit Survey (Logbook)

Objectives

Students will be able to analyze results use them present their findings as well as to brainstorm redesign prototype alternatives.

Students will be able to demonstrate an understanding of the challenge and concepts through completion of a technical writing report and collaboratively presenting information.

Students will demonstrate knowledge gained through completion of a technical report, post-test, and post-unit survey.

Instructional Process

1. Have students to discuss testing results and possible ways they could improve their prototype.
2. Allow time for teams to work on their Brief Technical Report and Mini-Presentation.
3. Score on the Engineering Design Challenge Rubric as they present on day 9.
4. Collect Brief Technical Report, administer Post-Test, and have students complete Post-Unit Survey on day 10.

Differentiation

Engineering Design Challenge
Modify brief technical report requirements, and/or provide a scaffold.
Modify post-tests as necessary.

Assessments

Brief technical report
Post-Test
Rubric
Engineering Logbook
Post-Unit Survey

Section III: Unit Resources

Materials and Resource Master List

Pre/Post-Test (2 per student)
Engineering Logbook (1 per student)
Computer with Projection Capabilities
Graphing Paper
Visual Representation of Engineering Design Process
Balls (tennis, whiffle, rubber, ping-pong, or foam)
Large Outdoor Area or Gymnasium
Rope/Spray Paint (to map off "backyard")
Hula Hoops or Buckets (targets)
Rulers
Meter Sticks or Tape Measures
Pencils
Wheelchair (optional, a chair may be used)
Calculators
Graphing Calculators or Excel (optional for displaying collected data)
Computers (1 per team for Brief Technical Report)

Clinometer (homemade by copying on card stock or digital) Materials per Team for Homemade:
Protractor (may use card stock template provided)
Washer
String (6 inches)

Suggested Basic Construction Tools Per Team
Hammer
Screw Driver
Scissors

Suggested Materials Per Team (or use similar materials available to you; quantities and size of each material are not set and can be determined by the teacher):
Dowel Rod
Rubber Bands
PVC Piping
Duct Tape
Scrap Wood Piece
Metal Tubing
String
Tape
Cardboard
Straws
Pencils
Pipe Cleaners


The Dayton Regional
STEM Center
Science, Technology, Engineering and Math

Key Vocabulary

ENGINEERING:

Constraint
the state of being checked, restricted, or compelled to avoid or perform some action

Engineering Design Process
the 8 step process which guide engineers when designing new products and processes

Objectives
something toward which effort is directed : an aim, goal, or end of action

Decision Analysis Matrix
a matrix used in engineering to choose designs based on the constraints and objectives desired by the client

Prototype
a first full-scale and usually functional form of a new type or design of a construction (as an airplane)

MATH:

Angle of Elevation
the angle between the horizontal and the line of sight to an object above the horizontal

Clinometer
device used to measure the angle of elevation

Coordinate Plane
a plane spanned by the x-axis and y-axis in which the coordinates of a point are its distances from two intersecting perpendicular axes

Function
a set of ordered pairs in which none of the first elements of the pairs appears twice

Input
the x value of a function

Linear
an equation when graphed is a straight line

Non-linear
an equation when graphed is not a straight line

Output
the y value of a function

Pythagorean Theorem
a theorem in geometry: the square of the length of the hypotenuse of a right triangle equals the sum of the squares of the lengths of the other two sides

Scatter plot
a graphic representation of bivariate data as a set of points in the plane that have Cartesian coordinates equal to corresponding values of the two variates

Slope
intercept form-a linear equation determined by the slope any y-intercept of the line, y=mx+b (rise/run)

Y-intercept
where the graph of the equation crosses the y-axis

SCIENCE:

Force
strength or power exerted on an object

Gravity
the force of attraction that moves or tends to move bodies towards the centre of a celestial body, such as the

Technical Brief

There are 5 steps in the Engineering Design Process that the students will work through on this project.
Ask:
What is the problem?
What have others done?
What are the constraints and criteria?

Think:
What are some possible solutions?
Brainstorm ideas and choose the best ones.

Plan:
Write your plan for solving the problem.
Draw a diagram of your solution.
Make a list of materials you will need.
Test:
Follow your plan for solving the problem.
Test your solution.

Improve:
Think about design modifications.
Make a plan for implementing modifications.
Follow your plan and test again.

The Decision Analysis Matrix:
The students will brainstorm all the possible constraints and criteria for the project. They give each constraint or criteria a weight of 1 to 10 with 10 being the most important. Then each design is given a score: 1 is does not meet the goal, 2 somewhat meets the goal and 3 is totally meets the goal. The score is multiplied times the weight to get a value. The values for each goal are added up to find the total value given to each design. These total values are used to help the team decide which design best meets all their constraints and criteria.

Science:
Motion can be described in different ways by different observers (e.g., a pencil held in someone's hand may appear to be at rest, but to an observer in a car speeding by, the pencil may appear to be moving backward).

A force is described by its strength (magnitude) and in what direction it is acting. Many forces can act on a single object simultaneously. The forces acting on an object can be represented by arrows drawn on an isolated picture of the object (a force diagram). The direction of each arrow shows the direction of push or pull. When many forces act on an object, their combined effect is what influences the motion of that object. The sum of all the forces acting on an object depends not only on how strong the forces are, but also in what directions they act.

Safety and Disposal

Have students wear safety goggles and other appropriate safety equipment when constructing prototype.

References

Brown, Brunswick, Harper, McNally. (2011) Engineering community gardens. Retrieved July 3, 2012, from http://www.daytonregionalstemcenter.org/stem-curriculum/16/58/

Caldwell, Fiona. Service dogs: all work, some play and belly rubs. (2012, April 20) Pets best insurance. Retrieved July 18, 2012, from http://blog.mlive.com/grpress/2008/07/_dogs_dogs_most_service.html

Dictionary. (n.d.) Retrieved July 19, 2012, from http://dictionary.com

Dictionary and thesaurus- Merriam-Webster online. (n.d.) Dictionary and thesaurus-Merriam Webster-Online. Retreived July 19, 2012, from http://merriam-webster.com

Job descriptions (n.d.) Retrieved July 3, 2012, from http://www.jobdescriptions.net

New breed of assistance dogs hone skills, including 'scent-abilities'. (2008, July 29) The Grand Rapids Press. Retrieved July 17, 2012, from http://www.babyboomercaretaker.com/assistive-technology/wheelchair/Training-Dogs-For-People-In-Wheelchairs.html

Ohio department of education. (n.d.) Retreived June 28, 2012, from http://www.ode.state.oh.us

"Service dogs for people with limited mobility - YouTube." YouTube-broadcast yourself. 8 December 2006. Web. 3 July 2012. <http://blog.mlive.com/grpress/2008/07/_dogs_d
ogs_most_service.html >

Training dogs for people in wheelchairs. (n.d.) Baby boomer care. Retrieved July 18, 2012, from http://www.babyboomercaretaker.com/assistive-technology/wheelchair/Training-Dogs-For-People-In-Wheelchairs.html

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Section IV: Appendices

Appendix A:Teacher Resources:
-Pre/Post Test
-Pre/Post Test answer key
-Decision Analysis Matrix Teacher instructions
-Clinometer
-Logbook Answer key
-Materials Cost List

Appendix B: Engineering Logbook:
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-Group Engineering Rubric
-Individual Engineering Logbook Rubric
-Group Brief Technical Report Rubric
-Team Code of Cooperation and Team Careers
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-Day 2: Possible Designs, Homework, and Reflection
-Day 3: Decision Analysis Matrix, Force Homework, Reflection, and Career Connection
-Day 4: Reflections
-Day 5: Reflections and Career Connection
-Day 6/7: Prototype Testing, Graphing Data, Science Homework, Reflection,Pre-Challenge Question, and Career Connection
-Day 8: Reflections
-Day 9: Brief Technical Report and Mini-Presentation Requirements, Reflection, and Career Connectoin
-Day 10: Post-Unit Survey