Cedar Grove School District

Cedar Grove, NJ

2017 | Grades 5-8

S.T.E.M.

Science, Technology, Engineering and Math

Approved by the Cedar Grove Board of Education

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S.T.E.M.
Course Description

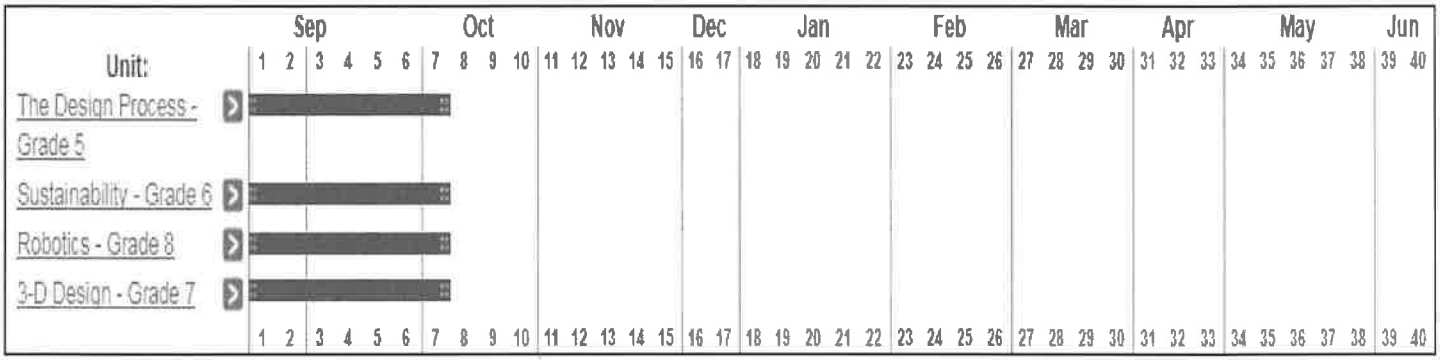
These grade level S.T.E.M. courses are designed to introduce students to the world of engineering and the impact science, technology, and math have on the field. The underlying theme that anyone can become an engineer will be nurtured through the use of problem-based learning. Students will begin by looking at the design process and the importance of coming up with a plan. The idea of questioning how something works and how it can be done better will be a main idea. Students will be introduced to the notion that learning from failing is a large part of how engineers come up with new and better designs. The concepts of sustainability and biomimicry will show students how engineers consider impacts to the environment and nature's existing designs in the planning process. Students will also look at how 3D printers are transforming the manufacturing industry and how new designs are created. Finally, coding and robotics will be taught through the use of Lego Mindstorms EV3 Core Education kits. Students will control different types of sensors through coding while learning how loops drastically affect the efficiency of coding. Through these courses, students will become 21st Century problem solvers and be better prepared for the rigors of the real world.

This curriculum was written in accordance with the NEW JERSEY STUDENT LEARNING STANDARDS for Technology, Science, Mathematics, and 21st Century Life & Careers

A full listing of the Grade 4 New Jersey Student Learning Standards can be viewed at:
http://www.state.nj.us/education/cccs/

S.T.E.M. – Grades 5-8

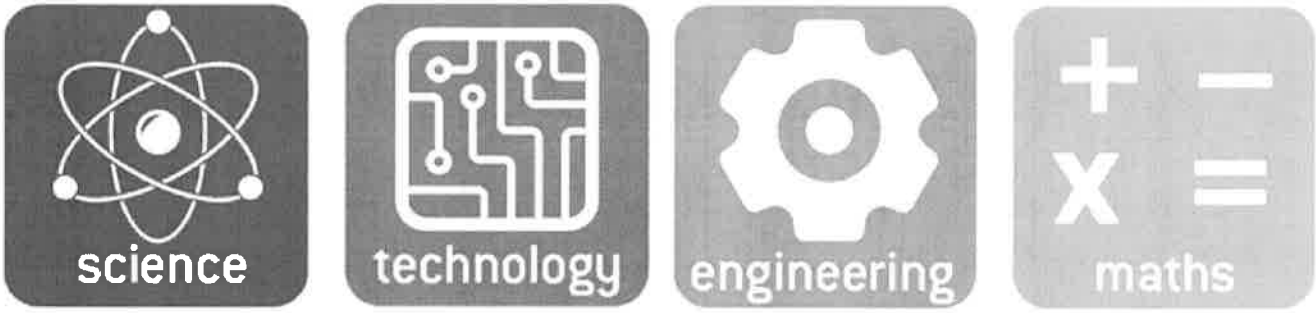
Course Calendar



S.T.E.M.

Science, Technology, Engineering and Math

Grade 5



The Design Process - Grade 5

Collaboration

Stage 1: Desired Results

NJ Standards

NJSLS-S: Science and Engineering Practices

NJSLS-S: 3-5

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 3–5 builds on K–2 experiences and progresses to specifying qualitative relationships.

- Ask questions about what would happen if a variable is changed.
- Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.
- Use prior knowledge to describe problems that can be solved.
- Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.

Practice 7. Engaging in argument from evidence

Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s).

- Compare and refine arguments based on an evaluation of the evidence presented.
- Distinguish among facts, reasoned judgment based on research findings, and speculation in an explanation.
- Respectfully provide and receive critiques from peers about a proposed procedure, explanation, or model by citing relevant evidence and posing specific questions.
- Construct and/or support an argument with evidence, data, and/or a model.
- Use data to evaluate claims about cause and effect.
- Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

NJ: 2014 SLS: Technology

NJ: Grades 3-5

8.2 Technology Education, Engineering, Design, and Computational Thinking

C. Design: The design process is a systematic approach to solving problems.

- 8.2.5.C.1 Collaborate with peers to illustrate components of a designed system.
- 8.2.5.C.2 Explain how specifications and limitations can be used to direct a product's development.
- 8.2.5.C.3 Research how design modifications have lead to new products.
- 8.2.5.C.4 Collaborate and brainstorm with peers to solve a problem evaluating all solutions to provide the best results with supporting sketches or models.
- 8.2.5.C.5 Explain the functions of a system and subsystems.
- 8.2.5.C.7 Work with peers to redesign an existing product for a different purpose.

D. Abilities for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

- 8.2.5.D.1 Identify and collect information about a problem that can be solved by technology, generate ideas to solve the problem, and identify constraints and trade-offs to be considered.
- 8.2.5.D.2 Evaluate and test alternative solutions to a problem using the constraints and trade-offs identified in the design process to evaluate potential solutions.
- 8.2.5.D.3 Follow step by step directions to assemble a product or solve a problem.
- 8.2.5.D.7 Explain the impact that resources such as energy and materials used in a process to produce products or system have on the environment.

Enduring Understandings

- Engineers use mathematics, scientific knowledge, new technology, critical thinking skills, and questioning to develop solutions to real world problems.
- Using the design process helps engineers and inventors solve problems.

Essential Questions

- What is engineering?
- Why is questioning such an important part of engineering?
- Who can be an engineer?
- What is a good invention?
- What is the process for coming up with a new invention?
- How does teamwork affect the outcome of a solution?

Content

A. The importance of questioning
B. Using evidence to back up an argument
C. The attributes of design
D. The application of engineering design
E. The role of troubleshooting, research and development, invention and innovation and experimentation in problem-solving.
F. Assess the impact of products and systems

Skills

A.1 Create questions that look at variables and cause and effect of an outcome
A.2 Question existing solutions to problems and come up with new solutions using prior knowledge
A.3 Understand how the constraints on materials, time, and, cost effect the development of a product
B.1 Use evidence, data, and/or a model to construct a valid argument
B.2 Collaborate with peers to construct and evaluate a valid argument
B.3 Use evidence and data to evaluate claims of cause and effect
C.1 Collaborate with peers to look at the design process
C.2 Use research to understand how the design process leads to new solutions and products
D.1 Solve a problem in the best way as a team using brainstorming after evaluating several different solutions
D.2 Use step by step directions to effectively solve a problem or create a solution
E.1 Understand the importance of being able to troubleshoot a problem
F.1 Understand how new solutions should be environmentally friendly

Stage 2: Assessment Evidence

Assessments

Stage 3: Learning Plan

Learning Activities

Suggested Learning Activities:

- Model the Design Process
- Understand circuits using Makey Makeys
- Make a structure out of toothpicks
- Create a Rube Goldberg machine
- Guided Practice
- Lecture and Demonstration
- Discussions and activities relating to the design process
- Collaborate with other students to create solutions

Resources

Suggested Resources:

- Google Classroom
- Chromebooks
- *Makey Makey.* http://makeymakey.com/
- *Engineering.com.* http://www.engineering.com/GamesPuzzles/DynamicSystems.aspx
- *Quizlet.* https://quizlet.com/6362823/flashcards
- *NASA's Best Students: Beginning Engineering, Science and Technology: An Educator's Guide to the Engineering Design Process.*

https://www.nasa.gov/pdf/630753main_NASAsBESTActivityGuide3-5.pdf

- *NASA Goddard Media Studios.* https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=10515
- *TryEngineering.Org.* http://tryengineering.org/

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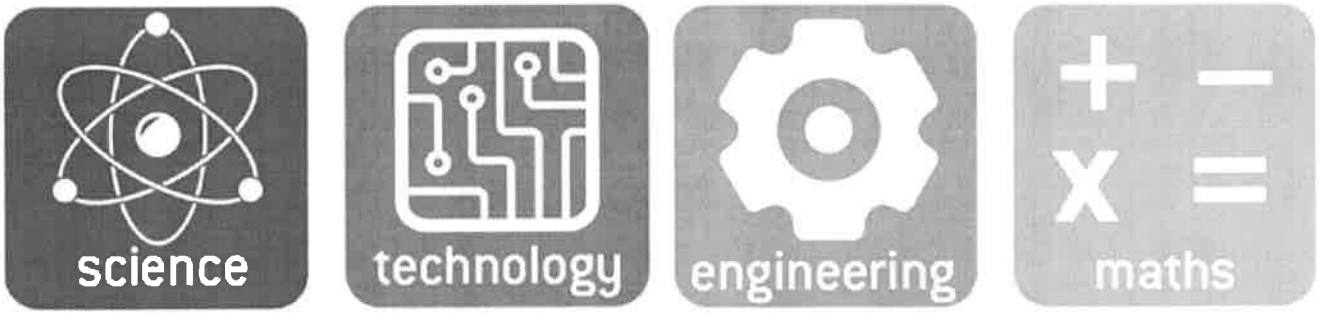
Science, Technology, Engineering and Math

Grade 6



Sustainability - Grade 6

Collaboration

Stage 1: Desired Results

NJ Standards

NJSLS-S: Science and Engineering Practices

NJSLS-S: 6-8

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to identify and/or clarify evidence and/or the premise(s) of an argument.
- Ask questions to determine relationships between independent and dependent variables and relationships in models.

Practice 3. Planning and carrying out investigations

Planning and carrying out investigations in 6-8 builds on K-5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or solutions.

- Collect data about the performance of a proposed object, tool, process or system under a range of conditions.

Practice 4. Analyzing and interpreting data

Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.

- Analyze and interpret data to determine similarities and differences in findings.

Connections to the Nature of Science: Most Closely Associated with Practices

Scientific Knowledge is Open to Revision in Light of New Evidence

- Scientific explanations are subject to revision and improvement in light of new evidence.
- The certainty and durability of science findings varies.
- Science findings are frequently revised and/or reinterpreted based on new evidence.

NJ: 2016 SLS: Mathematics

NJ: Grade 6

The Number System

6.NS.C. Apply and extend previous understandings of numbers to the system of rational numbers.

- 6.NS.C.5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

Statistics & Probability

6.SP.A. Develop understanding of statistical variability.

- 6.SP.A.1. Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers.

Mathematical Practice

MP.The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

- MP.1. Make sense of problems and persevere in solving them.
- MP.2. Reason abstractly and quantitatively.
- MP.3. Construct viable arguments and critique the reasoning of others.
- MP.4. Model with mathematics.

NJ: 2016 SLS: Science

NJ: MS Earth & Space Sciences

MS-ESS3 Earth and Human Activity

Performance Expectations

- MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

NJ: MS Engineering Design

MS-ETS1 Engineering Design

Performance Expectations

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

NJ: 2014 SLS: Technology

NJ: Grades 6-8

8.1 Educational Technology

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

- 8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.

F: Critical thinking, problem solving, and decision making: Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.

- 8.1.8.F.1 Explore a local issue, by using digital tools to collect and analyze data to identify a solution and make an informed decision.

8.2 Technology Education, Engineering, Design, and Computational Thinking

8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.
A. The Nature of Technology: Creativity and Innovation
Technology systems impact every aspect of the world in which we live.

- 8.2.8.A.4 Redesign an existing product that impacts the environment to lessen its impact(s) on the environment.

B. Technology and Society: Knowledge and understanding of human, cultural and society values are fundamental when designing technology systems and products in the global society.

- 8.2.8.B.1 Evaluate the history and impact of sustainability on the development of a designed product or system over time and present results to peers.
- 8.2.8.B.2 Identify the desired and undesired consequences from the use of a product or system.
- 8.2.8.B.7 Analyze the historical impact of waste and demonstrate how a product is upcycled, reused or remanufactured into a new product.

D. Abilties for a Technological World: The designed world is the product of a design process that provides the means to convert resources into products and systems.

- 8.2.8.D.1 Design and create a product that addresses a real world problem using a design process under specific constraints.

Enduring Understandings

- Sustainability is a both a local and global issue.
- Communities are made up of people, animals, and plants that live in them.
- Every organism depends on others.
- Many cycles are found in the natural world.
- Resources must be shared across time and space to meet the needs of all living things now and in the future.
- We can make a difference.

Essential Questions

- Why is sustainability important?
- How can we help our community?
- How do our choices affect ourselves, our community, and the world?
- What cycles can be found in our community?
- Who decides what is fair and equitable in a community?
- What is the difference between wants and needs?

Content

A. Carbon dioxide and the environment
B. Hybrid Engines
D. Biomimicry

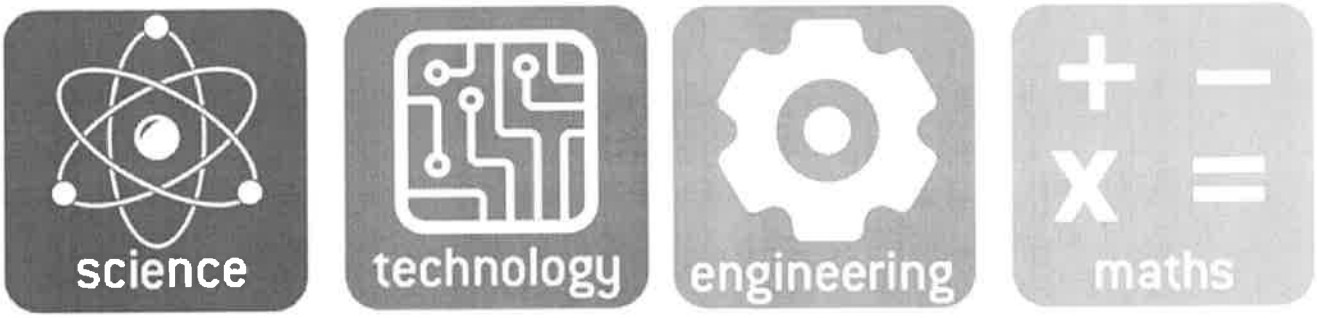
Skills

A.1 Understand what Carbon Dioxide is
A.2 Determine how and why CO_2 emissions have increased over time
A.3 Identify how CO_2 emissions are created and their effects on the environment
A.4 Calculate individual contributions of CO_2 emissions
B.1 Understand the science and engineering behind a Hybrid engine

S.T.E.M.

Science, Technology, Engineering and Math

Grade 7



3-D Design - Grade 7

Collaboration

Stage 1: Desired Results

NJ Standards

NJSLS-S: Science and Engineering Practices

NJSLS-S: 6-8

Practice 1. Asking questions (for science) and defining problems (for engineering)

Asking questions and defining problems in 6–8 builds on K–5 experiences and progresses to specifying relationships between variables, and clarifying arguments and models.

- Ask questions to clarify and/or refine a model, an explanation, or an engineering problem.
- Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Use mathematical representations to describe and/or support scientific conclusions and design solutions.

NJ: 2016 SLS: Mathematics

NJ: Grade 7

Mathematical Practice

MP.The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

- MP.1. Make sense of problems and persevere in solving them.
- MP.2. Reason abstractly and quantitatively.
- MP.3. Construct viable arguments and critique the reasoning of others.
- MP.4. Model with mathematics.
- MP.5. Use appropriate tools strategically.

NJ: 2016 SLS: Science

NJ: MS Engineering Design

MS-ETS1 Engineering Design

Performance Expectations

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved..

NJ: 2014 SLS: Technology

NJ: Grades 6-8

8.1 Educational Technology

8.1 Educational Technology: All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
A. Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.

- 8.1.8.A.1 Demonstrate knowledge of a real world problem using digital tools.

8.2 Technology Education, Engineering, Design, and Computational Thinking

8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming: All students will develop an understanding of the nature and impact of technology, engineering, technological design, computational thinking and the designed world as they relate to the individual, global society, and the environment.

A. The Nature of Technology: Creativity and Innovation

Technology systems impact every aspect of the world in which we live.

- 8.2.8.A.1 Research a product that was designed for a specific demand and identify how the product has changed to meet new demands (i.e. telephone for communication - smart phone for mobility needs).

C. Design: The design process is a systematic approach to solving problems.

- 8.2.8.C.2 Explain the need for optimization in a design process.
- 8.2.8.C.7 Collaborate with peers and experts in the field to research and develop a product using the design process, data analysis and trends, and maintain a design log with annotated sketches to record the developmental cycle.

Enduring Understandings

- There is always a better way to complete a task.
- The engineering design process helps to create new solutions.
- Anyone can be an engineer.
- Designing in 3D is changing the way engineers create solutions.

Essential Questions

- How has engineering changed the world?
- What are some of the most important things that have been engineered by humans?
- How have 3D printers changed how engineers create solutions?
- What are the most important concepts of 3D design?

Content

A. The Importance of Questioning
B. Website Design
C. 3D Design
D. 3D Printing

Skills

A.1 Create questions that look at variables and cause and effect of an outcome
A.2 Question existing solutions to problems and come up with new solutions using prior knowledge
A.3 Understand how the constraints on materials, time, and, cost effect the development of a product
A.4 Use math skills to solve problems
A.5 Understand how digital tools can help solve problems
A.6 Explain how working with others can lead to better solutions
A.7 Explain how the design process helps to solve problems systematically
B.1 Create a website
B.2 Add Images
B.3 Edit Headers
B.4 Edit Themes
B.5 Add Pages
B.6 Publish a site
C.1 Use and Define a workplane
C.2 Use the ruler tool to correctly place shapes
C.3 Use shapes
C.4 Use holes
C.5 Group objects
C.6 Align objects
C.7 Flip objects
C.8 Export Designs
D.1 Import Designs
D.2 Scale Designs
D.3 Rotate Designs
D.4 Move Designs
D.5 Load Filament
D.6 Unload Filament

Stage 2: Assessment Evidence

Assessments

Stage 3: Learning Plan

Learning Activities

Suggested Learning Activities:

- Research an existing design and improve on it
- Create a new design that will solve a problem
- Create a website to document a design
- Show a thorough understanding of the design process

Resources

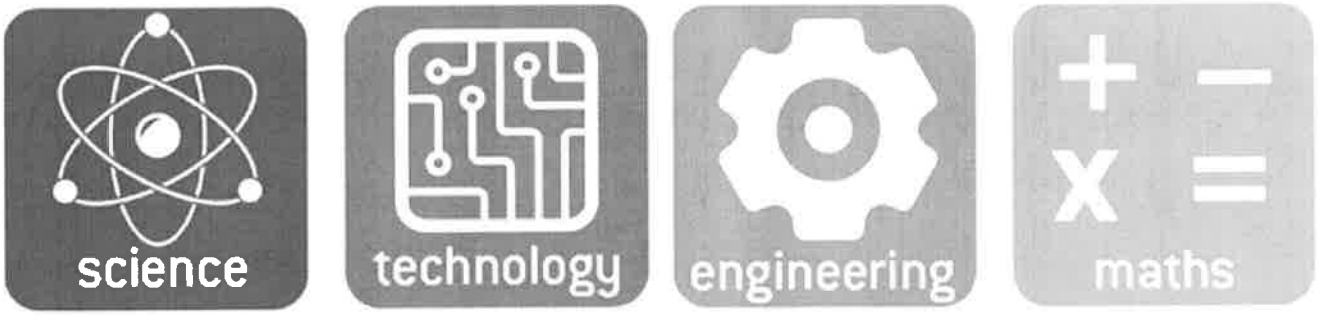
Suggested Resources:

- Google Classrooms
- Google Sites
- Chromebooks
- *Tinkercad.* http://www.tinkercad.com
- *MakerBot.* http://www.makerbot.com
- Makerbot Software
- 3D Printer

S.T.E.M.

Science, Technology, Engineering and Math

Grade 8



Robotics - Grade 8

Collaboration

Stage 1: Desired Results

NJ Standards

NJSLS-S: Science and Engineering Practices

NJSLS-S: 6-8

Practice 5. Using mathematics and computational thinking

Mathematical and computational thinking in 6–8 builds on K–5 experiences and progresses to identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

- Apply mathematical concepts and/or processes (e.g., ratio, rate, percent, basic operations, simple algebra) to scientific and engineering questions and problems.

Practice 6. Constructing explanations (for science) and designing solutions (for engineering)

Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

- Construct an explanation using models or representations.

NJ: 2016 SLS: Mathematics

NJ: Grade 8

Mathematical Practice

MP.The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students.

- MP.1. Make sense of problems and persevere in solving them.
- MP.2. Reason abstractly and quantitatively.
- MP.4. Model with mathematics.
- MP.6. Attend to precision.
- MP.7. Look for and make use of structure.
- MP.8. Look for and express regularity in repeated reasoning.

NJ: 2016 SLS: Science

NJ: MS Engineering Design

MS-ETS1 Engineering Design

Performance Expectations

- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved..

NJ: 2014 SLS: Technology

NJ: Grades 6-8

8.2 Technology Education, Engineering, Design, and Computational Thinking

C. Design: The design process is a systematic approach to solving problems.

- 8.2.8.C.4 Identify the steps in the design process that would be used to solve a designated problem.
- 8.2.8.C.5 Explain the interdependence of a subsystem that operates as part of a system.

E. Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

- 8.2.8.E.2 Demonstrate an understanding of the relationship between hardware and software.

- 8.2.8.E.3 Develop an algorithm to solve an assigned problem using a specified set of commands and use peer review to critique the solution.

Enduring Understandings

- Programming is a precise practice.
- Mental models help make sense of how a system works.
- Difficult problems are easier to solve when they are broken down.
- Data from sensors give a robot information about its environment.
- Computational thinking applies everywhere.
- Computational thinking requires humans to consider problems analytically and use data to inform decisions.

Essential Questions

- How have robots changed the way goods are produced?
- Do robots and humans share common characteristics?
- What are the benefits of using the design process?
- When is it appropriate to break down a problem?
- How do robots use sensors and data?
- How does computational thinking affect engineering?
- How is computational thinking used to solve problems?
- What are some different ways to analyze problems?

Content

A. Basic Understanding
B. Programming

Skills

A.1 Setup a robot
A.2 Understand basic robot operation and maintenance
A.3 Use commands in a sequence
A.4 Download and run programs
B.1 Program a robot to move straight
B.2 Program a robot to turn
B.3 Program a robot to use a touch sensor
B.4 Program a robot to use an ultrasonic sensor
B.5 Program a robot to use a gyro sensor
B.6 Program a robot to use a color sensor
B.7 Use loops and switches to control the robot more efficiently

Stage 2: Assessment Evidence

Assessments

Stage 3: Learning Plan

Learning Activities

Suggested Learning Activities:

- Discussion regarding computational thinking
- Videos explaining key concepts of computational thinking
- Self-paced problems
- Group activities
- Section challenges
- Final Challenge
- Reflective questions

Resources

Suggested Resources:

- Google Classroom
- Videos
- Google Sites
- Mindstorms EV3 Robots
- Mindstorms EV3 Education Software
- Engineering Logs
- *Introduction to Programming LEGO® MINDSTORMS® EV3.* http://www.education.rec.ri.cmu.edu/content/lego/ev3/files/EV3%20teachers%20guideWEB.pdf