

WARREN COUNTY SCHOOL DISTRICT

PLANNED INSTRUCTION

COURSE DESCRIPTION

Course Title: STEM - Design and Modeling

Course Number: 00755

Course Prerequisites: None

Course Description: Design and Modeling provides students opportunities to apply the design process to creatively solve problems. Students are introduced to the unit problem in the first activity and are asked to make connections to the problem throughout the lessons in the unit. Students learn and utilize methods for communicating design ideas through sketches, solid materials, and mathematical models. Students will understand how models can be simulated to represent an authentic situation and generate data for further analysis and observations. Students work in teams to identify design requirements, research the topic, and engage stakeholders. Teams design, fabricate, test, and make necessary modifications to optimize the design solution.

Suggested Grade Level: Grades 6-8

Length of Course: One Nine-Week Marking Period

Units of Credit: .25

PDE Certification and Staffing Policies and Guidelines (CSPG) Required Teacher Certifications:

CSPG 65

To find the CSPG information, go to [CSPG](#)

Certification verified by the WCSD Human Resources Department: Yes No

WCSD STUDENT DATA SYSTEM INFORMATION

Course Level: Academic

Mark Types: Check all that apply.

F – Final Average MP – Marking Period EXM – Final Exam

GPA Type: GPAEL-GPA Elementary GPAML-GPA for Middle Level NHS-National Honor Society

UGPA-Non-Weighted Grade Point Average GPA-Weighted Grade Point Average

State Course Code: 21017

To find the State Course Code, go to [State Course Code](#), download the Excel file for SCED, click on SCED 6.0 tab, and chose the correct code that corresponds with the course.

WARREN COUNTY SCHOOL DISTRICT

PLANNED INSTRUCTION

TEXTBOOKS AND SUPPLEMENTAL MATERIALS

Board Approved Textbooks, Software, and Materials:

Title: Project Lead the Way Durable and Consumable Resources

Publisher:

ISBN #:

Copyright Date:

WCSD Board Approval Date:

Supplemental Materials:

Curriculum Document

WCSD Board Approval:

Date Finalized: 8/28/2018

Date Approved: 10/8/2018

Date(s) Revised: 3/11/2019, 4/8/2019, 1/11/21

Implementation Year: 2018-2019

SPECIAL EDUCATION, 504, and GIFTED REQUIREMENTS

The teacher shall make appropriate modifications to instruction and assessment based on a student's Individual Education Plan (IEP), Chapter 15 Section 504 Plan (504), and/or Gifted Individual Education Plan (GIEP).

ASSESSMENTS

PSSA Academic Standards, Assessment Anchors, and Eligible Content: The teacher must be knowledgeable of the PDE Academic Standards, Assessment Anchors, and Eligible Content and incorporate them regularly into planned instruction.

Formative Assessments: The teacher will utilize a variety of assessment methods to conduct in-process evaluations of student learning.

Effective formative assessments for this course include: Teacher questioning, classroom discussions, peer check and connect, and note taking

Summative Assessments: The teacher will utilize a variety of assessment methods to evaluate student learning at the end of an instructional task, lesson, and/or unit.

Effective summative assessments for this course include: Design and building of a therapeutic toy for student with cerebral palsy, tests, and quizzes

Have you ever wanted to create a toy or a device to help people?

Students use tools such as the design process, a dynamic mathematics software, a computer-aided design program, computer simulations, an engineering notebook, and possibly a 3D printer to design, model, and build objects.

Discover the design process and turn your ideas into realities!

Design and Modeling (DM) provides students opportunities to apply the design process to creatively solve problems. Students are introduced to the unit problem in the first activity and are asked to make connections to the problem throughout the lessons in the unit. Students learn and utilize methods for communicating design ideas through sketches, solid models, and mathematical models. Students will understand how models can be simulated to represent an authentic situation and generate data for further analysis and observations. Students work in teams to identify design requirements, research the topic, and engage stakeholders. Teams design a toy or game for a child with cerebral palsy, fabricate and test it, and make necessary modifications to optimize the design solution.

DM Lesson Summary

Lesson 1	Introduction to Design
Lesson 2	Modeling and Statistical Analysis Design
Lesson 3	Challenge

Lesson 1: Introduction to Design

Students discover the design process as they complete an instant design challenge to create an ankle foot orthosis. They learn thumbnail, orthographic, isometric, and perspective sketching as methods for communicating design ideas effectively without the use of technology. The use of a common measurement system is essential for communicating and fabricating designs. Students learn conversions between two measurement systems and apply measurement skills while dimensioning sketches. Students conduct a mechanical dissection in the lesson project to better understand how objects and parts interact while using sketches to communicate and document their findings.

Lesson 2: Modeling and Statistical Analysis

In this lesson, students transfer a two-dimensional representation to a three-dimensional solid model with technology. Students study basic geometric shapes within a mathematical model and use combinations of geometric primitives to form more complex shapes. During the design project, students work in teams and apply the design process to create a puzzle cube. Students create a solid model using a computer-aided design (CAD) application and fabricate their design solution for testing. Students use a dynamic mathematics program to complete statistical analysis from their testing results to determine if their design met the criteria and constraints.

Lesson 3: Design Challenge

Students use a simulation to better understand cerebral palsy prior to beginning their Therapeutic Toy Design Challenge. Within teams, students brainstorm and select a design solution to the problem based on design requirements. They establish team norms, collaborate, and recognize that solving authentic problems involves interdisciplinary skills such as engineering, biomedical science, and computer science skills. Using the design process, students create a solid model of their design, build a prototype for design testing, and make necessary design modifications based on testing results.

New Design and Modeling (DM)

Lesson 1

Common Core State Standards for English Language Arts 7th Grade

7.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

7.SL.1.b - Speaking and Listening

Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.

7.SL.1.c - Speaking and Listening

Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.

7.SL.1.d - Speaking and Listening

Acknowledge new information expressed by others and, when warranted, modify their own views.

7.SL.4 - Speaking and Listening

Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

New Design and Modeling (DM)

Lesson 1

Common Core State Standards for English Language Arts Anchor Standards

AS.R.1 - Reading

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

AS.R.4 - Reading

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

AS.R.7- Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

AS.SL.1 - Speaking and Listening

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

AS.SL.2 - Speaking and Listening

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

AS.SL.4 - Speaking and Listening

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning, and the organization, development, and style are appropriate to task, purpose, and audience.

AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

AS.L.4- Language

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

AS.L.6 - Language

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

New Design and Modeling (DM)

Lesson 1

Common Core State Standards for English Language Arts 6-8 Literacy Standards for History/Social Studies, Science, and Technical Subjects

6-8.RH.7 - Reading History/Social Studies

Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

6-8.RST.3 - Reading Science/Technical

Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.

6-8.RST.4 - Reading Science/Technical

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.

6-8.RST.7 - Reading Science/Technical

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (in a flowchart, diagram, model, graph, or table).

New Design and Modeling (DM)

Lesson 1

Common Core State Standards for Mathematics

6.RP.3 - Ratios and Proportional Relationships

Use ratio and rate reasoning to solve real-world and mathematical problems, that is, by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

6.RP.3.b - Ratios and Proportional Relationships

Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?

6.RP.3.d - Ratios and Proportional Relationships

Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

6.NS.1 -The Number System

Interpret and compute quotients of fractions, and solve word problems involving division of fractions by fractions, e.g., by using visual fraction models and equations to represent the problem. For example, create a story context for $(\frac{2}{3}) \div (\frac{3}{4})$ and use a visual fraction model to show the quotient; use the relationship between multiplication and division to explain that $(\frac{2}{3}) \div (\frac{3}{4}) = \frac{8}{9}$ because $\frac{3}{4}$ of $\frac{8}{9}$ is $\frac{2}{3}$. (In general, $(\frac{a}{b}) \div (\frac{c}{d}) = \frac{ad}{bc}$.) How much chocolate will each person get if 3 people share $\frac{1}{2}$ lb of chocolate equally? How many $\frac{3}{4}$ -cup servings are in $\frac{2}{3}$ of a cup of yogurt? How wide is a rectangular strip of land with length $\frac{3}{4}$ mi and area $\frac{1}{2}$ square mi?

6.NS.2 -The Number System

Fluently divide multi-digit numbers using the standard algorithm.

6.NS.3 - The Number System

Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.

6.G.1 - Geometry

Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

PLTW Standards and Alignment

6.G.2 - Geometry

Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = l w h$ and $V = b h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

7.NS.3- The Number System

Solve real-world and mathematical problems involving the four operations with rational numbers.

7.G.2 - Geometry

Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

7.G.4 - Geometry

Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

7.G.6 - Geometry

Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

8.G.9 - Geometry

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

New Design and Modeling (DM)

Lesson 1

Next Generation Science Standards

NGSS.MS-ETS1-2 - Engineering Design

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

NGSS.P2 - Science and Engineering Practices

Developing and using models

NGSS.P3 - Science and Engineering Practices

Planning and carrying out investigations

NGSS.P5 - Science and Engineering Practices

Using mathematics and computational thinking

NGSS.P6 - Science and Engineering Practices

Constructing explanations (for science) and designing solutions (for engineering)

NGSS.P8 - Science and Engineering Practices

Obtaining, evaluating, and communicating information

New Design and Modeling(DM)

Lesson 1

Standards for Technological Literacy

1.9-12.L - Students will develop an understanding of the characteristics and scope of technology.

Inventions and innovations are the results of the specific, goal-directed research.

2.6-8.R - Students will develop an understanding of the core concepts of technology.

Requirements are the parameters placed on the development of a product or system.

2.9-12.Z - Students will develop an understanding of the core concepts of technology.

Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.

2.9-12.AA- Students will develop an understanding of the core concepts of technology.

Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.

2.9-12.EE - Students will develop an understanding of the core concepts of technology.

Management is the process of planning, organizing, and controlling work.

3.6-8.F - Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

4.6-8.D - Students will develop an understanding of the cultural, social, economic, and political effects of technology.

The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.

6.6-8.E - Students will develop an understanding of the role of society in the development and use of technology.

The use of inventions and innovations has led to changes in society and the creation of new needs and wants.

7.6-8-D - Students will develop an understanding of the influence of technology on history.

The specialization of function has been at the heart of many technological improvements.

PLTW Standards and Alignment

8.6-8 .E - Students will develop an understanding of the attributes of design.

Design is a creative planning process that leads to useful products and systems.

8.6-8.F- Students will develop an understanding of the attributes of design.

There is no perfect design.

8.6-8.G - Students will develop an understanding of the attributes of design.

Requirements for design are made up of criteria and constraints.

8.9-12.H - Students will develop an understanding of the attributes of design.

The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

9.6-8.F - Students will develop an understanding of engineering design.

Design involves a set of steps, which can be performed in different sequences and repeated as needed.

9.6-8.G - Students will develop an understanding of engineering design.

Brainstorming is a group problem-solving design process, in which each person in the group presents his or her ideas in an open forum.

9.9-12.J - Students will develop an understanding of engineering design.

Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

9.9-12 .K - Students will develop an understanding of engineering design.

A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

9.9-12.L- Students will develop an understanding of engineering design.

The process of engineering design takes into account a number of factors.

11.6-8.H - Students will develop the abilities to apply the design process.

Apply a design process to solve problems in and beyond the laboratory-classroom.

11.6 -8 .J - Students will develop the abilities to apply the design process.

Make two-dimensional and three-dimensional representations of the designed solution.

11.6- 8. K - Students will develop the abilities to apply the design process.

Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.

11.6-8.L - Students will develop the abilities to apply the design process.

Make a product or system and document the solution.

11.9-12.N - Students will develop the abilities to apply the design process.

Identify criteria and constraints and determine how these will affect the design process.

12.9-12.L - Students will develop the abilities to use and maintain technological products and systems.

Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

14.6-8.G - Students will develop an understanding of and be able to select and use medical technologies.

Advances and innovations in medical technologies are used to improve healthcare.

14.9-12.K - Students will develop an understanding of and be able to select and use medical technologies.

Medical technologies include prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, genetic engineering, and the systems within which health is protected and maintained.

17.6-8.J - Students will develop an understanding of and be able to select and use information and communication technologies.

The design of a message is influenced by such factors as intended audience, medium, purpose, and the nature of the message.

17.6-8.K- Students will develop an understanding of and be able to select and use information and communication technologies.

The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas.

17.9-12.Q - Students will develop an understanding of and be able to select and use information and communication technologies.

Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

New Design and Modeling(DM)

Lesson 2

Common Core State Standards for English Language Arts Anchor Standards

AS.R.1 - Reading

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

AS.R.4 - Reading

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

AS.SL.1 - Speaking and Listening

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

AS.SL.2 - Speaking and Listening

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

AS.L.4 - Language

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

AS.L.6 - Language

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

New Design and Modeling (DM)

Lesson 2

Common Core State Standards for English Language Arts 6-8 Literacy Standards for History/Social Studies, Science, and Technical Subjects

6-8.RH.7 - Reading History/Social Studies

Integrate visual information (in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

6-8.RST.3 - Reading Science/Technical

Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.

6-8.RST.4 - Reading Science/Technical

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.

6-8.RST.7 - Reading Science/Technical

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (in a flowchart, diagram, model, graph, or table).

New Design and Modeling (DM)

Lesson 2

Common Core State Standards for Mathematics

6.RP.3.d - Ratios and Proportional Relationships

Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

6.NS.6 - The Number System

Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates.

6.NS.6.a - The Number System

Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., $-(-3) = 3$, and that 0 is its own opposite.

6.NS.6.b - The Number System

Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.

6.NS.6.c - The Number System

Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane.

6.NS.8 - The Number System

Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate.

6.G.1 - Geometry

Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.

6.G.2 - Geometry

Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas $V = l w h$ and $V = b h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.

6.G.3 - Geometry

Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

6.G.4 - Geometry

Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

6.SP.1 - Statistics and Probability

Recognize a statistical question as one that anticipates variability in the data related to the question and accounts for it in the answers. For example, "How old am I?" is not a statistical question, but "How old are the students in my school?" is a statistical question, because one anticipates variability in students' ages.

6.SP.2 - Statistics and Probability

Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

6.SP.4 - Statistics and Probability

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.5 - Statistics and Probability

Summarize numerical data sets in relation to their context, such as by:

- a. Reporting the number of observations.
- b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
- c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
- d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

7.G.1 - Geometry

Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

7.G.2 - Geometry

Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

7.G.3 - Geometry

Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

7.G.4- Geometry

Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

7.G.6 - Geometry

Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

7.SP.8 - Statistics and Probability

Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation.

7.SP.8.b - Statistics and Probability

Represent sample spaces for compound events using methods, such as organized lists, tables and tree diagrams. For an event described in everyday language (for example, "rolling double sixes"), identify the outcomes in the sample space which compose the event.

8.G.1 - Geometry

Verify experimentally the properties of rotations, reflections, and translations:
a. Lines are taken to lines, and line segments to line segments of the same length.
b. Angles are taken to angles of the same measure.
c. Parallel lines are taken to parallel lines.

New Design and Modeling (DM)

Lesson 2

The Computer Science Teachers Association Standards

CSTA.3A.CL3 -Computer Science in the Modern World (MW)

Describe how computing enhances traditional forms and enables new forms of experience, expression, communication, and collaboration.

CSTA.3A.CPP 12 - Computer Science in the Modern World (MW)

Describe how mathematical and statistical functions, sets, and logic are used in computation.

New Design and Modeling (DM)

Lesson 2

Next Generation Science Standards

NGSS.MS-ETS1-1- Engineering Design

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.

NGSS.MS-ETS1-3 - Engineering Design

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.

NGSS.MS-ETS1-4 - Engineering Design

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.

NGSS.P2 - Science and Engineering Practices

Developing and using models

NGSS.P3 - Science and Engineering Practices

Planning and carrying out investigations

NGSS.P4- Science and Engineering Practices

Analyzing and interpreting data

NGSS.P5 - Science and Engineering Practices

Using mathematics and computational thinking

NGSS.P6 - Science and Engineering Practices

Constructing explanations (for science) and designing solutions (for engineering)

NGSS.P7- Science and Engineering Practices

Engaging in argument from evidence

NGSS.P8 - Science and Engineering Practices

Obtaining, evaluating, and communicating information

New Design and Modeling (DM)

Lesson 2

Standards for Technological Literacy

- 2.6-8.M - Students will develop an understanding of the core concepts of technology.
Technologies' systems include input, processes, output, and at times, feedback.
- 2.6-8.R - Students will develop an understanding of the core concepts of technology.
Requirements are the parameters placed on the development of a product or system.
- 2.6-8.T - Students will develop an understanding of the core concepts of technology.
Different technologies involve different sets of processes.
- 2.9-12.AA - Students will develop an understanding of the core concepts of technology.
Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.
- 7.6-8-C - Students will develop an understanding of the influence of technology on history.
Many inventions and innovations have evolved using slow and methodical processes of tests and refinements.
- 8.6-8.E - Students will develop an understanding of the attributes of design.
Design is a creative planning process that leads to useful products and systems.
- 8.6-8.F - Students will develop an understanding of the attributes of design.
There is no perfect design.
- 8.6-8.G - Students will develop an understanding of the attributes of design.
Requirements for design are made up of criteria and constraints.
- 8.9-12.H - Students will develop an understanding of the attributes of design.
The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

9.6-8.G - Students will develop an understanding of engineering design.

Brainstorming is a group problem-solving design process, in which each person in the group presents his or her ideas in an open forum.

9.6-8.H - Students will develop an understanding of engineering design.

Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

9.9-12.I - Students will develop an understanding of engineering design.

Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

9.9-12.J - Students will develop an understanding of engineering design.

Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

9.9-12.K - Students will develop an understanding of engineering design.

A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

9.9-12.L - Students will develop an understanding of engineering design.

The process of engineering design takes into account a number of factors.

11.6-8.J - Students will develop the abilities to apply the design process.

Make two-dimensional and three-dimensional representations of the designed solution.

11.6-8.K - Students will develop the abilities to apply the design process.

Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.

11.6-8.L - Students will develop the abilities to apply the design process.

Make a product or system and document the solution.

11.9-12.N - Students will develop the abilities to apply the design process.

Identify criteria and constraints and determine how these will affect the design process.

11.9-12.O - Students will develop the abilities to apply the design process.

Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

11.9-12.P - Students will develop the abilities to apply the design process.

Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process to check for proper design and to note areas where improvements are needed.

11.9-12.Q - Students will develop the abilities to apply the design process.

Develop and produce a product or system using a design process.

11.9-12.R - Students will develop the abilities to apply the design process.

Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

12.6-8.H - Students will develop the abilities to use and maintain technological products and systems.

Use information provided in manuals, protocols, or by experienced people to see and understand how things work.

12.6-8.J - Students will develop the abilities to use and maintain technological products and systems.

Use computers and calculators in various applications.

12.9-12.L - Students will develop the abilities to use and maintain technological products and systems.

Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

12.9-12.P - Students will develop the abilities to use and maintain technological products and systems.

Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.

13.6-8.G - Students will develop the abilities to assess the impact of products and systems.

Use data collected to analyze and interpret trends to identify the positive and negative effects of a technology.

13.6-8.I - Students will develop the abilities to assess the impact of products and systems.

Interpret and evaluate the accuracy of the information obtained and determine if it is useful.

13.9-12.J - Students will develop the abilities to assess the impact of products and systems.

Collect information and evaluate its quality.

13.9-12.K - Students will develop the abilities to assess the impact of products and systems.

Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.

17.6-8.J - Students will develop an understanding of and be able to select and use information and communication technologies.

The design of a message is influenced by such factors as intended audience, medium, purpose, and the nature of the message.

17.6-8.K- Students will develop an understanding of and be able to select and use information and communication technologies.

The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas.

17.9-12.Q - Students will develop an understanding of and be able to select and use information and communication technologies.

Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

New Design and Modeling (DM)

Lesson 3

Common Core State Standards for English Language Arts 7th Grade

7.W.2.a - Writing

Introduce a topic clearly, previewing what is to follow; organize ideas, concepts, and information, using strategies such as definition, classification, comparison/contrast, and cause/effect; include formatting (e.g., headings), graphics (e.g., charts, tables), and multimedia when useful to aiding comprehension.

7.W.2.d - Writing

Use precise language and domain-specific vocabulary to inform about or explain the topic.

7.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, relevant descriptive details, and well-structured event sequences.

7.W.10 - Writing

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

7.SL.1.b - Speaking and Listening

Follow rules for collegial discussions, track progress toward specific goals and deadlines, and define individual roles as needed.

7.SL.1.c - Speaking and Listening

Pose questions that elicit elaboration and respond to others' questions and comments with relevant observations and ideas that bring the discussion back on topic as needed.

7.SL.1.d - Speaking and Listening

Acknowledge new information expressed by others and, when warranted, modify their own views.

7.SL.2 - Speaking and Listening

Analyze the main ideas and supporting details presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how the ideas clarify a topic, text, or issue under study.

7.SL.4 - Speaking and Listening

Present claims and findings, emphasizing salient points in a focused, coherent manner with pertinent descriptions, facts, details, and examples; use appropriate eye contact, adequate volume, and clear pronunciation.

New Design and Modeling (DM)

Lesson 3

Common Core State Standards for English Language Arts Anchor Standards

AS.R.1 - Reading

Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

AS.R.4 - Reading

Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

AS.R.7 - Reading

Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

AS.W.3 - Writing

Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

AS.W.4 - Writing

Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

AS.W.6 - Writing

Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

AS.SL.1 - Speaking and Listening

Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

AS.SL.2 - Speaking and Listening

Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

AS.SL.4 - Speaking and Listening

Present information, findings, and supporting evidence such that listeners can follow the line of reasoning, and the organization, development, and style are appropriate to task, purpose, and audience.

AS.SL.5 - Speaking and Listening

Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

AS.L.4 - Language

Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

AS.L.6 - Language

Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

New Design and Modeling (DM)

Lesson 3

Common Core State Standards for English Language Arts 6-8 Literacy Standards for History/Social Studies, Science, and Technical Subjects

6-8.RH.7 - Reading History/Social Studies

Integrate visual information (in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

6-8.RST.3 - Reading Science/Technical

Follow precisely a multi-step procedure when carrying out experiments, taking measurements, or performing technical tasks.

6-8.RST.4 - Reading Science/Technical

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.

6-8.RST.7- Reading Science/Technical

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (in a flowchart, diagram, model, graph, or table).

6-8.RST.9 - Reading Science/Technical

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

New Design and Modeling (DM)

Lesson 3

Common Core State Standards for Mathematics

6.RP.3.d- Ratios and Proportional Relationships

Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

6.NS.2 - The Number System

Fluently divide multi-digit numbers using the standard algorithm.

6.NS.3 -The Number System

Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation.

6.G.3 - Geometry

Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems.

6.SP.4 - Statistics and Probability

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.SP.5 - Statistics and Probability

Summarize numerical data sets in relation to their context, such as by:

- a. Reporting the number of observations.
- b. Describing the nature of the attribute under investigation, including how it was measured and its units of measurement.
- c. Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.
- d. Relating the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered.

7. NS.3 - The Number System

Solve real-world and mathematical problems involving the four operations with rational numbers.

7.G.2 - Geometry

Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle.

7.G.3- Geometry

Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids.

7.G.6 - Geometry

Solve real-world and mathematical problems involving area, volume, and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.

8.G.1- Geometry

Verify experimentally the properties of rotations, reflections, and translations:

- Lines are taken to lines, and line segments to line segments of the same length.
- Angles are taken to angles of the same measure.
- Parallel lines are taken to parallel lines.

8.G.9 - Geometry

Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

New Design and Modeling (DM)

Lesson 3

The Computer Science Teachers Association Standards

CSTA.3A.CL3 - Computer Science in the Modern World (MW)

Describe how computing enhances traditional forms and enables new forms of experience, expression, communication, and collaboration.

CSTA.3A.CPP 10 - Computer Science in the Modern World (MW)

Explore a variety of careers to which computing is central.

CSTA.3A.CPP 12 - Computer Science in the Modern World (MW)

Describe how mathematical and statistical functions, sets, and logic are used in computation.

CSTA.3A.CT 8 - Computer Science in the Modern World (MW)

Use modeling and simulation to represent and understand natural phenomena.

New Design and Modeling (DM)

Lesson 3

Next Generation Science Standards

NGSS.MS-ETS1-1- Engineering Design

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.

NGSS.MS-ETS1-2 - Engineering Design

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

NGSS.MS-ETS1-3 - Engineering Design

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.

NGSS.MS-ETS1-4- Engineering Design

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.

NGSS.P1 - Science and Engineering Practices

Asking questions (for science) and defining problems (for engineering)

NGSS.P2 - Science and Engineering Practices

Developing and using models

NGSS.P3 - Science and Engineering Practices

Planning and carrying out investigations

NGSS.P4 - Science and Engineering Practices

Analyzing and interpreting data

NGSS.P5 - Science and Engineering Practices

Using mathematics and computational thinking

NGSS.P6 - Science and Engineering Practices

Constructing explanations (for science) and designing solutions (for engineering)

NGSS.P7- Science and Engineering Practices

Engaging in argument from evidence

NGSS.P8 - Science and Engineering Practices

Obtaining, evaluating, and communicating information

New Design and Modeling (DM)

Lesson 3

Standards for Technological Literacy

1.9-12.L - Students will develop an understanding of the characteristics and scope of technology.

Inventions and innovations are the results of the specific, goal-directed research.

2.6-8.M - Students will develop an understanding of the core concepts of technology.

Technologies' systems include input, processes, output, and at times, feedback.

2.6-8.N - Students will develop an understanding of the core concepts of technology.

Systems thinking involves considering how every part relates to others.

2.6-8.R - Students will develop an understanding of the core concepts of technology.

Requirements are the parameters placed on the development of a product or system.

2.9-12.Z - Students will develop an understanding of the core concepts of technology.

Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.

2.9-12.AA - Students will develop an understanding of the core concepts of technology.

Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.

2.9-12.EE - Students will develop an understanding of the core concepts of technology.

Management is the process of planning, organizing, and controlling work.

3.6-8.F - Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.

4.6-8.D - Students will develop an understanding of the cultural, social, economic, and political effects of technology.

The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.

4.6-8.F - Students will develop an understanding of the cultural, social, economic and political effects of technology.

The development and use of technology poses ethical issues.

4.9-12.J - Students will develop an understanding of the cultural, social, economic, and political effects of technology.

Ethical considerations are important in the development, selection, and use of technologies.

6.6-8.E - Students will develop an understanding of the role of society in the development and use of technology.

The use of inventions and innovations has led to changes in society and the creation of new needs and wants.

8.6-8.E - Students will develop an understanding of the attributes of design.

Design is a creative planning process that leads to useful products and systems.

8.6-8.F - Students will develop an understanding of the attributes of design.

There is no perfect design.

8.6-8.G - Students will develop an understanding of the attributes of design.

Requirements for design are made up of criteria and constraints.

8.9-12.H - Students will develop an understanding of the attributes of design.

The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating processes and results.

8.9-12.I - Students will develop an understanding of the attributes of design.

Design problems are seldom presented in a clearly defined form.

8.9-12.J - Students will develop an understanding of the attributes of design.

The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.

9.6-8.F - Students will develop an understanding of engineering design.

Design involves a set of steps, which can be performed in different sequences and repeated as needed.

9.6-8.G - Students will develop an understanding of engineering design.

Brainstorming is a group problem-solving design process, in which each person in the group presents his or her ideas in an open forum.

9.6-8.H - Students will develop an understanding of engineering design.

Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.

9.9-12.I - Students will develop an understanding of engineering design.

Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.

9.9-12.J - Students will develop an understanding of engineering design.

Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

9.9-12.K- Students will develop an understanding of engineering design.

A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

9.9-12.L- Students will develop an understanding of engineering design.

The process of engineering design takes into account a number of factors.

10.9-12.L - Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

Many technological problems require a multidisciplinary approach.

11.6-8.H - Students will develop the abilities to apply the design process.

Apply a design process to solve problems in and beyond the laboratory-classroom.

11.6-8.I - Students will develop the abilities to apply the design process.

Specify criteria and constraints for the design.

11.6-8.J - Students will develop the abilities to apply the design process.

Make two-dimensional and three-dimensional representations of the designed solution.

11.6-8.K- Students will develop the abilities to apply the design process.

Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.

11.6-8.L - Students will develop the abilities to apply the design process.

Make a product or system and document the solution.

11.9-12.M - Students will develop the abilities to apply the design process.

Identify the design problem to solve and decide whether or not to address it.

11.9-12.N - Students will develop the abilities to apply the design process.

Identify criteria and constraints and determine how these will affect the design process.

11.9-12.O - Students will develop the abilities to apply the design process.

Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

11.9-12.P - Students will develop the abilities to apply the design process.

Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design process to check for proper design and to note areas where improvements are needed.

11.9-12.Q - Students will develop the abilities to apply the design process.

Develop and produce a product or system using a design process.

11.9-12.R - Students will develop the abilities to apply the design process.

Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.

12.6-8.H - Students will develop the abilities to use and maintain technological products and systems.

Use information provided in manuals, protocols, or by experienced people to see and understand how things work

12.6-8.J - Students will develop the abilities to use and maintain technological products and systems.

Use computers and calculators in various applications.

12.9-12.L - Students will develop the abilities to use and maintain technological products and systems.

Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

12.9-12.P - Students will develop the abilities to use and maintain technological products and systems.

Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.

13.6-8.G - Students will develop the abilities to assess the impact of products and systems.

Use data collected to analyze and interpret trends to identify the positive and negative effects of a technology.

13.6-8.I - Students will develop the abilities to assess the impact of products and systems.

Interpret and evaluate the accuracy of the information obtained and determine if it is useful.

13.9-12.J - Students will develop the abilities to assess the impact of products and systems.

Collect information and evaluate its quality.

13.9-12.K - Students will develop the abilities to assess the impact of products and systems.

Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.

14.6-8.G - Students will develop an understanding of and be able to select and use medical technologies.

Advances and innovations in medical technologies are used to improve healthcare.

17.6-8.J - Students will develop an understanding of and be able to select and use information and communication technologies.

The design of a message is influenced by such factors as intended audience, medium, purpose, and the nature of the message.

17.6-8.K- Students will develop an understanding of and be able to select and use information and communication technologies.

The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas.

17.9-12.Q - Students will develop an understanding of and be able to select and use information and communication technologies.

Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.