Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

In a modern and innovative society, where advancements are plentiful and communication is instantaneous, science and technology are a part of everyday life.
-Julie Payette

STEM Department
Melissa Strype, Supervisor

Curriculum Committee
Ralph Scimeca
Derek Skoldberg

Curriculum Developed:
July 2021

Date of Board Approval:
September 21, 2021

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Table of Contents

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Mission Statement

We commit to inspiring and empowering all students in Randolph schools to reach their full potential as unique, responsible and educated members of a global society.

Affirmative Action Statement
Equality and Equity in Curriculum

The Randolph Township School district ensures that the district's curriculum and instruction are aligned to the state's standards. The curriculum provides equity in instruction, educational programs and provides all students the opportunity to interact positively with others regardless of race, creed, color, national origin, ancestry, age, marital status, affectional or sexual orientation, gender, religion, disability or socioeconomic status.

N.J.A.C. 6A:7-1.7(b): Section 504, Rehabilitation Act of 1973; N.J.S.A. 10:5; Title IX, Education Amendments of 1972

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

EDUCATIONAL GOALS
VALUES IN EDUCATION

The statements represent the beliefs and values regarding our educational system. Education is the key to self-actualization, which is realized through achievement and self-respect. We believe our entire system must not only represent these values, but also demonstrate them in all that we do as a school system.

We believe:

- The needs of the child come first
- Mutual respect and trust are the cornerstones of a learning community
- The learning community consists of students, educators, parents, administrators, educational support personnel, the community and Board of Education members
- A successful learning community communicates honestly and openly in a non-threatening environment
- Members of our learning community have different needs at different times. There is openness to the challenge of meeting those needs in professional and supportive ways
- Assessment of professionals (i.e., educators, administrators and educational support personnel) is a dynamic process that requires review and revision based on evolving research, practices and experiences
- Development of desired capabilities comes in stages and is achieved through hard work, reflection and ongoing growth

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Introduction

Science and Technology is a marking period course offered to 8th grade students interested in science, technology, and engineering. The study of these disciplines focuses on a deep understanding of experimental and engineering design, and real-world problem solving. Students will focus on experimental design by developing scientific questions, gathering evidence, and supporting a claim. Students will then be prompted with a sustainable design problem and construct experiments and prototypes to find the most optimal solution. Extending further, students will have an opportunity to redesign their solutions and reflect on the processes that are used to solve global and local problems. This course will be guided by the current New Jersey Learning Standards in Computer Science and Design Thinking, Learning Standards in Career Readiness, Life Literacies, and Key Skills, Mathematics, and Science.

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Curriculum Pacing Chart

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
2 weeks	**I**	**Experimental Design**
5 weeks	**II**	**Engineering Design Applications**
2 weeks	**III**	**Optimizing the Design Solution**

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit I: Experimental Design

<table>
<tr><td colspan="3">TRANSFER: Students will be able to mobilize the engineering design process and domain knowledge to create an original model given limitations and constraints.</td></tr>
<tr><td rowspan="6">STANDARDS / GOALS:

NJ 2020 SLS: Computer Science and Design Thinking
8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.

8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>Scientists plan and carry out investigations to answer questions about the natural world.</td><td>• How can an investigation be designed to better understand a natural phenomenon?</td></tr>
<tr><td>Using procedural methods when solving a problem can promote reliability and scientific significance.</td><td>• How can you solve a problem?</td></tr>
<tr><td>Scientific inquiry begins by asking questions and defining problems.</td><td>• What constitutes a good question?</td></tr>
<tr><td><u>KNOWLEDGE</u>
Students will know:</td><td><u>SKILLS</u>
Students will be able to:</td></tr>
<tr><td>Science assumes that objects and events in natural systems occur in consistent patterns that are understandable through measurement and observation.</td><td>Collect and organize data from an experiment using trials and methods.

Compose scientific questions after observing natural phenomenon.</td></tr>
</table>

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit I: Experimental Design

NJ 2020 SLS: Science 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 2016 SLS: Literacy in History, Social Studies, & Technical Subjects** RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. RST.6-8.4: 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.	An independent variable is a single planned change from the control group and the experimental group. Scientists frame a hypothesis based on observations and scientific principles. Experiments should be conducted numerous times to validate results. Science knowledge is based upon logical and conceptual connections between evidence and explanations.	Identify the independent variable to be tested in an experiment. Construct a hypothesis based on observing a natural phenomenon and past experiences. Evaluate the distance traveled in various trials. Justify the number of trials used in experiments. Apply scientific evidence to explain the results of an experiment. Construct a rationale using claim, evidence, and reasoning for an investigation.
NJ 2020 SLS: Science – Crosscutting Concepts 6-8 • Cause and effect • Structure and function • Patterns	**VOCABULARY:** design, procedures, brainstorming, developing, building, testing, reflection, patterns, variable, gravity, distance, independent variable, dependent variable, observation, trials, evidence.	

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit I: Experimental Design

NJ 2020 SLS: Science - Science and Engineering Practices 6 – 8 • Asking questions and defining problems • Developing and using models • Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations and designing solutions • Engaging in Argument from Evidence **NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8** ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions **NJ 2016 SLS: Mathematical Practices** MP1: Make sense of problems and persevere in solving them. MP3: Construct viable arguments and critique the reasoning of others. MP5: Use appropriate tools strategically.	**KEY TERMS:** Aerodynamics**,** wing, fuselage, nose, fin, lift, thrust, drag, control group, experimental group, hypothesis	

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit I: Experimental Design

ASSESSMENT EVIDENCE: Students will show their learning by:

- Reflecting on past and present learning through prompts in a OneNote journal
- Designing and carrying out scientific experiments
- Writing scientific explanations using claim evidence and reason

KEY LEARNING EVENTS AND INSTRUCTION:

- Students will investigate a natural phenomenon using experimental design
- Students will test hypotheses using control and experimental groups
- Students will use results to defend a scientific claim

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit I: Experimental Design

SUGGESTED TIME ALLOTMENT	**2 weeks**
SUPPLEMENTAL UNIT RESOURCES	Required Supplies/Activities/Software: Computer with an internet connection Microsoft OneNote Suggested Supplies/Activities/Software: https://ny.pbslearningmedia.org/resource/hs11.global.ancient.earl.lpexperwith/experimenting-with-experiments/ "Experimenting with Experiments" Design an Experiment: Paper Airplanes

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit II: Engineering Design Applications

TRANSFER: Students will be able to mobilize the engineering design process and domain knowledge to create an original model given limitations and constraints.

STANDARDS / GOALS:	**ENDURING UNDERSTANDINGS**	**ESSENTIAL QUESTIONS**
NJ 2020 SLS: Computer Science and Design Thinking 8.1.8.AP.2: Create clearly named variables that represent different data types and perform operations on their values. 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. 8.2.8.ED.3: Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch) 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches)	Scientific discoveries lead to further technological advances which in turn can allow us to study new areas.	• How can the relationship between science and technology change as society develops?
	Project constraints and specifications can limit the ability to successfully solve a problem, however it can encourage innovation.	• How can you be more innovative?
	KNOWLEDGE **Students will know:**	**SKILLS** **Students will be able to:**
	Engineering advances and scientific discoveries have led to the development of entire industries and engineered systems.	Identify the connection between science and technology. Predict the outcome of an advancement in either science or technology.
	The engineering design process is a series of steps that engineers follow to come up with the best solutions to a problem.	Identify the different steps of the engineering design process.

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit II: Engineering Design Applications

8.2.8.ITH.3: Evaluate the impact of sustainability on the development of a designed product or systems. **NJ 2020 SLS: Science** MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. 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. **NJ 2016 SLS: Literacy in History, Social Studies, & Technical Subjects** RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments,	Requirements for a design are made up of the criteria for success and the constraints. The burning of fossil fuels has increased CO^2 levels to record highs, but renewable energies and energy efficient designs can help mitigate CO^2 gas production.	Apply the engineering design process to the problem of sustainable design of technologies. Appraise the steps taken throughout the engineering design process judging which is most important and why. Identify the criteria and constraints of sustainable design of technologies while considering scientific principles such as fuel efficiency. Justify sustainable technology design decisions based on criteria and constraints. Identify how greenhouse gases affect the environment. Design useful technology such as air transportation that utilizes optimal design to be more sustainable.

Unit II: Engineering Design Applications

taking measurements, or performing technical tasks. RST.6-8.4: 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. **NJ 2020 SLS: Science – Crosscutting Concepts 6-8** • Cause and effect • Structure and function • Patterns **NJ 2020 SLS: Science - Science and Engineering Practices 6 – 8** • Asking questions and defining problems • Planning and carrying out investigations • Analyzing and interpreting data • Constructing explanations and designing solutions	Renewable energy does not consume earth's finite resources. Solar energy uses PV cells (Photo Voltaic) to effectively turn sunlight into energy. Engineers brainstorm multiple solution ideas for a problem before beginning their designs. During the planning step, engineers can avoid mistakes by researching past solutions and selecting the most promising solution.	Identify the positive effects of renewable energy. Design an experiment to test the effectiveness of a PV cell or PV cell technology. Describe the brainstorming process and why it is important to have multiple solution ideas. Construct multiple sustainable technology solution ideas and judge them based on the criteria and constraints of the problem. Analyze information of possible solutions from reliable sources. Select the best possible sustainable technology solution based on information and preliminary evaluation.

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit II: Engineering Design Applications

<table>
<tr><td rowspan="2">NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8
ETS1.A: Defining and Delimiting Engineering Problems
ETS1.B: Developing Possible Solutions

NJ 2016 SLS: Mathematical Practices
MP1: Make sense of problems and persevere in solving them.
MP2: Reason abstractly and quantitatively.
MP3: Construct viable arguments and critique the reasoning of others.
MP5: Use appropriate tools strategically.</td><td></td><td>Develop and use a scientific model to describe a natural phenomenon such as flight.</td></tr>
<tr><td>VOCABULARY: criteria, constraints, science, technology, engineering design process, drag, gravity, lift, thrust, brainstorm, model

KEY TERMS: greenhouse gas, sustainability, Photo Voltaic, renewable energy</td><td></td></tr>
<tr><td colspan="3">ASSESSMENT EVIDENCE: Students will show their learning by:
Reflecting on present and past learning through prompts in a OneNote journal
Constructing a sustainable solution using the engineering design process
Constructing a scientific model
KEY LEARNING EVENTS AND INSTRUCTION:
Students will explore different sustainable solutions and propose solutions
Students will research and plan effective designs for a problem
Students will build and test possible solutions while collecting data</td></tr>
</table>

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit II: Engineering Design Applications

SUGGESTED TIME ALLOTMENT	**5 weeks**
SUPPLEMENTAL UNIT RESOURCES	Required Supplies/Activities/Software: Computer with an internet connection Microsoft OneNote Suggested Supplies/Activities/Software: https://youtu.be/xI1_aSvkNMM "How to Make a Hoop Glider" https://www.youtube.com/watch?v=m9ntqxh8FvQ Compressed Air-Rockets https://phet.colorado.edu/sims/html/circuit-construction-kit-dc-virtual-lab/latest/circuit-construction-kit-dc-virtual-lab_en.html "Circuit Construction Kit: CS – Virtual Lab"

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

TRANSFER: Students will be able to mobilize the engineering design process and domain knowledge to create an original model given limitations and constraints.

STANDARDS / GOALS:	**ENDURING UNDERSTANDINGS**	**ESSENTIAL QUESTIONS**
NJ 2020 SLS: Computer Science and Design Thinking 8.1.8.CS.3: Justify design decisions and explain potential system trade-offs.	The engineering design process allows engineers to move from finding "a" solution to finding "the best" solution to a problem.	• How can engineers improve existing designs? • What makes a solution the best one?
8.1.8.AP.6: Refine a solution that meets users' needs by incorporating feedback from team members and users	**KNOWLEDGE** **Students will know:**	**SKILLS** **Students will be able to:**
8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. 8.2.8.ED.4: Investigate a malfunctioning system, identify its impact, and explain the step-by-step process used to troubleshoot, evaluate, and test options to repair the product in a collaborative team.	Sustainable technologies allow humans to reduce the impact on the planet. Identifying the characteristics of the best performing design can provide useful information for the redesign process.	Identify sustainable technologies that could be improved through iteration and design. Explain the trade-offs associated with using different sustainable technologies. Identify the key components of a product or technology that has gone through a redesign process.

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

8.2.8.ED.5: Explain the need for optimization in a design process. 8.2.8.ED.6: Analyze how trade-offs can impact the design of a product. 8.2.8.ED.7: Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches) 8.2.8.ITH.1: Explain how the development and use of technology influences economic, political, social, and cultural issues. 8.2.8.ITH.3: Evaluate the impact of sustainability on the development of a designed product or systems. 8.2.8.ITH.4: Identify technologies that have been designed to reduce the negative consequences of other technologies and explain the change in impact.	Prototypes are preliminary models of a solution that are quickly made and tested to gather information about the design. Communicating design results is a vital step in the engineering design process.	Evaluate multiple tested solutions to create a plan for a prototype based upon experimental results. Describe the difference between a final product and a prototype. Develop a prototype for testing and redesign based on experimental data and past designs. Appraise the design of a prototype using test data to make improvements. Arrange design and results to display in a digital media. Present design ideas and results to a group of peers and scientists across the globe. Evaluate decisions made in the design process and reflect on modifications or improvements.

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills 9.4.8.TL.3: Select appropriate tools to organize and present information digitally. **NJ 2020 SLS: Science** MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused climate change over the past century. 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.	**VOCABULARY:** Sustainable technologies, trade-offs, resources, experimental data, design process **KEY TERMS:** prototype, redesign, iteration	

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

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 2016 SLS: Literacy in History, Social Studies, & Technical Subjects** RST.6-8.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. RST.6-8.4: 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. **NJ 2020 SLS: Science – Crosscutting Concepts 6-8** • Cause and effect • Structure and function • Patterns **NJ 2020 SLS: Science - Science and Engineering Practices 6 – 8** • Analyzing and interpreting data	

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

• Constructing explanations and designing solutions • Engaging in Argument from Evidence • Obtaining, Evaluating, and Communicating Information **NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8** ETS1.B: Developing Possible Solutions **NJ 2016 SLS: Mathematical Practices** MP1: Make sense of problems and persevere in solving them. MP2: Reason abstractly and quantitatively. MP3: Construct viable arguments and critique the reasoning of others. MP5: Use appropriate tools strategically.	

ASSESSMENT EVIDENCE: Students will show their learning by:

- Reflecting on present and past learning through prompts in a OneNote journal
- Building and testing sustainable technology prototypes
- Evaluating results and design to reflect on process and improvements

KEY LEARNING EVENTS AND INSTRUCTION:

- Students will evaluate sustainable technologies and trade-offs associated
- Students will build and test prototypes for a sustainable technology
- Students will share and evaluate designs and results of prototypes

Randolph Township Schools
Randolph Middle School
Science and Technology Curriculum

Unit III: Optimizing the Design Solution

SUGGESTED TIME ALLOTMENT	**5 weeks**
SUPPLEMENTAL UNIT RESOURCES	Required Supplies/Activities/Software: Computer with an internet connection Microsoft OneNote Suggested Supplies/Activities/Software: https://www.teachengineering.org/activities/view/cub_creative_activity6 "Design Step 7: Improve and Redesign"