Randolph Township Schools
Randolph Middle School
Exploring Computer Science Curriculum

"Coding is today's language of creativity."
Maria Klave

STEM Department
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Curriculum Developed:
July 2020

Date of Board Approval:
August 18, 2020

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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

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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

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Introduction

This marking period course is offered to seventh and eighth grade students who have an interest in exploring the possibilities of programming computational devices. Throughout Exploring Computer Science, students will dive into understanding computer science concepts and computational thinking, such as abstraction and input-output through text-based coding in Python. To begin, students will construct programs in Python to create and modify variables, manipulate datatypes, and construct algorithms to obtain a desired output. While learning the fundamentals, students will engage in the problem-solving process to create, develop, and apply solutions to real-world problems. Through programming physical devices such as microcontrollers and drones, along with utilizing the greenhouse and other technologies, students will be able to see their code affect the physical world and explore ideas of changing the world with computer programming. By the end of this course, students will gain valuable skills in computational thinking and problem-solving that they can use in high school programming courses and beyond. This course will be guided by the current New Jersey Learning Standards in Computer Science and Design Thinking, Career Readiness, Life Literacies, and Key Skills Science, Mathematics, and English.

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Curriculum Pacing Chart

SUGGESTED TIME ALLOTMENT	UNIT NUMBER	CONTENT - UNIT OF STUDY
4 weeks	**I**	**Computational Problem Solving**
3 weeks	**II**	**Exploring Solutions**
2 weeks	**III**	**Constructing Solutions**

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Unit I: Computational Problem Solving

<table>
<tr><td colspan="3">TRANSFER: Students will be able to independently engage in the problem-solving process to integrate technical knowledge, skills, and understanding in order to develop real-world solutions.</td></tr>
<tr><td rowspan="5">STANDARDS / GOALS:

NJ 2020 SLS: Computer Science and Design Thinking
8.1.8.IC.2: Describe issues of bias and accessibility in the design of existing technologies.

8.1.8.DA.4: Transform data to remove errors and improve the accuracy of the data for analysis.

8.1.8.DA.5: Test, analyze, and refine computational models.

8.1.8.AP.1: Design and illustrate algorithms that solve complex problems using flowcharts and/or pseudocode.

8.1.8.AP.2: Create clearly named variables that represent different data types and perform operations on their values.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>Computer programmers follow a problem-solving process to identify and solve complex problems.</td><td>• Why is it important to have a method when creating or solving a problem?

• How does a computer programmer identify and solve problems?</td></tr>
<tr><td><u>KNOWLEDGE</u>
Students will know:</td><td><u>SKILLS</u>
Students will be able to:</td></tr>
<tr><td>The problem-solving process is a series of steps that computer programmers follow to construct the best solution to a problem.</td><td>Identify the different steps of the problem-solving process.

Evaluate the steps of the problem-solving process and why they are important.</td></tr>
<tr><td>A computer is an electronic device designed to store and process information to perform tasks that have an input and output.</td><td>Identify and compare the different components of a computer along with the function of the parts.</td></tr>
</table>

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Unit I: Computational Problem Solving

8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals. 8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs. 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse. 8.1.8.AP.9: Document programs in order to make them easier to follow, test, and debug. 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. **NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills** 9.4.8.CI.2: Repurpose an existing resource in an innovative way. 9.4.8.TL.3: Select appropriate tools to organize and present information digitally.	A program is a set of instructions meant to be carried out by a computer that is written in a programming language that a computer can understand. Debugging is the process of finding and fixing errors in a computer program and an essential step in the problem-solving process. An algorithm is a set of steps or instructions for completing a task.	Judge an electrical system and evaluate whether it would be classified as a computer. Define programs that are used in your lives and identify problems they solved. Model the sequence of steps in a program. Judge a program based on its function and performance. Identify where debugging fits into the problem-solving process. Apply the debugging process to a project. Judge the frequency and scope of debugging in a project. List the steps in an example as an algorithm.

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Unit I: Computational Problem Solving

NJ 2020 SLS: Science MS-ETS1-4: Develop a model to generate data for iterative 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.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **NJ 2020 SLS: Science – Crosscutting Concepts 6-8** • Patterns **NJ 2020 SLS: Science – Science and Engineering Practices 6-8** • Asking questions and defining problems • Developing and using models • Analyzing and interpreting data	Comments are text in a program that give information about the code but do not run or affect the program. Parameters consist of an integer, string, or variable that controls how a command is run. A variable is a digital container that lets you store a value to use later. The variable name is a label used to relate a variable to its function.	Evaluate an algorithm based on its function and results. Describe when to use comments and their function. Judge the comprehension of a set of code with and without comments. Name different parameters used in programming. Develop a program with the use of parameters. Predict parameters used in different fields of computer programming. Identify a variable in a set of code.

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Unit I: Computational Problem Solving

• Using mathematical and computational thinking • Constructing explanations and designing solutions **NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8** ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution **NJ 2016 SLS: Mathematical Practices** MP5: Use appropriate tools strategically. MP7: Look for and make use of structure.	A conditional is a statement that causes a program to take a different action based on whether the input meets a certain condition or criteria. Loops are blocks of code that will run more than once.	Compose a variable name that is correctly formatted and relates to the function. Appraise a set of code and identify where/if a variable can be used to improve a program. Locate different conditional statements in a set of code. Illustrate a conditional statement based on a real-life example. Design a program that uses conditional statements to change the outcome. Define a loop. Give an example of where a loop could be used to improve a program. Design a program that uses loops to run sections more than once.

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Unit I: Computational Problem Solving

	Data types are values with different characteristics such as strings and integers.	Define a string and integer. Match different values to their data type. Compare the uses of each data type while predicting situations where one would be better suited than the other.
	The coordinate plane is a flat area defined by an x-axis that runs horizontally (side to side) and a y-axis that runs vertically (up and down.	Recognize the position of a sprite based on its y and x position. Compose a program that utilizes horizontal and vertical movement across the coordinate plane.
	VOCABULARY: problem-solving, function, evaluate, computer, process, variable, parameters, testing, reflection, criteria, analyze, coordinate plane	

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Unit I: Computational Problem Solving

	KEY TERMS: debugging, algorithm, hardware, software, program, conditional, if statements, else statements	

ASSESSMENT EVIDENCE: Students will show their learning by:

- Answering reflection, knowledge, and skill-based questions on the problem-solving process and programming concepts
- Constructing illustrations to describe programming concepts and logic using graphics and flow charts
- Constructing computer programs that use previous and new programming concepts and skills
- Testing computer program designs by debugging and redesigning
- Presenting self-created programming projects to the class while explaining design and problem-solving steps

KEY LEARNING EVENTS AND INSTRUCTION:

- Daily programming design journal reflections
- Self-guided computer programming online modules
- Design a program that will output information to a user
- Design a program that uses an input
- Build a program that uses a variable to store and display a value
- Construct a program that has different outputs based on conditions
- Create a program that runs a line of code more than once
- Create a program that incorporates changing the data type of a variable
- Build a program that give the user an output

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Unit I: Computational Problem Solving

SUGGESTED TIME ALLOTMENT	**4 weeks**
SUPPLEMENTAL UNIT RESOURCES	<u>Required Supplies/Activities/Software:</u> Computers Edhesive Exploration in Coding Links to resources <u>Suggested Supplies/Activities/Software:</u> Edhesive "Module 1: Introduction to Computer Science" Edhesive "Module 2: Coding in Digital Space" Edhesive "Module 3: Shapes and Drawing" Edhesive "Module 4: Intro to Logic" Edhesive "Module 5: Putting Things in Order" Edhesive "Module 6: Exploring Variables - Part 1" Edhesive "Module 7: Exploring Variables - Part 2" Edhesive "Module 8: Math and Computation" Edhesive "Module 9: Cumulative Review"

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Unit II: Exploring Solutions

TRANSFER: Students will be able to independently engage in the problem-solving process to integrate technical knowledge, skills, and understanding to develop real-world solutions.		
STANDARDS / GOALS:	**ENDURING UNDERSTANDINGS**	**ESSENTIAL QUESTIONS**
NJ 2020 SLS: Computer Science and Design Thinking 8.1.8.DA.1: Organize and transform data collected using computational tools to make it usable for a specific purpose. 8.1.8.DA.4: Transform data to remove errors and improve the accuracy of the data for analysis. 8.1.8.DA.5: Test, analyze, and refine computational models. 8.1.8.AP.1: Design and illustrate algorithms that solve complex problems using flowcharts and/or pseudocode. 8.1.8.AP.2: Create clearly named variables that represent different data types and perform operations on their values.	Identifying a problem by asking questions and exploring solutions are vital steps in the problem-solving process.	• How do different problems compare to each other?
	Computational devices and innovative programs can be used to solve complex real-world problems that impact and change the world around us.	• What problems can be solved or mitigated with the use of a computation device and innovative programs? • How can computational devices be used to change the way we live? • How can we sense and control the physical world using computers?

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Unit II: Exploring Solutions

8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals. 8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs. 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse. 8.1.8.AP.7: Design programs, incorporating existing code, media, and libraries, and give attribution. 8.1.8AP.8: Systematically test and refine programs using a range of test cases and users. 8.1.8.AP.9: Document programs in order to make them easier to follow, test, and debug. 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem.	**<u>KNOWLEDGE</u>** **Students will know:**	**SKILLS** **Students will be able to:**
	The process of decomposing a problem is breaking it down into its parts, which allows us to tackle large and complex problems by looking at smaller pieces at a time.	Identify smaller parts of a larger problem. Illustrate the decomposition process with a real-world problem. Judge the importance of individual parts of a problem.
	Computers have been programmed and utilized to help solve many problems we encounter.	Identify programmed computers that exist to make our lives easier. Plan a computer program that solves a real-world problem. Evaluate a computer program plan to identify obstacles and weaknesses in its design.

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Unit II: Exploring Solutions

NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills 9.4.8.CI.2: Repurpose an existing resource in an innovative way. 9.4.8.CI.4: Explore the role of creativity and innovation in career pathways and industries. 9.4.8.DC.6: Analyze online information to distinguish whether it is helpful or harmful to reputation. 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping. 9.4.8.TL.3: Select appropriate tools to organize and present information digitally. **NJ 2020 SLS: Science** MS-ETS1-1: Define the criteria 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.	Microcontrollers utilize components such as sensors and motors to record and change the physical world around us. **VOCABULARY:** problem-solving, function, evaluate, computer, process, variable, parameters, testing, reflection, criteria, analyze, coordinate plane **KEY TERMS:** Microcontrollers, decomposing	Describe a microcontroller and explain how it relates to programming. Explain the role of sensors and motors in physical computing. Plan a system of microcontrollers, components, and code that solves a real-world problem. Evaluate a computer system plan to identify obstacles and weaknesses in its design.

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Unit II: Exploring Solutions

NJ 2016 SLS: Literacy in History, Social Studies, & Technical Subjects RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **NJ 2020 SLS: Science – Crosscutting Concepts 6-8** • Patterns • Systems and System Models **NJ 2020 SLS: Science – Science and Engineering Practices 6-8** • Asking questions and defining problems • Developing and using models • Using mathematical and computational thinking **NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8** ETS1.A: Defining and Delimiting Engineering Problems		

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Unit II: Exploring Solutions

NJ 2016 SLS: Mathematical Practices MP1: Make sense of problems and persevere in solving them. MP5: Use appropriate tools strategically. MP7: Look for and make use of structure.		

ASSESSMENT EVIDENCE: Students will show their learning by:

- Answering reflection, knowledge, and skill-based questions on the problem-solving process and programming concepts
- Constructing illustrations to describe programming concepts and logic using graphics and flow charts
- Constructing computer programs that use previous and new programming concepts and skills
- Testing computer program designs by debugging and redesigning
- Presenting self-created programming projects to the class while explaining design and problem-solving steps

KEY LEARNING EVENTS AND INSTRUCTION:

- Daily programming design journal reflections
- Self-guided computer programming online modules
- Design a program that will change the output of a microcontroller
- Design a program that uses a sensor on a microcontroller to take in information
- Build a program that uses sensory data to change the output of a microcontroller based on conditions
- Small group collaboration on programming projects and design ideas
- Design a solution to a real-world problem using programmable computers

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Unit II: Exploring Solutions

SUGGESTED TIME ALLOTMENT	**3 weeks**
SUPPLEMENTAL UNIT RESOURCES	<u>Required Supplies/Activities/Software:</u> Computers Notepad ++/Pycharm Mirco:bits DJI Tello Drones Arduino Uno Boards Electrical Components <u>Suggested Supplies/Activities/Software:</u> TinkerCAD Arduino Online Lessons “Micro:bit Coding Activities” “Ardunios and Agriculture” “Programmable Drone Challenges”

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Unit III: Constructing Solutions

<table>
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<tr><td rowspan="5">STANDARDS / GOALS:

NJ 2020 SLS: Computer Science and Design Thinking
8.1.8.IC.2: Describe issues of bias and accessibility in the design of existing technologies.

8.1.8.DA.4: Transform data to remove errors and improve the accuracy of the data for analysis.

8.1.8.DA.5: Test, analyze, and refine computational models.

8.1.8.AP.3: Design and iteratively develop programs that combine control structures, including nested loops and compound conditionals.</td><td>ENDURING UNDERSTANDINGS</td><td>ESSENTIAL QUESTIONS</td></tr>
<tr><td>Constructing innovative programs provides programmers an opportunity to impact the world around us.</td><td>• How can the world be changed with the use of computational devices and innovative programs?</td></tr>
<tr><td>Creating, testing, and redesign are important steps in the problem-solving process.</td><td>• How does the creating step of the problem-solving process impact previous and future steps?</td></tr>
<tr><td><u>KNOWLEDGE</u>
Students will know:</td><td>SKILLS
Students will be able to:</td></tr>
<tr><td>Iterating is the process of improving a program to make a new and better version.</td><td>Define iteration and explain what steps of the problem-solving process are involved.

Judge the impacts previous and future steps have on iteration.</td></tr>
</table>

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8.1.8.AP.4: Decompose problems and sub-problems into parts to facilitate the design, implementation, and review of programs. 8.1.8.AP.5: Create procedures with parameters to organize code and make it easier to reuse. 8.1.8AP.8: Systematically test and refine programs using a range of test cases and users. 8.1.8.AP.9: Document programs in order to make them easier to follow, test, and debug. 8.2.8.ED.2: Identify the steps in the design process that could be used to solve a problem. **NJ 2020 SLS: Career Readiness, Life Literacies, and Key Skills** 9.4.8.CI.2: Repurpose an existing resource in an innovative way. 9.4.8.IML.3: Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping.	The problem-solving process provides guidance to designing and creating technology that can solve real-world problems.	Define a real-world problem and utilize the problem-solving process to develop solutions. Judge various solutions and identify which would be the best solution to a real-world problem. Compose a research-based plan using computational devices and programming. Develop an iteration of a program that solves a real-world problem. Evaluate an iteration of a program while taking into consideration the criteria and constraints of the solution. Create a new iteration of a program or solution with considerations to a previous evaluation. Recommend use of a program or solution based on previous tests and evaluations.

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9.4.8.TL.3: Select appropriate tools to organize and present information digitally. **NJ 2020 SLS: Science** MS-ETS1-1: Define the criteria 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-ETS1-4: Develop a model to generate data for iterative 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.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). **NJ 2020 SLS: Science – Crosscutting Concepts 6-8** • Patterns	**VOCABULARY:** problem-solving, function, evaluate, computer, process, variable, parameters, testing, reflection, criteria, analyze, criteria, constraints **KEY TERMS:** iterating	

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Unit III: Constructing Solutions

NJ 2020 SLS: Science – Science and Engineering Practices 6-8 • Using mathematical and computational thinking • Constructing explanations and designing solutions • Obtaining, evaluating, and communicating information **NJ 2020 SLS: Science – Disciplinary Core Ideas 6-8** ETS1.A: Defining and Delimiting Engineering Problems ETS1.B: Developing Possible Solutions ETS1.C: Optimizing the Design Solution **NJ 2016 SLS: Mathematical Practices** MP1: Make sense of problems and persevere in solving them. MP7: Look for and make use of structure.		

ASSESSMENT EVIDENCE: Students will show their learning by:

- Answering reflection, knowledge, and skill-based questions on the problem-solving process and programming concepts
- Constructing illustrations to describe programming concepts and logic using graphics and flow charts
- Constructing computer programs that use previous and new programming concepts and skills
- Testing computer program designs by debugging and redesigning
- Presenting self-created programming projects to the class while explaining design and problem-solving steps

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Unit III: Constructing Solutions

- Final Independent Computational Solutions Project

KEY LEARNING EVENTS AND INSTRUCTION:

- Daily programming journal reflection
- Independent Computational Solutions Project
- Reflection writing on the Independent Computational Solutions Project

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Unit III: Constructing Solutions

SUGGESTED TIME ALLOTMENT	**2 weeks**
SUPPLEMENTAL UNIT RESOURCES	<u>Required Supplies/Activities/Software:</u> Computers Notepad ++/Pycharm Mirco:bits DJI Tello Drones Arduino Uno Boards Electrical Components <u>Suggested Supplies/Activities/Software:</u> “Independent Computational Solutions Project”