Wayne
Township Public Schools

Mathematics
Grade 10-12
Advanced Placement Computer Science Principles

Dr. Mark Toback, Superintendent
Committee: Neil Ascione, Ryan Dawson, Thomas Grasso, and Douglas Schemly

This curriculum may be modified through varying techniques, strategies, and materials as per an individual student's Individualized Educational Plan (IEP)

Approved by the Wayne Township Board of Education at the regular meeting held on November XX, 2021.

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 1: Digital Information**
Time Frame	13 days

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**

Data Analysis
Impacts of Computing

Unit Overview

Students explore the way computers store and represent complex information like numbers, text, images, and sound. The unit begins with students investigating what it means to represent information and challenges students to design their own representation systems. Students then learn the ideas behind real-world systems used to represent complex information. Later lessons focus on the challenges that arise from digitizing information, such as the need to compress it, or questions of intellectual property. The unit project emphasizes the profound impact digital information has on modern life.

Standard Number(s) ***** **i.e: Math: F.LE.A.4** **i.e.: NJSLSA.R4.**

- 8.1.12.DA.2: Describe the trade-offs in how and where data is organized and stored.
- 8.1.12.DA.3: Translate between decimal numbers and binary numbers.
- 8.1.12.DA.4: Explain the relationship between binary numbers and the storage and use of data in a computing device.
- 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices
- 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.

- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
- 9.4.12.CT.2: Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a)
- RST.11-12.4. 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 11-12 texts and topics.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
- WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Intended Outcomes - {Essential Questions}

- How can we use 1s and 0s to represent something complex like a video of a band playing a song, or a color image?
- How does computer software solve problems and benefit the user?
- Who is responsible for the harmful effects of computing innovations, whether intentional or not?
- In what scenarios are lossy compression algorithms more effective than lossy?

Enduring Understandings

- The way a computer represents data internally is different from the way the data are interpreted and displayed for the user.
- Programs are used to translate data into a representation more easily understood by people.
- Programs can be used to process data, which allows users to discover information and create new knowledge.

- While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences.
- Lossy data compression algorithms can usually reduce the number of bits stored or transmitted more than lossless compression algorithms.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**	E	**Creativity and Innovation**
	Environmental Literacy	E	**Critical Thinking and Problem Solving**
	Health Literacy	E	**Communication**
	Civic Literacy	E	**Collaboration**
X	**Financial, Economic, Business, and Entrepreneurial Literacy**		

Student Learning Targets/Objectives (Students will know/Students will understand)

- Describe positive and negative effects of computing innovations.
- Explain how the same piece of information can be represented in a variety of different ways.
- Use a device to represent different pieces of information
- Use patterns to represent information
- Represent decimal numbers using combinations of binary digits 0 and 1
- Represent binary numbers using combinations of decimal digits 0-9
- Explain how the position of each binary digit determines its place value and numeric value
- Understand that overflow and roundoff errors result from real-world limitations in representing place value.
- Develop a system for using numbers to represent text
- Describe the challenges in representing text when using a fixed number of bits for each character
- Explain how bits can be used to represent individual pixels in black and white or color images
- Explain how sampling is used to create a digital form of an analog image
- Create lossless compressions of text files
- Analyze patterns in data to determine compression strategies
- Examine the effects of lossy compression on text & images
- Given a piece of media, decide whether to use lossy or lossless compression based on the needs of a situation
- Explain how copyright and Creative Commons Licenses can be applied to digital works of creativity
- Argue if current copyright laws are helping or harming society

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

Part of this course is Project Based Learning. Students will work from a program specification to build their own creative solutions to problems. By its very nature the course is highly differentiated and each student is free to develop advanced features and enhancements beyond those required for a basic solution. The introduction of GUI (Graphic User Interfaces) early in the course further increases student options for creating exceptional graphics based applets and applications in addition or in place of a console based solution. Backwards Design in the discussion of a program solution will be featured regularly as we carefully consider which type of designs will provide for optimal solutions given the tools that students have acquired to date.

Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities	
Activities	• Lecture and class discussion. • Video and multimedia presentations. • Compression widget • Image encoding widget • Group and collaborative work. • Student presentations of projects and research assignments
Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A
Resources	

- **http://www.state.nj.us/education/cccs/**
- **http://www.corestandards.org/ELA-Literacy**
- **http://www.state.nj.us/education/cccs/**
- https://studio.code.org/s/csp1-2021
- Current articles from “ACM Tech News,” Association for Computing Machinery at technews.acm.org.
- Current articles from ScienceDaily at sciencedaily.com.
- Current articles from the Technology section of the New York Times at nytimes.com.
- AP Computer Science CED, College Board, Fall 2020.

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 2: The Internet**
Time Frame	10 days

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**

Network and Internet
Impact of Computing
Computing Systems
Digital Citizenship

Unit Overview

Students learn how the Internet works and discuss its impacts on politics, culture, and the economy. This unit heavily features the Internet Simulator, a tool designed to let students see, use, and explore the way different layers of the internet work. Through a series of activities that build on one another, students investigate the problems the original designers of the internet had to solve and then "invent" their own solutions. At the conclusion of the unit, students research an "Internet Dilemma," both from the standpoint of its technical background and its impacts on different groups of people.

Standard Number(s) * i.e: Math: F.LE.A.4 i.e.: NJSLSA.R4.

- 8.1.12.NI.1: Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
- 8.1.12.NI.2: Evaluate security measures to address various common security threats.
- 8.1.12.CS.1: Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
- 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practice
- 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society
- RST.11-12.4. 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 11-12 texts and topics.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
- WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Intended Outcomes - {Essential Questions}

- Why does some data get delivered out of order?
- What are the benefits of fault tolerant networks?
- What is the difference between network vulnerability and network failure?
- How was the internet designed to be scalable?
- Who controls the protocols that govern the internet?

Enduring Understandings

- Computer systems and networks facilitate the transfer of data
- The Internet is a computer network consisting of interconnected networks that use standardized, open (nonproprietary) communication protocols.
- The protocols used in the Internet are open, which allows users to easily connect additional computing devices to the Internet.
- Routing on the Internet is usually dynamic; it is not specified in advance.
- The Internet was designed to be scalable.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**	ETA	**Creativity and Innovation**
	Environmental Literacy	ETA	**Critical Thinking and Problem Solving**
	Health Literacy	ETA	**Communication**
	Civic Literacy	ETA	**Collaboration**

X	**Financial, Economic, Business, and Entrepreneurial Literacy**	

Student Learning Targets/Objectives (Students will know/Students will understand)

- Identify the path(s) connecting two devices in a simulated network
- Explain how computing devices can be connected to form a network
- Explain the need for open and shared protocols for communicating on the Internet
- Describe the way the Internet Protocol helps uniquely identify one another on the Internet
- Explain how data is routed through the Internet
- Describe how the redundant nature of networks can lead to dynamic, fault tolerant routes
- Describe how information flows through the Internet as a datastream of packets
- Explain how packet numbering and re-ordering can allow for large messages to reliably be sent even if packets are dropped or arrive out of order
- Explain the differences between the Transmission Control Protocol (TCP) and User Datagram Protocol (UDP)
- Describe how HTTP is used for sharing the files and pages that make up the World Wide Web
- Describe how the Domain Name System helps the Internet scale by allowing devices to find the IP
- Explain how different layers of protocols on the Internet build upon and rely on one another

Assessments (Pre, Formative, Summative, Other) *Denote required common assessments with an **

Part of this course in is Project Based Learning. Students will work from a program specification to build their own creative solutions to problems. By its very nature the course is highly differentiated and each student is free to develop advanced features and enhancements beyond those required for a basic solution. The introduction of GUI (Graphic User Interfaces) early in the course further increases student options for creating exceptional graphics based applets and applications in addition or in place of a console based solution. Backwards Design in the discussion of a program solution will be featured regularly as we carefully consider which type of designs will provide for optimal solutions given the tools that students have acquired to date.

Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities

Activities	• Lecture and class discussion. • Video and multimedia presentations. • Group and collaborative work. • Internet Simulator • Student presentations of projects and research assignments
Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A

Resources

- **http://www.state.nj.us/education/cccs/**
- **http://www.corestandards.org/ELA-Literacy**
- **http://www.state.nj.us/education/cccs/**
- https://studio.code.org/s/csp2-2021
- AP Computer Science CED, College Board, Fall 2020.

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 3: Intro to App Design**
Time Frame	15 days
Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**	
Algorithms and Programming Creativity and Innovation Critical Thinking and Problem Solving	
Unit Overview	

Students design their first app while learning both fundamental programming concepts and collaborative software development processes. Students work with partners to develop a simple app that teaches classmates about a topic of personal interest. Throughout the unit, they learn how to use Code.org's programming environment, App Lab, to design user interfaces and write simple event-driven programs. Along the way, students learn practices like debugging, pair programming, and collecting and responding to feedback, which they will be able to use throughout the course as they build increasingly more complex projects. The unit concludes with students sharing the apps they develop with their classmates.

Standard Number(s) *** i.e: Math: F.LE.A.4** **i.e.: NJSLSA.R4.**

- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
- 8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
- 8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.
- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- RST.11-12.4. 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 11-12 texts and topics.
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- WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.

Intended Outcomes - {Essential Questions}

- How can we store data in a program to solve problems?
- How do apps group different actions together based on user interaction, such as pressing buttons?
- How do video games group the different actions for a player based on what key is pressed on the keyboard or controller?
- What types of problems can be solved more easily with a computer, and what types can be solved more easily without a computer?

Enduring Understandings

- Incorporating multiple perspectives through collaboration improves computing innovations as they are developed.
- Developers create and innovate using an iterative design process that is user focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
- Programs are used to translate data into a representation more easily understood by people.
- The way statements are sequenced and combined in a program determines the computed result.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**	ETA	**Creativity and Innovation**
	Environmental Literacy	ETA	**Critical Thinking and Problem Solving**
	Health Literacy	ETA	**Communication**
	Civic Literacy	ETA	**Collaboration**
X	**Financial, Economic, Business, and Entrepreneurial Literacy**		

Student Learning Targets/Objectives (Students will know/Students will understand)

- Identify the inputs, outputs, and purpose of an application
- Set up user interfaces of an application, including buttons, text, and images
- Use feedback to help the design and functionality of an application
- Justify the existence of programming languages to precisely communicate instructions
- Define a program as a sequence of commands that are executed or run by a computer
- Explain the differences between how sequential and event-driven programs execute
- Define comments as notes or documentation into a program that do not affect how the program executes
- Debug simple sequential and event-driven programs, including using break points
- Effectively use pair programming while designing the features of an app

Assessments (Pre, Formative, Summative, Other) *Denote required common assessments with an **

Part of this course in is Project Based Learning. Students will work from a program specification to build their own creative solutions to problems. By its very nature the course is highly differentiated and each student is free to develop advanced features and enhancements beyond those required for a basic solution. The introduction of GUI (Graphic User Interfaces) early in the course further increases student options for creating exceptional graphics based applets and applications in addition or in place of a console based solution. Backwards Design in the discussion of a program solution will be featured regularly as we carefully consider which type of designs will provide for optimal solutions given the tools that students have acquired to date.

Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities

Activities	• Lecture and class discussion. • Video and multimedia presentations. • Build a console, applet and GUI based application. • Review and extend program functionality. • Group and collaborative work. • Student presentations of projects and research assignments

Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A

Resources

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- **http://www.corestandards.org/ELA-Literacy**
- **http://www.state.nj.us/education/cccs/**
- https://studio.code.org/s/csp2-2021
- Resources from AP Classroom
- Resources from Code.org
- “Unplugged – Building a Foundation” Code.org, YouTube video
- “CS Principles for High Schools” University of Alabama, Department of Computer Science

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 4: Advanced Programming Concepts**
Time Frame	55 days

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**

Algorithms and Programming
Creativity and Innovation
Critical Thinking and Problem Solving

Unit Overview

Students expand the types of apps they can create as they learn how to store information (variables), make decisions (conditionals), and better organize code (functions). Students will then learn to build apps that use and process lists of information. They will learn the core concepts of lists, loops, and traversals. Later in the unit, students are introduced to tools that allow them to import tables of real-world data to help further power the types of apps they can make. Students learn to design and analyze algorithms to understand how they work and why some algorithms are considered more efficient than others. Students will begin to extend their knowledge of programming concepts into Pseudocode, which is the documentation they will see on the AP Exam.. Finally, students will learn how to design clean and reusable code that can be shared with a single classmate or the entire world, as they practice designing libraries of functions that can be packaged up and shared with others. At the conclusion of this units, students will be given the Collegeboard-mandated 12 hours of class time to complete the Digital Portfolio, which comprises 30% of their AP Exam score.

Standard Number(s) ***i.e: Math: F.LE.A.4 i.e.: NJSLSA.R4.**

- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.2: Create generalized computational solutions using collections instead of repeatedly using simple variables.
- 8.1.12.AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
- 8.1.12.AP.4: Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
- 8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
- 8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
- 8.1.12.AP.8: Evaluate and refine computational artifacts to make them more usable and accessible
- 8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.
- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice
- RST.11-12.4. 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 11-12 texts and topics.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.

Intended Outcomes - {Essential Questions}

- When are collections appropriate to simplify code?
- How can we store data in programs to solve problems?
- How do computer programs group different actions together based on user interaction?
- What types of problems can be solved with a computer program?
- When are binary search algorithms more efficient than linear searches?
- How can a value be represented by a variable?
- What are the differences between selection, sorting, and iteration algorithms?

- What order does a program execute lines of code?

Enduring Understandings

- To find specific solutions to generalizable problems, programmers represent and organize data in multiple ways.
- Developers create and innovate using an iterative design process that is user focused, that incorporates implementation/feedback cycles, and that leaves ample room for experimentation and risk-taking.
- The way statements are sequenced and combined in a program determines the computed result.
- Programs incorporate iteration and selection constructs to represent repetition and make decisions to handle varied input values.
- Selection determines which parts of an algorithm are executed based on a condition being true or false.
- Conditional statements, or “if-statements,” affect the sequential flow of control by executing different statements based on the value of a Boolean expression.
- Iteration is a repeating portion of an algorithm. Iteration repeats a specified number of times or until a given condition is met.
- Algorithms can be written in different ways and still accomplish the same tasks.
- Some conditional statements can be written as equivalent Boolean expressions.
- Binary search is often more efficient than sequential/linear search when applied to sorted data.
- Programmers break down problems into smaller and more manageable pieces. By creating procedures and leveraging parameters, programmers generalize processes that can be reused. Procedures allow programmers to draw upon existing code that has already been tested, allowing them to write programs more quickly and with more confidence.
- There exist problems that computers cannot solve, and even when a computer can solve a problem, it may not be able to do so in a reasonable amount of time.
- Parallel and distributed computing leverage multiple computers to more quickly solve complex problems or process large data sets.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**			*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**		ETA	**Creativity and Innovation**
	Environmental Literacy		ETA	**Critical Thinking and Problem Solving**
	Health Literacy		ETA	**Communication**
	Civic Literacy		ETA	**Collaboration**
X	**Financial, Economic, Business, and Entrepreneurial Literacy**			

Student Learning Targets/Objectives (Students will know/Students will understand)

- Evaluate expressions that include numbers, strings, and arithmetic operators.
- Modify apps that make use of common programming patterns with variables to adjust their functionality
- Write and debug programs that use variables and expressions with the support of sample code.
- Implement programming patterns with variables to develop a functioning app
- Write comments to clearly explain both the purpose and function of different segments of code within an app
- Evaluate expressions that include Boolean values, comparison operators, and logical operators
- Write and debut programs that use boolean expressions and conditional statements
- Describe the way a function call interrupts the normal flow of execution within a program
- Write and debug programs that use functions and parameters
- Identify common programming patterns using lists
- Explain the purpose of programming patterns with lists both in terms of how they work and what they accomplish
- Accurately use list operations including accessing, inserting, and removing elements
- Identify the exit point of a loop
- Update the Boolean expression in a for loop to change how many times the loop runs
- Write and debug programs that use loops
- Explain the purpose of programming patterns with traversals both in terms of how they work and what they accomplish

- Implement programming patterns with traversals to develop a functioning app
- Explain the formal definitions of a problem, an algorithm, sequencing, selection, and iteration.
- Explain that some algorithms may look or operate differently but still solve the same problem.
- Compare the efficiency of Linear Search and Binary Search
- Explain the difference between problems that run in a reasonable time and those that do not
- Explain how both formal mathematical reasoning and informal measurement can be used to determine an algorithms efficiency
- Explain the difference between sequential, parallel, and distributed computing.
- Remove specifics from a function so that it can be used in a variety of situations
- Identify situations in which a function with a parameter or return value would be necessary
- Write functions with parameters and return values that meet a set of specified requirements
- Explain the process of preparing a function to be added to a library
- Test functions designed to be used in a library using different input values

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

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Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities

Activities	• Lecture and class discussion. • Video and multimedia presentations. • Build a console, applet and GUI based application. • Review and extend program functionality. • Group and collaborative work. • Student presentations of projects and research assignments
Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A
Resources	

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- **http://www.corestandards.org/ELA-Literacy**
- **http://www.state.nj.us/education/cccs/**
- Resources from AP Classroom
- “Programming Puzzles” Lightbot at lightbot.com
- Resources from Code.org
- “Unplugged – Building a Foundation” Code.org, YouTube video
- Resources from CS4Alabama
- “CS Principles for High Schools” University of Alabama, Department of Computer Science

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**

Unit Plan Title:	**Unit 5: Data**
Time Frame	15 days

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**

Data Analysis
Algorithms and Programming
Ethics of Computing
Information and Media Literacy
Technology Literacy

Unit Overview

Students explore and visualize datasets from a wide variety of topics as they hunt for patterns and try to learn more about the world around them from the data. Once again, students work with datasets but are now asked to make use of a data visualizer tool that assists students in finding data patterns. They learn how different types of visualizations can be used to better understand the patterns contained in datasets and how to use visualizations when investigating hypotheses. At the conclusion of the unit, students learn about the impacts of data analysis on the world around them and complete a final project in which they must uncover and present a data investigation they've completed independently.

Standard Number(s) ***** **i.e: Math: F.LE.A.4** **i.e.: NJSLSA.R4.**

- 8.1.12.DA.1: Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
- 8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
- 8.1.12.DA.5: Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
- 8.1.12.DA.6: Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
- 8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.
- 9.4.12.TL.1: Assess digital tools based on features such as accessibility options, capacities, and utility for accomplishing a specified task
- 9.4.12.IML.3: Analyze data using tools and models to make valid and reliable claims, or to determine optimal design solutions
- 9.4.12.IML.4: Assess and critique the appropriateness and impact of existing data visualizations for an intended audience
- RST.11-12.4. 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 11-12 texts and topics.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- WHST.11-12.5. Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- WHST.11-12.6. Use technology, including the Internet, to produce, share, and update writing products in response to ongoing feedback, including new arguments or information.
- WHST.11-12.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

Intended Outcomes - {Essential Questions}

- How can people participate in problem-solving processes at scale?
- What kind of information can be extracted from data?
- What challenges arise from processing data?
- What is the difference between correlation and causation?
- What types of data visualizations are appropriate, given a particular data set?

Enduring Understandings

- Information is the collection of facts and patterns extracted from data.
- Data provide opportunities for identifying trends, making connections, and addressing problems.
- Digitally processed data may show correlation between variables. A correlation found in data does not necessarily indicate that a causal relationship exists. Additional research is needed to understand the exact nature of the relationship
- Often, a single source does not contain the data needed to draw a conclusion. It may be necessary to combine data from a variety of sources to formulate a conclusion.
- Metadata are used for finding, organizing, and managing information.
- Computing innovations can reflect existing human biases because of biases written into the algorithms or biases in the data used by the innovation
- Science has been affected by using distributed and “citizen science” to solve scientific problems.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**			*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
	X	**Global Awareness**	ETA	**Creativity and Innovation**
		Environmental Literacy	ETA	**Critical Thinking and Problem Solving**
		Health Literacy	ETA	**Communication**
		Civic Literacy	ETA	**Collaboration**
	X	**Financial, Economic, Business, and Entrepreneurial Literacy**		

Student Learning Targets/Objectives (Students will know/Students will understand)

- Differentiate between what data shows and why that might be the case
- Explain the usefulness of metadata
- Draw conclusions by reading bar charts and histograms
- Explain the reasons that someone would create either a bar chart or a histogram in order to explore a single column of data
- Create filtered charts that answer specific questions
- Draw conclusions by reading crosstab and scatter charts
- Explain the reasons that someone would create either a crosstab and scatter chart in order to explore two columns of data
- Define and explain the impacts of crowdsourcing, crowdfunding, and citizen science
- Explain the impact of open data on scientific research and discovery
- Reason about how human bias plays a role in machine learning.

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

Part of this course in is Project Based Learning. Students will work from a program specification to build their own creative solutions to problems. By its very nature the course is highly differentiated and each student is free to develop advanced features and enhancements beyond those required for a basic solution. The introduction of GUI (Graphic User Interfaces) early in the course further increases student options for creating exceptional graphics based applets and applications in addition or in place of a console based solution. Backwards Design in the discussion of a program solution will be featured regularly as we carefully consider which type of designs will provide for optimal solutions given the tools that students have acquired to date.

Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities	
Activities	• Lecture and class discussion. • Video and multimedia presentations. • Build a console, applet and GUI based application. • Review and extend program functionality. • Group and collaborative work. • Student presentations of projects and research assignments
Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A

Resources	
• **http://www.state.nj.us/education/cccs/** • **http://www.corestandards.org/ELA-Literacy** • **http://www.state.nj.us/education/cccs/** • Resources from AP Classroom • Resources from Code.org (Data Visualizer)	

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 6: Cybersecurity and Global Impacts**
Time Frame	22 days

Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**

Ethics of Computing
Effects of Technology on the Natural World
Interaction of Technology and Humans
Network and Internet
Impacts of Computing
Digital Citizenship

Unit Overview

Students research and debate current events at the intersection of data, public policy, law, ethics, and societal impact. Throughout the unit, students learn about the privacy and security risks of many computing innovations and learn about the ways some of these risks can be mitigated. Students will also complete practice problems for the AP Exam Explore Multiple Choice questions in this section.

Standard Number(s) ***** **i.e: Math: F.LE.A.4** **i.e.: NJSLSA.R4.**

- 8.2.12.EC.1: Analyze controversial technological issues and determine the degree to which individuals, businesses, and governments have an ethical role in decisions that are made.
- 8.2.12.EC.3: Synthesize data, analyze trends, and draw conclusions regarding the effect of a technology on the individual, culture, society, and environment and share this information with the appropriate audience.

- 8.2.12.EC.2: Assess the positive and negative impacts of emerging technologies on developing countries and evaluate how individuals, non-profit organizations, and governments have responded.
- 8.2.12.ETW.1: Evaluate ethical considerations regarding the sustainability of environmental resources that are used for the design, creation, and maintenance of a chosen product.
- 8.2.12.ITH.3: Analyze the impact that globalization, social media, and access to open source technologies has had on innovation and on a society's economy, politics, and culture.
- 8.2.12.ITH.1: Analyze a product to determine the impact that economic, political, social, and/or cultural factors have had on its design, including its design constraints.
- 8.1.12.IC.1: Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices
- 8.1.12.IC.3: Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
- 8.1.12.NI.2: Evaluate security measures to address various common security threats.
- 8.1.12.NI.3: Explain how the needs of users and the sensitivity of data determine the level of security implemented.
- 8.1.12.NI.4: Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use.
- 9.4.12.DC.1: Explain the beneficial and harmful effects that intellectual property laws can have on the creation and sharing of content
- 9.4.12.DC.3: Evaluate the social and economic implications of privacy in the context of safety, law, or ethics
- 9.4.12.DC.4: Explain the privacy concerns related to the collection of data (e.g., cookies) and generation of data through automated processes that may not be evident to users
- 9.4.12.DC.7: Evaluate the influence of digital communities on the nature, content and responsibilities of careers, and other aspects of society
- RST.11-12.4. 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 11-12 texts and topics.
- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
- WHST.11-12.4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
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Intended Outcomes - {Essential Questions}

- Are innovators responsible for the harmful effects of their computing innovations, even if those effects were unintentional?
- How can a computing innovation have an impact beyond its intended purpose?
- What issues contribute to the digital divide?
- What types of biases exist in computing innovations?
- What types of legal and ethical concerns arise from the use of computing innovations?
- What risks to privacy arise from collecting and storing personal data on a computer system?

Enduring Understandings

- While computing innovations are typically designed to achieve a specific purpose, they may have unintended consequences
- A single effect can be viewed as both beneficial and harmful by different people, or even by the same person.
- Not every effect of a computing innovation is anticipated in advance
- Computing innovations can be used in ways that their creators had not originally intended
- Internet access varies between socioeconomic, geographic, and demographic characteristics, as well as between countries
- Personally identifiable information (PII) is information about an individual that identifies, links, relates, or describes them
- Authentication measures protect devices and information from unauthorized access.
- Computer viruses often attach themselves to legitimate programs and start running independently on a computer.

In this unit plan, the following 21st Century themes and skills are addressed.

Check all that apply. **21st Century Themes**		*Indicate whether these skills are **E**-Encouraged, **T**-Taught, or **A**-Assessed in this unit by marking **E, T, A** on the line before the appropriate skill.* **21st Century Skills**	
X	**Global Awareness**	ETA	**Creativity and Innovation**
	Environmental Literacy	ETA	**Critical Thinking and Problem Solving**
	Health Literacy	ETA	**Communication**

	Civic Literacy	ETA	**Collaboration**
X	**Financial, Economic, Business, and Entrepreneurial Literacy**		

Student Learning Targets/Objectives (Students will know/Students will understand)

- Describe the different types of data that are used and collected by modern computing innovations
- Define Personally Identifiable Information as information about an individual that identifies, links, relates, or describes them.
- Explain how disparate pieces of personal information can be combined to identify individuals or deduce other private information.
- Evaluate whether the benefits to society from a given computing innovation outweigh the privacy risks it poses.
- Assess a computing innovation to identify the specific privacy risks that could arise from the data it collects and stores.
- Explain the risks to privacy that arise from using modern computing technology
- Identify commons security risks: phishing, keylogging, malware, rogue access points
- Explain how these common security risks target people
- Explain the difference between asymmetrical and symmetrical encryption
- Explain the benefits of multifactor authentication
- Evaluate innovations for its potential benefits and harms based on the perspective of a specific audience

Assessments (Pre, Formative, Summative, Other) ***Denote required common assessments with an ****

Part of this course in is Project Based Learning. Students will work from a program specification to build their own creative solutions to problems. By its very nature the course is highly differentiated and each student is free to develop advanced features and enhancements beyond those required for a basic solution. The introduction of GUI (Graphic User Interfaces) early in the course further increases student options for creating exceptional graphics based applets and applications in addition or in place of a console based solution. Backwards Design in the discussion of a program solution will be featured regularly as we carefully consider which type of designs will provide for optimal solutions given the tools that students have acquired to date.

Formative and summative evaluations in the form of worksheets, quizzes and tests - both paper based and computer based will be utilized as needed to reinforce learning objectives and evaluate student progress.

Teaching and Learning Activities	
Activities	• Lecture and class discussion. • Video and multimedia presentations. • Build a console, applet and GUI based application. • Review and extend program functionality. • Group and collaborative work. • Student presentations of projects and research assignments
Differentiation Strategies	• Individual and collaborative research, design and problem solving • Student interest and skill level assessment • Individual, small group, and large group instruction • Media presentations and guest speakers • Student presentations and Flipped Lessons
Honors	N/A
Resources	

- http://www.state.nj.us/education/cccs/
- http://www.corestandards.org/ELA-Literacy
- http://www.state.nj.us/education/cccs/
- Resources from AP Classroom
- Resources from Code.org (encryption widgets)
- Resources from CodeHS (cybersecurity unit)

Content Area/ Grade Level/ Course:	**Mathematics** **10-12** **Advanced Placement Computer Science Principles**
Unit Plan Title:	**Unit 7: Creative Development**
Time Frame	Remainder of School Year
Anchor Standards/Domain* ***i.e: ELA: reading, writing i.e.: Math: Algebra**	

Algorithms and Programming
Data Analysis

Unit Overview

In this unit, students will brainstorm their own final project, discuss their ideas with their peers,scope their project to fit within the time constraints of the class, plan out milestones for incremental development, and create their own final product from scratch. This project allows students to think creatively about the applications of the concepts covered in the course, and create something of personal value.

Standard Number(s) * i.e: Math: F.LE.A.4 i.e.: NJSLSA.R4.

- 8.1.12.AP.1: Design algorithms to solve computational problems using a combination of original and existing algorithms.
- 8.1.12.AP.2: Create generalized computational solutions using collections instead of repeatedly using simple variables.
- 8.1.12.AP.3: Select and combine control structures for a specific application based upon performance and readability, and identify trade-offs to justify the choice.
- 8.1.12.AP.4: Design and iteratively develop computational artifacts for practical intent, personal expression, or to address a societal issue.
- 8.1.12.AP.5: Decompose problems into smaller components through systematic analysis, using constructs such as procedures, modules, and/or objects.
- 8.1.12.AP.6: Create artifacts by using procedures within a program, combinations of data and procedures, or independent but interrelated programs.
- 8.1.12.AP.7: Collaboratively design and develop programs and artifacts for broad audiences by incorporating feedback from users.
- 8.1.12.AP.8: Evaluate and refine computational artifacts to make them more usable and accessible
- 8.1.12.AP.9: Collaboratively document and present design decisions in the development of complex programs.
- RST.11-12.4. 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 11-12 texts and topics.

- RST.11-12.7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.
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- 9.4.12.CI.1: Demonstrate the ability to reflect, analyze, and use creative skills and ideas
- 9.4.12.CT.1: Identify problem-solving strategies used in the development of an innovative product or practice

Intended Outcomes - {Essential Questions}

- When are collections appropriate to simplify code?
- How can libraries be created and shared in order to simplify code?
- In what ways can a program be tested and debugged in order to find potential improvements?
- How can we store data in programs to solve problems?
- How do computer programs group different actions together based on user interaction?

Enduring Understandings

- Write and debug programs that use variables and expressions with the support of sample code.
- Implement programming patterns with variables to develop a functioning app
- Write comments to clearly explain both the purpose and function of different segments of code within an app
- Evaluate expressions that include Boolean values, comparison operators, and logical operators
- Write and debut programs that use boolean expressions and conditional statements
- Describe the way a function call interrupts the normal flow of execution within a program
- Write and debug programs that use functions and parameters
- Identify common programming patterns using lists
- Explain the purpose of programming patterns with lists both in terms of how they work and what they accomplish
- Accurately use list operations including accessing, inserting, and removing elements
- Identify the exit point of a loop
- Update the Boolean expression in a for loop to change how many times the loop runs
- Write and debug programs that use loops

- Explain the purpose of programming patterns with traversals both in terms of how they work and what they accomplish
- Implement programming patterns with traversals to develop a functioning app

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Honors	N/A
Resources	

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- **http://www.corestandards.org/ELA-Literacy**
- **http://www.state.nj.us/education/cccs/**
- Resources from Code.org (App Lab workspace)
- Resources from CodeHS (programming Sandbox)
- Resources from CodeCademy (programming language courses)