PATERSON PUBLIC SCHOOLS
Preparing All Children for College and Career

Department of College and Career Readiness

AP Mobile Computer Science Principles Curriculum

5.0 Credits

Unit Three

AP Mobile Computer Science Principles

Course Description

Mobile CSP is a project-based course based on the AP CS Principles Framework. The course covers the **7 Big Ideas** and **6 Computational Thinking Practices**. During the course, students complete two collaborative programming projects and an individual research and writing project on the impact of a recent, computing innovation that appeals to the student. These projects conform to the College Board's two **performance tasks** on programming and impact. The emerging CS Principles AP course will use these performance tasks, in addition to a written exam, as a primary means for a student to demonstrate what they've learned.

Twenty-eight lessons and projects focus on building socially useful mobile apps with App Inventor for Android.   Another 30 lessons focus on computer science topics ranging from algorithms to binary numbers to computer security. Readings from Blown to Bits ask students to reflect on some of the big societal issues that characterize 21st century computing, such as privacy, security, social networking.

AP CS Principles Exam

Students who complete this course will be prepared to take the AP CS Principles Exam. The AP CS Principles Framework is followed in conjunction with the official Mobile CSP Syllabus.

Prerequisites (As described by the College Board)

It is recommended that a student in the AP Computer Science Principles course should have successfully completed a first-year high school algebra course with a strong foundation in basic algebraic concepts dealing with function notation, such as f(x) = 5 x^2 and problem-solving strategies that require multiple approaches and collaborative efforts. In addition, students should be able to use a Cartesian (x, y) coordinate system to represent points on a plane. It is important that students and their advisers understand that any significant computer science course builds upon a foundation of mathematical reasoning that should be acquired before attempting such a course.

Programming Environment:

App Inventor for Android (ai2.appinventor.mit.edu), a free online software platform, is used in this course to build mobile apps for Android devices.

Online Resources:

The complete curriculum is hosted online and free of charge: https://ram8647.appspot.com/mobileCSP. The course uses many freely available resources that are only available online to ensure that the course material is current and adaptable. Students maintain individual online portfolios of their course work by using Google sites (https://www.google.com/sites/overview.html). Self-check and live coding exercises make use of Quizly (https://github.com/ram8647/quizly), a Web-based live coding platform for App Inventor. Throughout the course, students will also use a number of online articles and videos from sources such as The New York Times (www.nytimes.com), Wikipedia (www.wikipedia.org), CS Bits and Bytes (http://www.nsf.gov/cise/csbytes/), Logic.ly (www.logic.ly), YouTube (www.youtube.com), and CS Unplugged (http://csunplugged.org).

Reference Text:

- App Inventor 2: Create Your Own Android Apps. David Wolber, Hal Abelson, Ellen Spertus, and Liz Looney O'Reilly Media, Inc., 2014
- Blown to Bits: Your Life, Liberty, and Happiness After the Digital Explosion. Hal Abelson, Ken Ledeen, Harry Lewis. Addison-Wesley, 2010

AP Mobile Computer Science Principles

Pacing Guide

Unit	Topic	Suggested Timing
Unit 1	Getting Started: Preview & Setup Introduction to Mobile Apps & Pair Programming Creating Graphics & Images Bit by Bit	approx. 8 weeks
Unit 2	Create Task: Programming Performance Task #1 Exploring Computing: Animation, Simulation, & Modeling Explore Task: Impact of Computing Innovations Performance Task #1	approx. 9 weeks
Unit 3	Algorithms and Procedural Abstractions Using and Analyzing Data & Information Explore Task: Impact of Computing Innovations Performance Task #2	approx. 9 weeks
Unit 4	Communication Through The Internet Create Task: Programming Performance Task #2 Data Project (Optional)	approx. 9 weeks

Educational Technology Standards

8.1.12.A.1, 8.1.12.A.2, 8.1.12.A.3, 8.1.12.B.2, 8.1.12.C.1, 8.1.12.D.1, 8.1.12.D.4, 8.1.12.D.5,8.1.12.E.2, 8.1.12.F.1

- **Technology Operations and Concepts**
  - Create a personal digital portfolio which reflects personal and academic interests, achievements, and career aspirations by using a variety of digital tools and resources.
  - Produce and edit a multi-page digital document for a commercial or professional audience and present it to peers and/or professionals in that related area for review.
  - Collaborate in online courses, learning communities, social networks or virtual worlds to discuss a resolution to a problem or issue.
- **Creativity and Innovation**
  - Apply previous content knowledge by creating and piloting a digital learning game or tutorial.
- **Communication and Collaboration**
  - Develop an innovative solution to a real world problem or issue in collaboration with peers and experts, and present ideas for feedback through social media or in an online community.
- **Digital Citizenship**
  - Demonstrate appropriate application of copyright, fair use and/or Creative Commons to an original work.
  - Research and understand the positive and negative impact of one's digital footprint.
  - Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.
- **Research and Information Literacy**
  - Research and evaluate the impact on society of the unethical use of digital tools and present your research to peers.
- **Critical Thinking, Problem Solving, Decision Making**
  - Evaluate the strengths and limitations of emerging technologies and their impact on educational, career, personal and or social needs.

Career Ready Practices

Career Ready Practices describe the career-ready skills that all educators in all content areas should seek to develop in their students. They are practices that have been linked to increase college, career, and life success. Career Ready Practices should be taught and reinforced in all career exploration and preparation programs with increasingly higher levels of complexity and expectation as a student advances through a program of study.

CRP1. **Act as a responsible and contributing citizen and employee**
Career-ready individuals understand the obligations and responsibilities of being a member of a community, and they demonstrate this understanding every day through their interactions with others. They are conscientious of the impacts of their decisions on others and the environment around them. They think about the near-term and long-term consequences of their actions and seek to act in ways that contribute to the betterment of their teams, families, community and workplace. They are reliable and consistent in going beyond the minimum expectation and in participating in activities that serve the greater good.

CRP2. Apply appropriate academic and technical skills.
Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

CRP4. Communicate clearly and effectively and with reason.
Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP5. Consider the environmental, social and economic impacts of decisions.
Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social

Career Ready Practices

condition, the environment and the profitability of the organization.

CRP6. Demonstrate creativity and innovation.
Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP7. Employ valid and reliable research strategies.
Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.
Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP9. Model integrity, ethical leadership and effective management.
Career-ready individuals consistently act in ways that align personal and community-held ideals and principles while employing strategies to positively influence others in the workplace. They have a clear understanding of integrity and act on this understanding in every decision. They use a variety of means to positively impact the directions and actions of a team or organization, and they apply insights into human behavior to change others’ action, attitudes and/or beliefs. They recognize the near-term and long-term effects that management’s actions and attitudes can have on productivity, morals and organizational culture.

CRP11. Use technology to enhance productivity.

Career Ready Practices

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

CRP12. Work productively in teams while using cultural global competence.
Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

Differentiated Instruction

Strategies to Accommodate Students Based on Individual Needs

Time/General	Processing	Comprehension	Recall
• Extra time for assigned tasks • Adjust length of assignment • Timeline with due dates for reports and projects • Communication system between home and school • Provide lecture notes/outline	• Extra Response time • Have students verbalize steps • Repeat, clarify or reword directions • Mini-breaks between tasks • Provide a warning for transitions • Reading partners	• Precise step-by-step directions • Short manageable tasks • Brief and concrete directions • Provide immediate feedback • Small group instruction • Emphasize multi-sensory learning	• Teacher-made checklist • Use visual graphic organizers • Reference resources to promote independence • Visual and verbal reminders • Graphic organizers
Assistive Technology	**Tests/Quizzes/Grading**	**Behavior/Attention**	**Organization**
• Computer/whiteboard • Tape recorder • Spell-checker • Audio-taped books	• Extended time • Study guides • Shortened tests • Read directions aloud	• Consistent daily structured routine • Simple and clear classroom rules • Frequent feedback	• Individual daily planner • Display a written agenda • Note-taking assistance • Color code materials

Enrichment

Strategies Used to Accommodate Based on Students Individual Needs:

- Adaption of Material and Requirements
- Evaluate Vocabulary
- Additional Projects
- Independent Student Options
- Projects completed individual or with Partners
- Self Selection of Research
- Tiered/Multilevel Activities
- Learning Centers
- Individual Response Board
- Independent Book Studies
- Open-ended activities
- Community/Subject expert mentorships

Assessments

Suggested Formative/Summative Classroom Assessments

Portfolios: In this course students will document their work on their **portfolios**. That is, they will post answers to reading questions, write-ups of hands-on tutorials, written responses to assigned readings, and documentation of creative programming projects on their personal portfolio page. Each student will create a portfolio using Google sites (https://www.google.com/sites/overview.html). The portfolios will promote collaboration and sharing -- students can learn from each other -- and will constitute a full record of what the students have done in the course that they can refer back to during and after the course and share with their friends and family. Portfolios will be graded periodically throughout the duration of the course.

Reading and Homework Assignments: There will be regular reading and/or out-of-class homework assignments. These may include reading a chapter from the textbook and/or completing a tutorial or worksheet. Brief, clear, and concise written responses to the study questions must be posted on students' portfolios.

Labs: This course will be taught in a computer lab. Students will have access to computers and mobile devices and any other necessary hardware, both during the class and during free periods. Students can work in the lab during their free periods. Internet access will be available to students throughout the course. In each unit, there will be at least three labs designed to practice and/or reinforce key concepts. Some are unplugged and others are completed in an online development environment. Most are completed in App Inventor.

Projects There will be two (2) creative programming projects in which students will use lab time to work both individually and collaboratively (in pairs) to create a socially useful mobile app that they propose (pitch), design, and implement. One of these will be a practice for the College Board's Create Performance Task. The second will be the official College Board Create Performance Task. Twelve (12) hours of class time will be provided for completion of the official Create Performance Task.

There will also be two (2) written research projects that students will work on individually. These research projects will focus on examining a computing innovation that has impacted society. One will be a practice for the Explore Performance Task. The second will be the College Board's Explore Performance Task. Eight (8) hours of class time will be provided for completion of the official College Board Explore Performance Task.

Oral and Video presentations: There will be approximately three (3) oral and/or videotaped presentations of students' projects during the course.

Quizzes and exams: There will be periodic quizzes, typically to wrap up the end of each unit, and a midterm exam given during the course. There will be a comprehensive final exam. Quizzes will be hand written and/or electronic and exams will be electronic.

Self-check and Live coding exercises: All lessons in this course are accompanied by short, interactive, self-check exercises that consist of multiple choice and fill-in question as well as automatically graded, live-coding, programming exercises (https://github.com/ram8647/quizly). These assessments are considered an essential part of the learning process. These are hosted online and may be done individually or with the class as a whole. Each question or exercise includes detailed feedback and students may repeat the question or exercise until it is correct.

AP Computer Science Principles Exam (AP Exam May 5, 2017) Students who complete this course will be prepared to take the AP CS Principles Exam.

Interdisciplinary Connections

English Language Arts

- Journal writing
- Close reading of industry-related content
- Create a brochure for a specific industry
- Keep a running word wall of industry vocabulary

Social Studies

- Research the history of a given industry/profession
- Research prominent historical individuals in a given industry/profession
- Use historical references to solve problems

World Language

- Translate industry-content
- Create a translated index of industry vocabulary
- Generate a translated list of words and phrases related to information technology

Math

- Compare and contrast use of equations and variables in algebra and programming.
- Program graphics and use the properties of geometric shapes
- Compare the computer graphic coordinate system with the Cartesian coordinate plane in math
- Compare probability and the use of random numbers in computer programming.
- Track and track various data, such as industry's impact on the GDP, career opportunities or among of individuals currently occupying careers

Fine & Performing Arts

- Create a poster recruiting young people to focus their studies on a career in Information Technology

Science

- Research the environmental impact of a given career or industry
- Research latest developments in Information technology
- Investigate applicable-careers in STEM fields

New Jersey Student Learning Standards

8.2 Technology Education, Engineering, Design, and Computational Thinking - Programming

Technology and Society

- 8.2.12.B.3: Analyze ethical and unethical practices around intellectual property rights as influenced by human wants and/or needs.

Design

- 8.2.12.C.1: Explain how open source technologies follow the design process.

Computational Thinking: Programming

- 8.2.12.E.1: Demonstrate an understanding of the problem-solving capacity of computers in our world.
- 8.2.12.E.2: Analyze the relationships between internal and external computer components.
- 8.2.12.E.3: Use a programming language to solve problems or accomplish a task.
- 8.2.12.E.4: Use appropriate terms in conversation.

9.3– Career and Technical Education

Career Cluster: Information Technology (IT)

- 9.3.12.IT.11: Demonstrate knowledge of the hardware components associated with information systems.
- 9.3.12.IT-SUP.9: Employ technical writing and documentation skills in support of an information system.

Pathway: Programming & Software Development (IT-PRG)

- 9.3.12.IT-PRG.4: Demonstrate the effective use of software development tools to develop software applications.
- 9.3.12.IT-PRG.5: Apply an appropriate software development process to design a software application.
- 9.3.12.IT-PRG.6: Program a computer application using the appropriate programming language.
- 9.3.12.IT-PRG.7: Demonstrate software testing procedures to ensure quality products.

Common Career Technical Core (CCTC)

Career Cluster Information Technology

IT.11 – Demonstrate knowledge of the hardware components associated with information systems.

- IT.11.1 - None available at this time.

IT-SUP.9 - Employ technical writing and documentation skills in support of an information system.

- IT-SUP.9.3 - Design technical documentation.

IT-PRG.4 - Demonstrate the effective use of software development tools to develop software applications.

- IT-PRG.4.1 - Employ tools in developing software applications.
- IT-PRG.4.3 - Apply language-specific programming tools/techniques.

IT-PRG.5 - Apply an appropriate software development process to design a software application.

- IT-PRG.5.1 - Describe software development processes and methodology.

IT-PRG.6 - Program a computer application using the appropriate programming language.

- IT-PRG.6.1 - Explain programming language concepts.
- IT-PRG.6.2 - Summarize program development methodology.
- IT-PRG.6.3 - Demonstrate proficiency in developing an application using an appropriate programming language.
- IT-PRG.6.4 - Explain basic software systems implementation.
- IT-PRG.6.6 - Resolve problems with integration.

IT-PRG.7 - Demonstrate software testing procedures to ensure quality products.

- IT-PRG.7.1 - Develop a software test plan.

Common Core State Standards (CCSS)

CCSS - English-Language Arts

Key Ideas and Details:

- CCSS.ELA-LITERACY.RL.11-12.1 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

Integration of Knowledge and Ideas:

- CCSS.ELA-LITERACY.W.11-12.1 Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

Production and Distribution of Writing:

- CCSS.ELA-LITERACY.W.11-12.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge:

- CCSS.ELA-LITERACY.W.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.

Range of Writing:

- CCSS.ELA-LITERACY.W.11-12.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences

Common Core State Standards (CCSS)

CCSS - Mathematics

Reason quantitatively and use units to solve problems:

- CCSS.MATH.CONTENT.HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

Create equations that describe numbers or relationships:

- CCSS.MATH.CONTENT.HSA-CED.A.1 Create equations and inequalities in one variable and use them to solve problems.

Analyze functions using different representations:

- CCSS.MATH.CONTENT.HSF-IF.C.7 Graph functions expressed symbolically and show key features of the graph.

Apply geometric concepts in modeling situations:

- CCSS.MATH.CONTENT.HSG-MG.A.1 Use geometric shapes, their measures, and their properties to describe objects

Calculate expected values and use them to solve problems:

- CCSS.MATH.CONTENT.HSS-MD.A.1 Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space;
- CCSS.MATH.CONTENT.HSS-MD.A.2 Calculate the expected value of a random variable;

Practice Standards - Mathematics

- 1. Make sense of problems and persevere in solving them.
- 2. Reason abstractly and quantitatively.
- 3. Construct viable arguments and critique the reasoning of others.
- 4. Model with mathematics.
- 5. Use appropriate tools strategically.
- 6. Attend to precision.
- 7. Look for and make use of structure.
- 8. Look for and express regularity in repeated reasoning.

<table>
<tr>
<td><b>Course:</b> AP Mobile Computer Science Principles
<b>Unit: 3</b> –
Algorithms and Procedural Abstractions
Using and Analyzing Data & Information
Explore Task: Impact of Computing Innovations Performance Task #2
<b>Grade Level:</b> 9-12</td>
<td>Unit Overview:
In this unit algorithms and procedures are examined in more detail. The Logo apps introduce the concept of procedural abstraction and students learn to define and use procedures -- named blocks of code that perform a specific task. By encapsulating the algorithms into named procedures and introducing parameters to help generalize the algorithms, students are led to see the advantages of procedural abstraction. In addition to designing and testing their own algorithms, students are also provided an introduction into the analysis of algorithms. Algorithm efficiency is examined for searching and sorting algorithms, which are analyzed both experimentally and through mathematical concepts such as functions and graphs. The impact section of this unit focuses on the impact that Web searching algorithms have had on our lives. The activities completed in Unit 5 build toward EU 2.2, EU 4.1, EU 4.2, EU 5.3 and EU 5.5 by focusing on abstraction, algorithms, and programming concepts.
The unit also focuses on various aspects of using and manipulating Data, both within mobile apps and on the Web and Internet. The App Inventor lessons in this unit focus on different types of programming data, including variables and structured data, such as lists and databases. Students build apps that involve persistent data, data that persists from one instance of the app to another, and learn how to share data online by using simple Application Programming Interfaces (APIs), such as the Google Fusion table API. This unit's CS Principles lessons build toward EU 3.1, EU 3.2, EU 7.1, EU 7.2, and EU 7.5 by focusing on the concept of Big Data and its growing importance and its impact on society. Students are also introduced to the some of the algorithms for processing massive datasets.
The unit culminates with the Explore Task: Impact of Computing Innovations Performance Task #2. This is task is submitted to the College Board for grading. Computing innovations impact our lives in ways that require considerable study and reflection for us to fully understand them. The close examination of a computing innovation will deepen the students' understanding of computer science principles. (see AP Computer Science Principles Course and Exam Description pages 72-75)</td>
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<tr>
<td colspan="2"><b>New Jersey Student Learning Standards (NJSLS):</b> 8.2.12.E.1, 8.2.12.E.3, 8.2.12.E.4
9.3.12.IT.11, 9.3.12.IT-SUP.9.3, 9.3.12.IT-PRG.4.1, 9.3.12.IT-PRG.4.3, 9.3.12.IT-PRG.5.1, 9.3.12.IT-PRG.6.1, 9.3.12.IT-PRG.6.3, 9.3.12.IT-PRG.6.4, 9.3.12.IT-PRG.6.6, 9.3.12.IT-PRG.7.1</td>
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<tr>
<td colspan="2"><b>Common Career Technical Core (CCTC):</b> IT.11, IT-SUP.9.3, IT-PRG.4.1, IT-PRG.4.3, IT-PRG.5.1, IT-PRG.6.1, IT-PRG.6.3, IT-PRG.6.4, IT-PRG.6.6, IT-PRG.7.1</td>
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Common Core State Standards (CCSS): RL.11-12.1; W.11-12.1; W.11-12.4; W.11-12.7; W.11-12.10; HSF-IF.C.7; HSG-MG.A.1; HSS-MD.A.1; HSS-MD.A.2;

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
A: STUDENTS WILL KNOW: EU 2.2 Multiple levels of abstraction are used to write programs or create other computational artifacts. EU 4.1 Algorithms are precise sequences of instructions for processes that can be executed by a computer and are implemented using programming languages. EU 4.2 Algorithms can solve many, but not all, computational problems. EU 5.1 Programs can be developed for creative expression, to satisfy personal curiosity, to create new knowledge, or to solve problems (to help people, organizations, or society). EU 5.3 Programming is facilitated by appropriate abstractions. EU 5.4 Programs are developed, maintained, and used by people for different purposes. EU 7.1 Computing enhances communication, interaction, and cognition. ***B: STUDENTS WILL UNDERSTAND THAT:*** EK 2.2.1C An abstraction generalizes functionality with input parameters that allow software reuse. EXCLUSION STATEMENT (for EK 2.2.1C): An understanding of the difference between value and reference parameters is beyond the scope of this course and the AP Exam.	**ESSENTIAL QUESTIONS THAT WILL FOCUS TEACHING AND LEARNING:** BI2 – How are vastly different kinds of data, physical phenomena, and mathematical concepts represented on a computer? BI2 – How does abstraction help us in writing programs, creating computational artifacts and solving problems? BI2 – How can computational models and simulations help generate new understanding and knowledge? BI4 - How are algorithms implemented and executed on computers and computational devices? BI4 - Why are some languages better than others when used to implement algorithms? BI 4 - What kinds of problems are easy, what kinds are difficult, and what kinds are impossible to solve algorithmically?	***C: STUDENTS WILL BE ABLE TO:*** LO 2.2.1 Develop an abstraction when writing a program or creating other computational artifacts. [P2] LO 2.2.2 Use multiple levels of abstraction to write programs. [P3] LO 4.1.1 Develop an algorithm for implementation in a program. [P2] LO 4.1.2 Express an algorithm in a language. [P5] LO 4.2.1 Explain the difference between algorithms that run in a reasonable time and those that do not run in a reasonable time. [P1] EXCLUSION STATEMENT (for LO 4.2.1): Any discussion of nondeterministic polynomial (NP) is beyond the scope of this course and the AP Exam.	• What is an algorithm? • Logo Part 1, • Logo Part 2, • Search Algorithms, • Sort Algorithms, • Analyzing Algorithms, • The Pong Game, • Limits of Algorithms, • Debugging Pong, • Blown to Bits: Web Searches, • Wrap up	Unit 5 - Algorithms & Procedural Abstraction Unit 5 - Algorithms & Procedural Abstraction Instructor Materials K-W-L chart Chapter 4: Needles in the Haystack of Blown to Bits

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
EK 2.2.2A Software is developed using multiple levels of abstractions, such as constants, expressions, statements, procedures, and libraries. EK 4.1.1A Sequencing, selection, and iteration are building blocks of algorithms. EK 4.1.1B Sequencing is the application of each step of an algorithm in the order in which the statements are given. EK 4.1.1C Selection uses a Boolean condition to determine which of two parts of an algorithm is used. EK 4.1.1D Iteration is the repetition of part of an algorithm until a condition is met or for a specified number of times. EK 4.1.1E Algorithms can be combined to make new algorithms. EK 4.1.1F Using existing correct algorithms as building blocks for constructing a new algorithm helps ensure the new algorithm is correct. EK 4.1.1H Different algorithms can be developed to solve the same problem. EK 4.1.1I Developing a new algorithm to solve a problem can yield insight into the problem. EK 4.1.2A Languages for algorithms include natural language, pseudocode, and visual and textual programming languages. EK 4.1.2B Natural language and pseudocode describe algorithms so that humans can understand them. EK 4.1.2C Algorithms described in programming languages can be executed on a computer. EK 4.1.2D Different languages are better suited for expressing different algorithms. EK 4.1.2E Some programming languages are designed for specific	BI4 - How are algorithms evaluated? BI5 - How are programs developed to help people, organizations, or society solve problems? BI5 - How are programs used for creative expression, to satisfy personal curiosity, or to create new knowledge? BI5 - How do computer programs implement algorithms? BI5 - How does abstraction make the development of computer programs possible? BI5 - How do people develop and test computer programs? BI5 - Which mathematical and logical concepts are fundamental to computer programming? BI7 - How does computing enhance human communication, interaction, and cognition? BI7 - How does computing enable innovation? BI7 - What are some potential beneficial and harmful effects of computing? GUIDING QUESTIONS: How are multiple levels of	LO 4.2.2 Explain the difference between solvable and unsolvable problems in computer science. [P1] EXCLUSION STATEMENT (for LO 4.2.2): Determining whether a given problem is solvable or unsolvable is beyond the scope of this course and the AP Exam. LO 4.2.3 Explain the existence of undecidable problems in computer science. [P1] LO 4.2.4 Evaluate algorithms analytically and empirically for efficiency, correctness, and clarity. [P4] LO 5.1.2 Develop a correct program to solve problems. [P2] LO 5.3.1 Use abstraction to manage complexity in programs. [P3] LO 5.4.1 Evaluate the correctness of a program. [P4] LO 7.1.1 Explain how computing innovations affect communication, interaction, and cognition. [P4]		

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
domains and are better for expressing algorithms in those domains. EK 4.1.2F The language used to express an algorithm can affect characteristics such as clarity or readability but not whether an algorithmic solution exists. EK 4.1.2G Every algorithm can be constructed using only sequencing, selection, and iteration. EK 4.1.2H Nearly all programming languages are equivalent in terms of being able to express any algorithm. EK 4.2.1A Many problems can be solved in a reasonable time. EK 4.2.1B Reasonable time means that as the input size grows, the number of steps the algorithm takes is proportional to the square (or cube, fourth power, fifth power, etc.) of the size of the input. EK 4.2.1C Some problems cannot be solved in a reasonable time, even for small input sizes. EK 4.2.1D Some problems can be solved but not in a reasonable time. In these cases, heuristic approaches may be helpful to find solutions in reasonable time. EK 4.2.2A A heuristic is a technique that may allow us to find an approximate solution when typical methods fail to find an exact solution. EK 4.2.2B Heuristics may be helpful for finding an approximate solution more quickly when exact methods are too slow. EXCLUSION STATEMENT (for EK 4.2.2B): Specific heuristic solutions are beyond the scope of this course and the AP Exam. EK 4.2.2C Some optimization	abstraction used to create computational artifacts? In what ways are some algorithms better than others? What limits do algorithms have?	LO 7.1.2 Explain how people participate in a problem solving process that scales. [P4]		

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
problems such as “find the best” or “find the smallest” cannot be solved in a reasonable time but approximations to the optimal solution can. EK 4.2.2D Some problems cannot be solved using any algorithm. EK 4.2.3A An undecidable problem may have instances that have an algorithmic solution, but there is no algorithmic solution that solves all instances of the problem. EK 4.2.3B A decidable problem is one in which an algorithm can be constructed to answer “yes” or “no” for all inputs (e.g., “is the number even?”). EK 4.2.3C An undecidable problem is one in which no algorithm can be constructed that always leads to a correct yes-or-no answer. EXCLUSION STATEMENT (for EK 4.2.3C): Determining whether a given problem is undecidable is beyond the scope of this course and the AP Exam. EK 4.2.4A Determining an algorithm’s efficiency is done by reasoning formally or mathematically about the algorithm. EK 4.2.4B Empirical analysis of an algorithm is done by implementing the algorithm and running it on different inputs. EK 4.2.4C The correctness of an algorithm is determined by reasoning formally or mathematically about the algorithm, not by testing an implementation of the algorithm. EXCLUSION STATEMENT (for EK 4.2.4C): Formally proving program correctness is beyond the				

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scope of this course and the AP Exam. EK 4.2.4D Different correct algorithms for the same problem can have different efficiencies. EK 4.2.4E Sometimes, more efficient algorithms are more complex. EK 4.2.4F Finding an efficient algorithm for a problem can help solve larger instances of the problem. EK 4.2.4G Efficiency includes both execution time and memory usage. EXCLUSION STATEMENT (for EK 4.2.4G): Formal analysis of algorithms (Big-O) and formal reasoning using mathematical formulas are beyond the scope of this course and the AP Exam. EK 4.2.4H Linear search can be used when searching for an item in any list; binary search can be used only when the list is sorted. EK 5.1.2C Incrementally adding tested program segments to correct working programs helps create large correct programs. EK 5.1.2D Program documentation helps programmers develop and maintain correct programs to efficiently solve problems. EK 5.1.2E Documentation about program components, such as blocks and procedures, helps in developing and maintaining programs. EK 5.3.1A Procedures are reusable programming abstractions. EK 5.3.1B A procedure is a named grouping of programming instructions. EK 5.3.1D Procedures have names and may have parameters and return values.				

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EK 5.3.1E Parameterization can generalize a specific solution. EK 5.3.1G Parameters provide different values as input to procedures when they are called in a program. EK 5.4.1A Program style can affect the determination of program correctness. EK 5.4.1B Duplicated code can make it harder to reason about a program. EK 5.4.1C Meaningful names for variables and procedures help people better understand programs. EK 5.4.1D Longer code blocks are harder to reason about than shorter code blocks in a program. EK 5.4.1E Locating and correcting errors in a program is called debugging the program. EK 5.4.1F Knowledge of what a program is supposed to do is required in order to find most program errors. EK 5.4.1G Examples of intended behavior on specific inputs help people understand what a program is supposed to do. EK 5.4.1H Visual displays (or different modalities) of program state can help in finding errors. EK 7.1.1G Search trends are predictors. EK 7.1.1H Social media, such as blogs and Twitter, have enhanced dissemination. EK 7.1.2D Human capabilities are enhanced by digitally enabled collaboration. EK 7.1.2E Some online services use the contributions of many people to benefit both individuals and society.				

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ESSENTIAL KNOWLEDGE, SKILLS, AND ENDURING UNDERSTANDINGS: ***A: STUDENTS WILL KNOW:*** EU 1.2 Computing enables people to use creative development processes to create computational artifacts for creative expression or to solve a problem. EU 3.1 People use computer programs to process information to gain insight and knowledge. EU 3.2 Computing facilitates exploration and the discovery of connections in information. EU 3.3 There are trade-offs when representing information as digital data. EU 5.1 Programs can be developed for creative expression, to satisfy personal curiosity, to create new knowledge, or to solve problems (to help people, organizations, or society). EU 5.2 People write programs to execute algorithms. EU 5.3 Programming is facilitated by appropriate abstractions. EU 5.5 Programming uses mathematical and logical concepts. EU 7.1 Computing enhances communication, interaction, and cognition. EU 7.2 Computing enables innovation in nearly every field. EU 7.3 Computing has a global affect —both beneficial and harmful — on people and society. ***B: STUDENTS WILL UNDERSTAND THAT:*** EK 1.2.1E Creative expressions in a	**ESSENTIAL QUESTIONS THAT WILL FOCUS TEACHING AND LEARNING:** BI1 - How can a creative development process affect the creation of computational artifacts? BI1 - How can computing and the use of computational tools foster creative expression? BI1 - How can computing extend traditional forms of human expression and experience? BI3 – How can computation be employed to help people process data and information to gain insight and knowledge? BI3 – How can computation be employed to facilitate exploration and discovery when working with data? BI3 – What considerations and trade-offs arise in the computational manipulation of data? BI3 – What opportunities do large data sets provide for solving problems and creating knowledge?	***C: STUDENTS WILL BE ABLE TO:*** LO 1.2.1 Create a computational artifact for creative expression. [P2] LO 1.2.2 Create a computational artifact using computing tools and techniques to solve a problem. [P2] LO 1.2.3 Create a new computational artifact by combining or modifying existing artifacts. [P2] LO 3.1.1 Use computers to process information, find patterns, and test hypotheses about digitally processed information to gain insight and knowledge. [P4] LO 3.1.2 Collaborate when processing information to gain insight and knowledge. [P6] LO 3.1.3 Explain the insight and knowledge gained from digitally processed data by using appropriate visualizations, notations, and precise language. [P5] LO 3.2.1 Extract information from data to discover and explain connections, patterns,	• Presidents Quiz Tutorial, • Presidents Quiz Projects, • Blown to Bits: Who Owns the Bits? • Lists of Lists, • Persistent Data, • Sharing Data on the Web, • Data Persistence Projects, • Big Data, • Using Fusion Tables to Visualize Big Data, • A Mobile Fusion Table App • Wrap up	Unit 6 - Using and Analyzing Data & Information Instructor Materials Unit 6 - Using and Analyzing Data & Information Blown to Bits Chapter 6 (starting on page 213)

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
computational artifact can reflect personal expressions of ideas or interests. EK 1.2.2A Computing tools and techniques can enhance the process of finding a solution to a problem. EK 1.2.3B Computation facilitates the creation and modification of computational artifacts with enhanced detail and precision. EK 3.1.1A Computers are used in an iterative and interactive way when processing digital information to gain insight and knowledge. EK 3.1.1B Digital information can be filtered and cleaned by using computers to process information. EK 3.1.1C Combining data sources, clustering data, and data classification are part of the process of using computers to process information. EK 3.1.1D Insight and knowledge can be obtained from translating and transforming digitally represented information. EK 3.1.1E Patterns can emerge when data is transformed using computational tools. EK 3.1.2F Investigating large data sets collaboratively can lead to insight and knowledge not obtained when working alone. EK 3.1.3A Visualization tools and software can communicate information about data. EK 3.1.3B Tables, diagrams, and textual displays can be used in communicating insight and knowledge gained from data. EK 3.1.3C Summaries of data analyzed computationally can be effective in communicating insight and knowledge gained from digitally	BI5 - How are programs developed to help people, organizations, or society solve problems? BI5 - How are programs used for creative expression, to satisfy personal curiosity, or to create new knowledge? BI5 - How do computer programs implement algorithms? BI5 - How does abstraction make the development of computer programs possible? BI5 - How do people develop and test computer programs? BI5 - Which mathematical and logical concepts are fundamental to computer programming? BI7 - How does computing enhance human communication, interaction, and cognition? BI7 - How does computing enable innovation? BI7 - What are some potential beneficial and harmful effects of computing?	or trends. [P1] LO 3.2.2. Use large data sets to explore and discover information and knowledge. [P3] LO 3.3.1 Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4] LO 5.1.2 Develop a correct program to solve problems. [P2] LO 5.2.1 Explain how programs implement algorithms. [P3] LO 5.3.1 Use abstraction to manage complexity in programs. [P3] LO 5.5.1 Employ appropriate mathematical and logical concepts in programming. [P1] LO 7.1.1 Explain how computing innovations affect communication, interaction, and cognition. [P4] LO 7.2.1 Explain how computing has impacted innovations in other fields. [P1] LO 7.3.1 Analyze the beneficial and harmful effects		

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
represented information. EK 3.1.3D Transforming information can be effective in communicating knowledge gained from data. EK 3.1.3E Interactivity with data is an aspect of communicating. EK 3.2.1A Large data sets provide opportunities and challenges for extracting information and knowledge. EK 3.2.1B Large data sets provide opportunities for identifying trends, making connections in data, and solving problems. EK 3.2.1C Computing tools facilitate the discovery of connections in information within large data sets. EK 3.2.1E Information filtering systems are important tools for finding information and recognizing patterns in the information. EK 3.2.1F Software tools, including spreadsheets and databases, help to efficiently organize and find trends in information. EXCLUSION STATEMENT (for EK 3.2.1F): Students are not expected to know specific formulas or options available in spreadsheet or database software packages. EK 3.2.2A Large data sets include data such as transactions, measurements, texts, sounds, images, and videos. EK 3.2.2B The storing, processing, and curating of large data sets is challenging. EK 3.2.2C Structuring large data sets for analysis can be challenging. EK 3.2.2D Maintaining privacy of large data sets containing personal information can be challenging.	GUIDING QUESTIONS: How does continuous access to large amounts of data change how people and organizations make decisions? How do computers put things in order and find things in a list? What is the connection between data, information, knowledge, and wisdom?	of computing. [P4]		

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
EK 3.2.2E Scalability of systems is an important consideration when data sets are large. EK 3.2.2F The size or scale of a system that stores data affects how that data set is used. EK 3.2.2G The effective use of large data sets requires computational solutions. EK 3.2.2H Analytical techniques to store, manage, transmit, and process data sets change as the size of data sets scale. EK 3.3.1G Data is stored in many formats depending on its characteristics (e.g., size and intended use). EK 3.3.1I Reading data and updating data have different storage requirements. EK 5.1.2B Developing correct program components and then combining them helps in creating correct programs. EK 5.1.2C Incrementally adding tested program segments to correct working programs helps create large correct programs. EK 5.1.2H Consultation and communication with program users is an important aspect of program development to solve problems. EK 5.2.1C Program instructions may involve variables that are initialized and updated, read, and written. EK 5.3.1K Lists and list operations, such as add, remove, and search, are common in many programs. EK 5.3.1L Using lists and procedures as abstractions in programming can result in programs that are easier to develop and maintain. EK 5.5.1H Computational methods may use lists and collections to solve				

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
problems. EK 5.5.1I Lists and other collections can be treated as abstract data types (ADTs) in developing programs. EK 5.5.1J Basic operations on collections include adding elements, removing elements, iterating over all elements, and determining whether an element is in a collection. EK 7.1.1F Public data provides widespread access and enables solutions to identified problems. EK 7.2.1C Computing enables innovation by providing the ability to access and share information. EK 7.2.1D Open access and Creative Commons have enabled broad access to digital information. EK 7.2.1E Open and curated scientific databases have benefited scientific researchers. EK 7.3.1A Innovations enabled by computing raise legal and ethical concerns. EK 7.3.1B Commercial access to music and movie downloads and streaming raises legal and ethical concerns. EK 7.3.1C Access to digital content via peer-to-peer networks raises legal and ethical concerns. EK 7.3.1D Both authenticated and anonymous access to digital in format EK 7.3.1P The Digital Millennium Copyright Act (DMCA) has been a benefit and a challenge in making copyrighted digital material widely available.				

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
ESSENTIAL KNOWLEDGE, SKILLS, AND ENDURING UNDERSTANDINGS: ***A: STUDENTS WILL KNOW:*** EU 1.1 Creative development can be an essential process for creating computational artifacts. EU 1.2 Computing enables people to use creative development processes to create computational artifacts for creative expression or to solve a problem. EU 3.1 People use computer programs to process information to gain insight and knowledge. EU 3.3 There are trade-offs when representing information as digital data. EU 7.1 Computing enhances communication, interaction, and cognition. EU 7.3 Computing has a global affect — both beneficial and harmful — on people and society. EU 7.4 Computing innovations influence and are influenced by the economic, social, and cultural contexts in which they are designed and used. EU 7.5 - An investigative process is aided by effective organization and selection of resources. Appropriate technologies and tools facilitate the accessing of information and enable the ability to evaluate the credibility of sources. ***B: STUDENTS WILL UNDERSTAND THAT:*** EK 1.1.1A A creative process in the development of a computational artifact can include, but is not limited	**ESSENTIAL QUESTIONS THAT WILL FOCUS TEACHING AND LEARNING:** BI1 - How can a creative development process affect the creation of computational artifacts? BI1 - How can computing and the use of computational tools foster creative expression? BI1 - How can computing extend traditional forms of human expression and experience? BI3 – How can computation be employed to help people process data and information to gain insight and knowledge? BI3 – How can computation be employed to facilitate exploration and discovery when working with data? BI3 – What considerations and trade-offs arise in the computational manipulation of data? BI3 – What opportunities do large data sets provide for solving problems and creating knowledge?	***C: STUDENTS WILL BE ABLE TO:*** LO 1.1.1 Apply a creative development process when creating computational artifacts. [P2] LO 1.2.1 Create a computational artifact for creative expression. [P2] LO 1.2.2 Create a computational artifact using computing tools and techniques to solve a problem. [P2] LO 1.2.3 Create a new computational artifact by combining or modifying existing artifacts. [P2] LO 1.2.5 Analyze the correctness, usability, functionality, and suitability of computational artifacts. [P4] LO 3.1.3 Explain the insight and knowledge gained from digitally processed data by using appropriate visualizations, notations, and precise language. [P4] LO 3.3.1 Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4]	Explore: Impact of a Computing Innovation Performance Task #2 (Creativity, Impact) Review the official proposed Explore Performance Task Fall 2015 Version **(effective as of 12/01/2015)** from the College Board. Students will select a computing innovation and then carefully follow all of the directions as presented by the College Board. A written report and artifact will be completed individually and address the requirements and prompts as outlined in the Performance Task directions.	Explore: Impact of Computing Innovations Performance Task #2 Explore: Impact of Computing Innovations Performance Task #2 - INSTRUCTOR MATERIALS

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
to, employing nontraditional, non-prescribed techniques; the use of novel combinations of artifacts, tools, and techniques; and the exploration of personal curiosities. EK 1.1.1B Creating computational artifacts employs an iterative and often exploratory process to translate ideas into tangible form. EK 1.2.1A A computational artifact is something created by a human using a computer and can be, but is not limited to, a program, an image, audio, video, a presentation, or a Web page file. EK 1.2.1B Creating computational artifacts requires understanding of and use of software tools and services. EK 1.2.1D A creatively developed computational artifact can be created by using nontraditional, non-prescribed computing techniques. EK 1.2.1E Creative expressions in a computational artifact can reflect personal expressions of ideas or interests. EK 1.2.2B A creative development process for creating computational artifacts can be used to solve problems when traditional or prescribed computing techniques are not effective. EK 1.2.3A Creating computational artifacts can be done by combining and modifying existing artifacts or by creating new artifacts. EK 1.2.5A The context in which an artifact is used determines the correctness, usability, functionality, and suitability of the artifact. EK 1.2.5B A computational artifact may have weaknesses, mistakes, or errors depending on the type of	BI7 - How does computing enhance human communication, interaction, and cognition? BI7 - How does computing enable innovation? BI7 - What are some potential beneficial and harmful effects of computing? GUIDING QUESTIONS: What computational research do you want to do? How does this research pertain to computer science? • What aspect of computer science is the most interesting to you?	LO 7.1.1 Explain how computing innovations affect communication, interaction, and cognition. [P4] LO 7.3.1 Analyze the beneficial and harmful effects of computing. [P4] LO 7.4.1 Explain the connections between computing and economic, social, and cultural contexts. [P1] LO 7.5.1 Access, manage, and attribute information using effective strategies. [P1] LO 7.5.2 Evaluate online and print sources for appropriateness and credibility. [P1]		

Student Learning Objectives (SLOs)	Essential Questions	Skills & Indicators	Sample Activities	Resources
artifact. EK 3.1.3A Visualization tools and software can communicate information about data. EK 3.1.3B Tables, diagrams, and textual displays can be used in communicating insight and knowledge gained from data. EK 3.1.3C Summaries of data analyzed computationally can be effective in communicating insight and knowledge gained from digitally represented information. EK 3.1.3D Transforming information can be effective in communicating knowledge gained from data. EK 3.1.3E Interactivity with data is an aspect of communicating. EK 3.3.1A Digital data representations involve trade-offs related to storage, security, and privacy concerns. EK 3.3.1B Security concerns engender trade-offs in storing and transmitting information. EK 3.3.1E Lossy data compression can significantly reduce the number of bits stored or transmitted at the cost of being able to reconstruct only an approximation of the original data. EK 3.3.1F Security and privacy concerns arise with data containing personal information. EK 3.3.1G Data is stored in many formats depending on its characteristics (e.g., size and intended use). EK 3.3.1H The choice of storage media affects both the methods and costs of manipulating the data it contains. EK 3.3.1I Reading data and updating data have different storage requirements.				

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EK 7.1.1M The Internet and the Web have enhanced methods of and opportunities for communication and collaboration. EK 7.1.1N The Internet and the Web have changed many areas, including e-commerce, health care, access to information and entertainment, and online learning. EK 7.3.1J Technology enables the collection, use, and exploitation of information about, by, and for individuals, groups, and institutions. EK 7.3.1K People can have instant access to vast amounts of information online; accessing this information can enable the collection of both individual and aggregate data that can be used and collected. EK 7.4.1A The innovation and impact of social media and online access varies in different countries and in different socioeconomic groups. EK 7.4.1B Mobile, wireless, and networked computing have an impact on innovation throughout the world. •				

Unit 3 Vocabulary	
Algorithm Procedures Abstractions Pseudocode Parameters Boolean Condition Logarithmic algorithm Linear algorithm n log n algorithm Quadratic algorithm Intractability Undecidability unsolvable	**Blown to Bits Chapter 4 Vocabulary** Background binary bot. cache firewall foreground HTML URL **Blown to Bits Chapter 6 Vocabulary** centralized systems commons: DRAM: DRM: flooding: gigabyte: peer-to-peer architecture: piracy: sealed storage: TPM: trusted platform module

Suggested Unit Projects

Choose At Least One

Explore: Impact of Computing Innovations Performance Task #2 https://ram8647.appspot.com/mobileCSP/assessment?name=115	**Create an original Pong game on scratch** https://scratch.mit.edu/projects/10000036/ https://scratch.mit.edu/projects/13152172/

Suggested Structured Learning Experiences

Arrange Code.org volunteers to visit your school and share their work experiences in technology with the students https://code.org see Volunteer	**Tour of Kean University's NSF funded automatic virtual environment (CAVE)** https://www.kean.edu/~cssc/workshops.html