AP® Computer Science Principles

Course Planning and Pacing Guide

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Greater Hartford Academy of Math and Science ▸ Hartford, CT

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The College Board strongly encourages educators to make equitable access a guiding principle for their AP® programs by giving all willing and academically prepared students the opportunity to participate in AP. We encourage the elimination of barriers that restrict access to AP for students from ethnic, racial, and socioeconomic groups that have been traditionally underrepresented. Schools should make every effort to ensure their AP classes reflect the diversity of their student population. The College Board also believes that all students should have access to academically challenging course work before they enroll in AP classes, which can prepare them for AP success. It is only through a commitment to equitable preparation and access that true equity and excellence can be achieved.

Welcome to the AP Computer Science Principles Course Planning and Pacing Guides

This guide is one of several course planning and pacing guides designed for AP Computer Science Principles teachers. Each provides an example of how to design instruction for the AP course based on the author's teaching context (e.g., demographics, schedule, school type, setting). These course planning and pacing guides highlight how the components of the *AP Computer Science Principles Curriculum Framework* — including the learning objectives, essential knowledge statements, and computational thinking practices — are addressed in the course. Each guide also provides valuable suggestions for teaching the course, including the selection of resources, instructional activities, and classroom assessments. The authors have offered insight into the *why* and *how* behind their instructional choices — displayed along the right side of the individual unit plans — to aid in course planning for AP Computer Science Principles teachers.

The primary purpose of these comprehensive guides is to model approaches for planning and pacing curriculum throughout the school year. However, they can also help with syllabus development when used in conjunction with the resources created to support the AP Course Audit: the Syllabus Development Guide and the four Annotated Sample Syllabi. These resources include samples of evidence and illustrate a variety of strategies for meeting curricular requirements.

Contents

Instructional Setting

Greater Hartford Academy of Math and Science ▸ Hartford, CT

School

The Greater Hartford Academy of Math and Science is a half-day public magnet school for students in grades 9–12. It hosts the Academy of Aerospace and Engineering, which is a full-day public magnet school. Students in both schools are in the same math and science classes.

Student population

The total enrollment of the two schools is 471 students. Student demographics are as follows:

- 61 percent Caucasian
- 20.2 percent black or African American
- 19.3 percent Hispanic
- 14.6 percent Asian
- 3.6 percent multiracial
- 0.6 percent American Indian or Alaska Native

Typically, all seniors go on to attend a four-year college or university.

Instructional time

The school year begins the last week of August and has 180 instructional days. Classes meet for 46 minutes for 3 days of the week and for 100 minutes for one day of the week, totaling approximately 238 minutes of instructional time per week.

Student preparation

The AP Computer Science Principles course is offered as an elective for juniors and seniors, most of whom have completed Algebra 1 and Geometry and are expected to be familiar with variables and functions. Most of the students in this class have had no prior experience with computer science.

Instructional Setting (continued)

Primary planning resources

Morelli, Ralph, Jen Rosato, Chery Takkunen, Chinma Uche, and Dave Wolber. Mobile CSP. Accessed June 9, 2015. **https://ram8647.appspot.com/mobileCSP/course**.

———. "Teaching Mobile CSP Principles." Mobile CSP. Accessed June 9, 2015. **https://ram8647.appspot.com/teach_mobileCSP/course**.

I use Mobile CSP as the primary source for my classes. This fully developed set of resources addresses all the big ideas and computational thinking practices in the AP Computer Science Principles Curriculum Framework. *The curriculum resources have both a student-facing site and a teacher-facing site, both of which cover day-to-day classroom organization and instruction. The course includes classroom-tested tools and assessments that have been successfully used in more than 100 classrooms.*

NOTE: *Teachers and students will need to register for this course (for free) at the links above in order to use these materials. The first link is for the student-facing site, and the second link is for the teacher-facing site.*

App Inventor. Accessed June 17, 2015. **http://appinventor.mit.edu.**

I use App Inventor from MIT for the programming component of the course. This is a visual block-based tool for developing mobile apps on the Android platform.

Abelson, Hal, Ken Ledeen, and Harry Lewis. *Blown to Bits: Your Life, Liberty, and Happiness After the Digital Explosion.* New York: Addison-Wesley, 2008. Accessed June 9, 2015. **http://www.bitsbook.com.**

Blown to Bits *provides engaging readings about the digital world and its social and political ramifications in regard to the past, present, and future. It is available free as a PDF online and for purchase in print.*

Overview of the Course

I use the Mobile CSP course because it uses App Inventor to develop mobile apps on the Android platform. App Inventor is a simple and powerful programming language that is appealing to students. The course emphasizes hands-on activities, creativity, collaboration, and connections to real-world applications as students write socially useful apps. Mobile CSP also provides classroom-tested and paced lessons that cover all the curriculum specifications of the *AP Computer Science Principles Curriculum Framework* at a free and open Google Course Builder site. The course is presented in two complementary pages: a student-facing page and a teacher-facing page. Mobile CSP recommends a one to two ratio of tablets (or smartphones) to students in the classroom.

The app development activities form the basis for covering the Creativity and Programming Big Ideas of the curriculum framework. Other resources, such as CS Unplugged activities, readings from *Blown to Bits*, and excerpts from *CS Bits & Bytes*, help cover all the other big ideas. In fact, learning App Inventor requires learning the skills needed for most programming languages, whereas the readings and projects cover nonprogramming aspects of computer science. My classes use Google resources extensively; each student needs a Google account to access course materials and maintain his or her own portfolios hosted on Google Sites.

The course is developed for all students and assumes that they have experience with Internet browsers, word processors, and calculators. The course builds on this knowledge but teaches App Inventor, which most students have not encountered. The lessons tap into prior knowledge by including a hook or motivation related to something the student may already know about or have learned in the course and include videos, printable lessons, and PowerPoint presentations that give teachers options for delivering the lesson, depending on how their students learn. The resources can also be used in a flipped classroom. Students can move at their own pace to a large degree because of the online materials presented throughout most of the course.

Mobile CSP lessons include online quizzes and portfolio write-ups that can be used as formative assessments. End-of-unit summative assessments are provided as well, and the course also has exit slips in some of the lessons as check-ins. Rubrics are provided for projects, and there are surveys in which students can self-rate their skills and learning. Mobile CSP is currently working on adding a teacher dashboard to the course so that teachers can monitor their students' progress and identify any concepts with which students might be struggling.

Mobile CSP provides links to the National Center for Women & Information Technology (NCWIT), the Computer Science Teachers Association, and other resources (posters, Talking Points cards, Counselors for Computing packets) for active recruiting. Our school includes an introductory app development unit in a 9th grade engineering course to expose all 9th grade students to computer science in a nonintimidating setting and to show them that they can be successful in studying computer science. We also run many activities throughout the year to promote computer science schoolwide, such as celebrating Computer Science Education Week (**www.csedweek.org**), during which all students participate in an Hour of Code event. Other activities include inviting prominent computer science experts as guest speakers to talk to students about studying the field, conducting field trips to local companies, hosting a cybersecurity workshop, and encouraging female students to participate in the Technovation Challenge (**http://www.technovationchallenge.org/home**). Computer science awards such as the NCWIT Aspirations Awards are given at the school's annual awards ceremony, and an afterschool computer science club brings together experienced and inexperienced programmers. Collectively, these activities have been successful in recruiting students into computer science courses.

Computational Thinking Practices

P1: Connecting Computing

Developments in computing have far-reaching effects on society and have led to significant innovations. The developments have implications for individuals, society, commercial markets, and innovation. Students in this course study these effects, and they learn to draw connections between different computing concepts. Students are expected to:

- Identify impacts of computing.
- Describe connections between people and computing.
- Explain connections between computing concepts.

P2: Creating Computational Artifacts

Computing is a creative discipline in which creation takes many forms, such as remixing digital music, generating animations, developing websites, and writing programs. Students in this course engage in the creative aspects of computing by designing and developing interesting computational artifacts as well as by applying computing techniques to creatively solve problems. Students are expected to:

- Create an artifact with a practical, personal, or societal intent.
- Select appropriate techniques to develop a computational artifact.
- Use appropriate algorithmic and information management principles.

P3: Abstracting

Computational thinking requires understanding and applying abstraction at multiple levels, such as privacy in social networking applications, logic gates and bits, and the human genome project. Students in this course use abstraction to develop models and simulations of natural and artificial phenomena, use them to make predictions about the world, and analyze their efficacy and validity. Students are expected to:

- Explain how data, information, or knowledge is represented for computational use.
- Explain how abstractions are used in computation or modeling.
- Identify abstractions.
- Describe modeling in a computational context.

P4: Analyzing Problems and Artifacts

The results and artifacts of computation and the computational techniques and strategies that generate them can be understood both intrinsically for what they are as well as for what they produce. They can also be analyzed and evaluated by applying aesthetic, mathematical, pragmatic, and other criteria. Students in this course design and produce solutions, models, and artifacts, and they evaluate and analyze their own computational work as well as the computational work others have produced. Students are expected to:

- Evaluate a proposed solution to a problem.
- Locate and correct errors.
- Explain how an artifact functions.
- Justify appropriateness and correctness of a solution, model, or artifact.

P5: Communicating

Students in this course describe computation and the impact of technology and computation, explain and justify the design and appropriateness of their computational choices, and analyze and describe both computational artifacts and the results or behaviors of such artifacts. Communication includes written and oral descriptions supported by graphs, visualizations, and computational analysis. Students are expected to:

- Explain the meaning of a result in context.
- Describe computation with accurate and precise language, notations, or visualizations.
- Summarize the purpose of a computational artifact.

P6: Collaborating

Innovation can occur when people work together or independently. People working collaboratively can often achieve more than individuals working alone. Learning to collaborate effectively includes drawing on diverse perspectives, skills, and the backgrounds of peers to address complex and open-ended problems. Students in this course collaborate on a number of activities, including investigation of questions using data sets and in the production of computational artifacts. Students are expected to:

- Collaborate with another student in solving a computational problem.
- Collaborate with another student in producing an artifact.
- Share the workload by providing individual contributions to an overall collaborative effort.
- Foster a constructive, collaborative climate by resolving conflicts and facilitating the contributions of a partner or team member.
- Exchange knowledge and feedback with a partner or team member.
- Review and revise their work as needed to create a high-quality artifact.

Pacing Overview

Unit	Hours of Instruction	Unit Summary
1: Creativity and Computing: Preview and Setup	7	This unit introduces the *AP Computer Science Principles Curriculum Framework* using Mobile CSP resources. Discussions of what computer science is, what a computer is, what the student expectations are in the course, what the course offers, and why students should take a computer science course, as well as a brief look at computer ethics, are supported with videos. A major activity is each student's creation of a Google Site, where he or she will host projects and reflections. The development and testing of the test app piques students' interest in the course.
2: Mobile Computers and Mobile Apps	10	Unit 2 focuses on the different views of App Inventor (the Designer view and the Blocks Editor view) and their role in the development of mobile apps for the Android platform. The development of the I Have a Dream app and a compass app introduces students to variables and conditional statements. Students also become familiar with some computer science terminology, such as *hardware, software, operating systems*, and *programming languages*. This unit emphasizes the different levels of hardware and software abstractions in a computer system.
3: Graphics and Drawing	10	Unit 3 more fully explores the App Inventor features that support graphics and drawing, such as Canvas in the Paint Pot app. The List data structure is introduced, and variables as abstractions are examined. The Magic 8 Ball and Map Tour apps are used to illustrate the use of the Activity Starter to access applications written by others. The timing of this unit encourages students to develop apps for a CSEdWeek showcase.
4: Animations, Simulations, and Modeling	13	Unit 4 focuses on abstraction and, more specifically, on simulations and modeling. Students use the Animation drawer of App Inventor to create, modify, and extend the Android Mash app while learning the different ways in which App Inventor models random numbers. Students explore pseudorandom number generators, as well as real-life models and ways in which technology affects people's privacy. A practice Explore Performance Task based on a phone-monitoring app is used to explain the requirements of the task. A midterm exam is available to registered teachers on Mobile CSP.
5: Algorithms and Procedural Abstractions	10	Unit 5 focuses on algorithms and uses the Logo app to strengthen students' understanding of procedure and control structures. Students explore some standard searching algorithms (linear and binary) and sorting algorithms (bubble, merge, and bucket) through hands-on activities. The unit introduces students to algorithm analysis. It also discusses Web searches through a chapter of *Blown to Bits* and has a focus on how Google searches work and the PageRank algorithm. Students complete the Explore Performance Task at the end of this unit.

Pacing Overview (continued)

Unit	Hours of Instruction	Unit Summary
6. Lists, Databases, Data, and Information	13	Unit 6 uses the fact that data is everywhere around us to discuss ways in which data can be stored and manipulated. It explores the List indexing features of App Inventor and tools for handling persistent data, including TinyDB and TinyWebDB. The Android Mash app is enhanced to develop a multiplayer app. Readings from *Blown to Bits* focus on the use and ownership of digital media, including discussions of file sharing. Data visualization tools, including the Fusion Table, are examined.
7: The Internet	10	Unit 7 focuses on the Internet, how it works, and how it is secured. Students take an in-depth look at cryptography. Three apps — No Texting While Busy, My Direction, and Broadcast Hub — are used to illustrate features of the Internet and its impact. Command-line features and some network architecture are introduced and discussed. Students complete the Create Performance Task at the end of this unit.
8. Further Explorations	10	Unit 8 is optional and will be applicable in schools at which students have a significant amount of time after the AP Computer Science Principles Exam (such as schools in the Northeast). This unit suggests activities that can be carried out for the last month or so of school. Suggestions include introductions to text-based programming using Hour of Code activities, Code in the Browser, and/or Greenfoot. An alternative is to allow students to explore any tools in which they have an interest, such as Game Maker, HTML and CSS, Arduino, Makey Makey, and Raspberry Pi.

UNIT 1: CREATIVITY AND COMPUTING: PREVIEW AND SETUP

Estimated Time: 15 Hours

BIG IDEA 1 Creativity
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 4.1, EU 5.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Mazes, Algorithms, and Programs
- Google Account and Portfolio Setup
- App Inventor Setup
- Diversity in Computing

Guiding Questions

- **Where do you see computers, and what do they do?**
- **How do you prepare yourself for the jobs of the future?**
- **Who created your favorite app?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 4.1.1: Develop an algorithm for implementation in a program. [P2] **LO 5.2.1:** Explain how programs implement algorithms. [P3]	**Web** Mobile CSP, 1.2: "Mazes, Algorithms, and Programs" "Hour of Code: Maze #1"	**Instructional Activity: Mazes, Algorithms, and Programs** In this first activity, students use "Hour of Code: Maze #1," which introduces block-based programming through Blockly. I also introduce some basic vocabulary through Mobile CSP, section 1.2 (*algorithm*, *program*, and *control structures*). Students will use this vocabulary throughout the course with the Hour of Code maze puzzles (accessible to all students). Students work on all 20 levels of the mazes on separate computers but are paired up so that everyone has another student to confer with when encountering difficulty. The completion of all 20 levels of puzzles is indicative of success in the use of sequences, selection, repetition, or a combination. **Essential knowledge addressed: 4.1.1** A-E; **5.2.1** A, B

Students like to work alone through the puzzles, but pairing students up facilitates peer-to-peer discussions of the control structure in use at the time.

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Learning Objectives	Materials	Instructional Activities and Classroom Assessments
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]	**Web** Mobile CSP, 1.3: "Google Account and Portfolio Setup" Google Sites	**Instructional Activity: Google Account and Portfolio Setup** Students set up a Google account specifically for the course. With this account, they create a Google site where they will host most of their work and share their ideas on contemporary issues throughout the course (see the next Formative Assessment). Each student's Google site will serve as his or her portfolio for this course. Students independently customize their site, reflecting the Mobile CSP style (see section 1.3), as well as their own personal style. Google Sites will also support writing skills and provide resources for review. It is essential that students successfully create an account and become familiar with the Google tools available. I encourage them to explore the tools in preparation for creating their portfolios. **Essential knowledge addressed: 1.1.1** A, B; **1.2.1** A, B, E; **1.2.2** A; **1.2.3** A-C
	Web Mobile CSP, 1.3: "Google Account and Portfolio Setup" Google Sites	**Formative Assessment: Personalized Google Site** Students independently follow directions in Mobile CSP section 1.3 to create and personalize their own Google site. At minimum, their home page should contain some personal information, including a photo or an image. Students submit their URLs to me by the end of the class period. **Essential knowledge addressed: 1.1.1** A, B; **1.2.1** A, B, E; **1.2.2** A; **1.2.3** A-C

Google Sites helps students share their work with others and is a great example of cloud computing; it allows students to access their work anywhere there is Wi-Fi access and a Wi-Fi–enabled device. I encourage students to create a Google account specifically for the course and not to use their personal accounts.

Formative assessments are included in the Mobile CSP student-facing site, while pedagogical considerations are on the Mobile CSP teacher-facing site.

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Enduring Understandings:

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Guiding Questions

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Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 1.1.1: Apply a creative development process when creating computational artifacts. [P2] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4]	**Web** Mobile CSP, 1.4: "App Inventor Setup" App Inventor	**Instructional Activity: App Inventor Setup** With the help of Mobile CSP section 1.4, students use their Google account to set up App Inventor. I encourage them to set up their Android device to use a Wi-Fi link, a USB cable, and the emulator. After setup, students download and use a test app to show that their device is properly configured. The test app gently introduces the features of App Inventor, namely Designer and Block Editor. By the end of this activity, students should have set up their Android devices and successfully displayed the test app. Creating a functional mobile app is a very rewarding experience for any student. This activity is the first of many moments of elation that students experience at the end of each app development. **Essential knowledge addressed: 1.1.1** A; **7.1.1** D	*Be sure to work with your IT department to ensure that the school's network is set up to allow App Inventor. Successfully running the test app establishes that the network is ready for development.*
LO 6.3.1: Identify existing cybersecurity concerns and potential options to address these issues with the Internet and the systems built on it. [P1] **LO 7.3.1:** Analyze the beneficial and harmful effects of computing. [P4] **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. [P5]	**Web** Mobile CSP, 1.5: "Blown to Bits" *CS Bits & Bytes*, "Self Driving Cars" Litvin and Litvin, "Appendix F: Computing in Context: Responsible and Ethical Computer Use," section F1 (prologue)	**Instructional Activity: Computer Ethics** In this activity, students read Appendix F of Maria and Gary Litvin's *Java Methods A & AB* and discuss the responsible and ethical use of computers. They read section F1 (prologue) as a class and then split up into groups. Each group reads one of the other sections ("Responsible Use of Computer Systems," "System Reliability and Security," or "Legal Issues") and summarizes for the class. Each group also reads "Searching the Internet," and one student reads aloud the conclusion. Students enjoy discussions of the responsible and ethical use of computers and easily find current examples illustrating their own views. This is meant to stimulate interest and encourage students to be responsible computer users. I also introduce *CS Bits & Bytes*, which highlights recent innovations in computing. **Essential knowledge addressed: 6.3.1** A, F, G; **7.3.1** A, Q; **7.5.1** A-C; **7.5.2** A, B	*When I have the time, I often allow students to explore the activities on "Self Driving Cars" in CS Bits & Bytes. If we do not complete these activities in class, I assign them as homework. These fun activities show students early in the course the power of computing. For such activities, students use the Snipping tool to get screenshots of completed levels.*

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Enduring Understandings:

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Projects and Major Assignments:

- Mazes, Algorithms, and Programs
- Google Account and Portfolio Setup
- App Inventor Setup
- Diversity in Computing

Guiding Questions

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- Who created your favorite app?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 7.1.1: Explain how computing innovations affect communication, interaction, and cognition. [P4] **LO 7.1.2:** Explain how people participate in a problem-solving process that scales. [P4]	**Web** Mobile CSP, 1.6: "Joining the Forum" Mobile CSP, Forum	**Instructional Activity: The Forum (Optional)** I introduce students to the Forum on the Mobile CSP site as a tool to access help and troubleshoot problems that arise during the course. Mobile CSP, section 1.6, lays out instructions on how to join the forum. We discuss as a class the etiquette of using the forum (laid out on the student-facing site in section 1.6) and how to find help. **Essential knowledge addressed: 7.1.1** A; **7.1.2** E, F
LO 7.4.1: Explain the connections between computing and real-world contexts, including economic, social, and cultural contexts. [P1]	**Web** "What Most Schools Don't Teach" "Who Is Grace Hopper?" "Women of the Digital Age" "Why Diversity in Computer Science Is Important" *CS Bits & Bytes*, "Diversity in Computing"	**Instructional Activity: Diversity in Computing** This activity starts with the projection, watching, and discussion of "What Most Schools Don't Teach," which encourages students to study computer science and gives them a glimpse into the lives of successful software engineers. Students then read "Diversity in Computing," and we have a whole-class discussion about who a computer scientist is: *What does a computer scientist look like? What does a computer scientist do*? The discussion is followed by a look at some historical figures, including Rear Admiral Grace Hopper and Ada Lovelace in "Power To Change the World," "Who Is Grace Hopper?," and "Women of the Digital Age." These videos discuss gender and computer science and show how women have contributed to the field. **Essential knowledge addressed: 7.4.1** C

I ask small groups to watch specific videos and then share what they have learned. Then we watch "What Most Schools Don't Teach" as a class and discuss the message as a group.

UNIT 1: CREATIVITY AND COMPUTING: PREVIEW AND SETUP

Estimated Time: 15 Hours

BIG IDEA 1 Creativity
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 4.1, EU 5.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Mazes, Algorithms, and Programs
- Google Account and Portfolio Setup
- App Inventor Setup
- Diversity in Computing

Guiding Questions

- **Where do you see computers, and what do they do?**
- **How do you prepare yourself for the jobs of the future?**
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Learning Objectives	Materials	Instructional Activities and Classroom Assessments
All of the learning objectives in this unit are addressed.	**Web** "Instructional Videos" "Unit 1 Review"	**Summative Assessment: Unit Test** This summative test, hosted on Google Drive, includes 20 multiple-choice and six free-response questions. Questions focus on features of App Inventor and Google Sites, as well as students' perception of the course. **All of the unit's essential knowledge statements are addressed.**

This summative assessment addresses all of the guiding questions for this unit.
To administer a test, I send students a link, which they open and complete in class. As they submit their work, the answers are collected on a Google Sheet. The multiple-choice section is graded using a Google add-on called Flubaroo.

UNIT 2: MOBILE COMPUTERS AND MOBILE APPS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:

- What Is Abstraction? ▸ Binary Numbers ▸ The Digital Explosion ▸ Mobile Apps and Mobile Devices

Guiding Questions

▸ What does it mean to program a computer? ▸ What are some abstractions encountered in programming with App Inventor? ▸ When can a conditional statement be used?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 1.2.1: Create a computational artifact for creative expression. [P2] **LO 1.2.3:** Create a new computational artifact by combining or modifying existing artifacts. [P2] **LO 1.3.1:** Use computing tools and techniques for creative expression. [P2] **LO 5.1.1:** Develop a program for creative expression, to satisfy personal curiosity, or to create new knowledge. [P2] **LO 5.2.1:** Explain how programs implement algorithms. [P3] **LO 5.4.1:** Evaluate the correctness of a program. [P4]	**Web** Mobile CSP, 2.2: "I Have a Dream Tutorial," 2.3: "I Have a Dream Part 2," and 2.5: "I Have a Dream Projects" "Pair Programming"	**Instructional Activity: I Have a Dream** Students explore App Inventor's programming platform by developing an app that plays the famous "I Have a Dream" speech. In Mobile CSP, section 2.2, students learn what the App Inventor program is, how an event handler is used, and how an app makes decisions with if-else control blocks. In section 2.3, students modify the app and create simple programs. Pair programming, described in the video, encourages collaboration. Stepwise refinement, in which programming is carried out in stages with errors corrected, is used as a problem-solving tool. Students also learn to resize images and edit sound files to meet App Inventor's size limits. Section 2.5 gives extension ideas to allow for creativity. As students enhance the app, we discuss copyright violations and free and open-source media. **Essential knowledge addressed: 1.2.1** A, E; **1.2.3** A; **1.3.1** E; **5.1.1** B; **5.2.1** A; **5.4.1** C-E, M
	Web Mobile CSP, 2.2: "I Have a Dream Tutorial," 2.3: "I Have a Dream Part 2," and 2.5: "I Have a Dream Projects" Google Sites	**Formative Assessment: I Have a Dream App Development** Students complete interactive quizzes in Mobile CSP, sections 2.2, 2.3, and 2.5, as well as reflections for their portfolios on the app development process. They also post their I Have a Dream app on their Google Sites. **Essential knowledge addressed: 1.2.1** A, E; **1.2.3** A; **5.1.1** B; **5.2.1** A; **5.4.1** C-E, M

The I Have a Dream app and its enhancements are broken down into chunks that can be taught over three or four lessons. Each student has a school-provided laptop. Students often want to work on their own and chat with peers when they have questions. We promote pair programming because it supports collaboration. The teacher has to be flexible because some students work ahead of the class.

The interactive questions at the end of each subunit in Mobile CSP enable students to get immediate feedback. Students learn how to build QR codes for their apps, and by posting their apps on their Google Sites they allow other students to download and test their apps.

UNIT 2: MOBILE COMPUTERS AND MOBILE APPS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▸ EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:

▸ What Is Abstraction? ▸ Binary Numbers ▸ The Digital Explosion ▸ Mobile Apps and Mobile Devices

Guiding Questions

▸ **What does it mean to program a computer?** ▸ **What are some abstractions encountered in programming with App Inventor?** ▸ **When can a conditional statement be used?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 2.1.1: Describe the variety of abstractions used to represent data. [P3]	**Web** Mobile CSP, 2.6: "What Is Abstraction?"	**Instructional Activity: What Is Abstraction?** I give a lecture describing abstraction (PowerPoint slides are available on the Mobile CSP teacher-facing site for section 2.6), and then I divide students into groups to brainstorm different examples of abstraction. Abstraction is introduced as a "habit of the mind" and a representation of a thing such as "chair," "rectangle," or "Mr. Smith." As in every other activity, students have access to the video recording of the lecture in Mobile CSP plus the text version of the lecture for easy, differentiated reviewing. **Essential knowledge addressed: 2.1.1** A	*This activity begins a discussion of what abstraction is. The idea is that if I say "chair," different people have different concepts of a chair. Some may think of a particular chair, what a chair is made of, etc. That is what makes a chair an abstraction. I give a lesson on this concept that explains that the difference between a general idea and the different ways that idea can be concretized, as well as different levels of abstraction.*
	Web Mobile CSP, 2.6: "What Is Abstraction?" Google Sites	**Formative Assessment: Abstraction** Students write a reflection on their understanding of abstraction based on the prompt in Mobile CSP, section 2.6, and post it on their Google Sites. **Essential knowledge addressed: 2.1.1** A	*Reflections allow students to write about completed work and understandings and are hosted on their Google Sites portfolios. The teacher can access the reflections to write comments and provide feedback.*

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:

▶ What Is Abstraction? ▶ Binary Numbers ▶ The Digital Explosion ▶ Mobile Apps and Mobile Devices

Guiding Questions

▶ What does it mean to program a computer? ▶ What are some abstractions encountered in programming with App Inventor? ▶ When can a conditional statement be used?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 2.1.1: Describe the variety of abstractions used to represent data. [P3] **LO 2.1.2:** Explain how binary sequences are used to represent digital data. [P5]	**Web** Mobile CSP, 2.8: "Binary Numbers" CS Unplugged, "Binary Numbers" Khan Academy, "Binary Numbers"	**Instructional Activity: Binary Numbers** Starting with the CS Unplugged "Binary Numbers" activity, I introduce the binary number system as a positional number system. I ask different students to stand in front of the class holding the numbers 1, 2, 4, 8, 16, 32, etc., in order from right to left. Students discuss the patterns, and by considering the number values as switches that can be on and off, they learn to write different base 10 numbers in binary. Students learn how to convert from one number base to another number base. I emphasize conversion between base 2 and bases 10, 8, or 16. I supplement with Mobile CSP and Khan Academy videos. **Essential knowledge addressed: 2.1.1** D, E; **2.1.2** D-F
	Web Mobile CSP, 2.8: "Binary Numbers"	**Formative Assessment: Binary Numbers** Students complete the binary number interactive exercises and reflection from the Mobile CSP site to post on their Google Sites. To go further, students can also answer the following problems and post responses to their Google Sites: 1. What decimal number is represented by the binary number 0011 1010 0011? 2. Represent the decimal number 517 as a binary number. 3. What is the decimal and binary value of the octal number 523? 4. Convert the base 5 number 243 into decimal. **Essential knowledge addressed: 2.1.1** D, E; **2.1.2** D-F

The computer represents all data as bits, and this assessment gives students the chance to show their understanding of the number system.

UNIT 2: MOBILE COMPUTERS AND MOBILE APPS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:
▸ EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:
▸ What Is Abstraction? ▸ Binary Numbers ▸ The Digital Explosion ▸ Mobile Apps and Mobile Devices

Guiding Questions

▸ **What does it mean to program a computer?** ▸ **What are some abstractions encountered in programming with App Inventor?** ▸ **When can a conditional statement be used?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 2.1.1: Describe the variety of abstractions used to represent data. [P3] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4]	**Print** Abelson, Ledeen, and Lewis, chapter 1 **Web** Mobile CSP, 2.7: "BB: The Digital Explosion"	**Instructional Activity: The Digital Explosion** We start with a whole-class reading of the first few pages of *Blown to Bits,* chapter 1 (the introduction). I separate students into three to six groups and assign each group pages to read with reflection questions for discussion. After small-group discussions, I pair up groups to summarize to each other. Students see that computing is transforming how we relate to one another and problem solve, as well as that everything on the computer is made up of binary digits (bits). The seven "Koans of Bits" are used to drill home the nature of bits, which leads to a class discussion of computing and its impact. **Essential knowledge addressed: 2.1.1** B, C; **7.1.1** E, F, I	*My current class carries out all the readings in groups this way. The Mobile CSP teacher-facing page suggests other ways the reading can be handled.*
	Print Abelson, Ledeen, and Lewis, chapter 1 **Web** Mobile CSP, 2.7: "BB: The Digital Explosion" Google Sites	**Formative Assessment: The Digital Explosion** Students post answers to reflective questions, including the following, from Mobile CSP on their Google Sites: 1. What is a bit, and what does it mean to say that "it's all just bits"? Give examples of the things that are stored today in bits. 2. Describe Moore's Law in your own words. 3. Give an example of how the digital explosion is "neither good nor bad" but has both positive and negative implications. **Essential knowledge addressed: 2.1.1** B, C; **7.1.1** E, F, I	*I read student reflections to gain an understanding of what each student has gleaned from class discussions on the readings. At this point I determine whether we need to review some key points or if we can move forward.*

UNIT 2: MOBILE COMPUTERS AND MOBILE APPS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:

- What Is Abstraction? ▸ Binary Numbers ▸ The Digital Explosion ▸ Mobile Apps and Mobile Devices

Guiding Questions

▸ **What does it mean to program a computer?** ▸ **What are some abstractions encountered in programming with App Inventor?** ▸ **When can a conditional statement be used?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 2.2.3: Identify multiple levels of abstractions that are used when writing programs. [P3] **LO 5.2.1:** Explain how programs implement algorithms. [P3]	**Web** Mobile CSP, 2.4: "Mobile Apps and Mobile Devices" Learn Free, "Computer Basics"	**Instructional Activity: Mobile Apps and Mobile Devices** Using resources from Learn Free and discussions of general-purpose computers, this unit addresses the hardware and software components of a computer, low- and high-level programming languages, and the different levels of abstraction in hardware and software. I use logic gates and circuits to show how the computer processes binary information. Learn Free contains tutorials on basic concepts in computing, some of which students may know very well. I write out the topic of a tutorial (such as "Mobile Devices") and ask students to discuss it. If they do not show good understanding of the topic, we watch the short video "Computer Basics" to clarify the concepts. For homework, students finish watching the videos on Mobile CSP or read the tutorials and reflect on the topic. **Essential knowledge addressed: 2.2.3** A-C, F-J; **5.2.1** F	*The aim here is to give students an appreciation of computer basics and terminology.*
LO 1.2.2: Create a computational artifact using computing tools and techniques to solve a problem. [P2] **LO 1.3.1:** Use computing tools and techniques for creative expression. [P2] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4]	**Web** Mobile CSP, 2.9: "Where Is North: A Compass App"	**Instructional Activity: Where Is North? A Compass App** I guide students, using Mobile CSP, to develop a compass app that uses the Location sensor and the Orientation sensor of App Inventor. While pair programming, students are shown how to use the Global Positioning System (GPS) to get the app's latitude and longitude. The Orientation sensor is used to determine the location of geographic north. App Inventor components such as Canvas and Image Sprite are useful for drawing, and students explore animations and some of the properties of these components. Students also explore the App Inventor coordinate system and how the size of a mobile device affects the placement of a component. **Essential knowledge addressed: 1.2.2** A; **1.3.1** E; **7.1.1** I, J	*I tend to ask students to pair program. However sometimes students go ahead of the class, which makes it difficult to enforce pair programming. I use such students as helpers.*

UNIT 2: MOBILE COMPUTERS AND MOBILE APPS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:
- EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 5.1, EU 5.2, EU 5.4, EU 7.1

Projects and Major Assignments:
- What Is Abstraction? ▸ Binary Numbers ▸ The Digital Explosion ▸ Mobile Apps and Mobile Devices

Guiding Questions

▸ What does it mean to program a computer? ▸ What are some abstractions encountered in programming with App Inventor? ▸ When can a conditional statement be used?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
All of the learning objectives in this unit are addressed.	**Web** "Unit 2 Review — Uche"	**Summative Assessment: Unit Test** This summative test is hosted on Google Drive and includes 25 multiple-choice and five free-response questions. Questions focus on the features of App Inventor, abstraction, bits, number base conversion, and the parts of a computer. **All of the unit's essential knowledge statements are addressed.**

This summative assessment addresses all of the guiding questions for this unit.

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

- Paint Pot App and Projects
- Image Representation and Error Detection
- Electronic Documents
- The Map Tour App

Guiding Questions

- **How can different types of data be represented in binary form?**
- **What happens to data when they are deleted from a computer?**
- **How is abstraction used in computer programming?**
- **What might errors in stored or transmitted data look like?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
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 1.3.1:** Use computing tools and techniques for creative expression. [P2] **LO 2.2.1:** Develop an abstraction when writing a program or creating other computational artifacts. [P2] **LO 5.1.1:** Develop a program for creative expression, to satisfy personal curiosity, or to create new knowledge. [P2] **LO 5.1.2:** Develop a correct program to solve problems. [P2] **LO 5.2.1:** Explain how programs implement algorithms. [P3] **LO 5.4.1:** Evaluate the correctness of a program. [P4] **LO 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]	**Web** Mobile CSP, 3.2: "Paint Pot Tutorial," 3.3: "Paint Pot Projects," 3.6: "Paint Pot 2 Tutorial," and 3.7: "Paint Pot 2 Projects" Google Sites	**Instructional Activity: Paint Pot App and Projects** Through the Paint Pot tutorial, its enhancements, and modifications, I introduce students to the drawing and painting features of App Inventor to support the creation of computational artifacts that include graphics. I introduce variables as abstractions to vary the radius of a dot. As a class, we discuss how to name variables, the need to initialize variables, and how to increment variables, plus debugging and how to handle errors in coding. These activities deepen students' understanding of event-driven programming using App Inventor and support the creation of meaningful apps. Paint Pot is introduced in section 3.2 and its enhancements in 3.3. Paint Pot 2, which is an extension of section 3.2 with variables introduced as abstractions, is introduced in section 3.6 and enhanced in 3.7. **Essential knowledge addressed: 1.1.1** B; **1.2.1** B; **1.2.2** A; **1.3.1** E; **2.2.1** A; **5.1.1** B; **5.1.2** B; **5.2.1** A; **5.4.1** E, G, M; **5.5.1** A, D	*The Paint Pot tutorials and projects may stretch over four lessons.*
	Web Mobile CSP, 3.2: "Paint Pot Tutorial," 3.3: "Paint Pot Projects," 3.6: "Paint Pot 2 Tutorial," and 3.7: "Paint Pot 2 Projects" Google Sites	**Formative Assessment: Paint Pot App and Projects** I assess my students' progress with the Paint Pot apps by monitoring the creation of the Paint Pot apps with their enhancements and by having students post reflection assignments to their Google Sites portfolios. The reflection assignments are listed in each of the referenced Mobile CSP sections. **Essential knowledge addressed: 1.1.1** B; **1.2.1** B; **1.2.2** A; **1.3.1** E; **2.2.1** A; **5.1.1** B; **5.1.2** B; **5.2.1** A; **5.4.1** E, G, M; **5.5.1** A, D	*When students post their reflections to their Google Sites portfolios, I can see each student's level of understanding and progress with the concepts at hand and provide personalized feedback.*

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

▶ Paint Pot App and Projects ▶ Image Representation and Error Detection ▶ Electronic Documents ▶ The Map Tour App

Guiding Questions

▶ **How can different types of data be represented in binary form?** ▶ **What happens to data when they are deleted from a computer?** ▶ **How is abstraction used in computer programming?** ▶ **What might errors in stored or transmitted data look like?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 2.1.1: Describe the variety of abstractions used to represent data. [P3] **LO 2.1.2:** Explain how binary sequences are used to represent digital data. [P5] **LO 3.1.2:** Collaborate when processing information to gain insight and knowledge. [P6] **LO 3.3.1:** Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4]	**Web** Mobile CSP, 3.4: "Representing Images," 3.8: "Error Detection," and 3.10: "Parity Error Checking" "ASCII" CS Unplugged, "Image Representation" and "Error Detection"	**Instructional Activity: Image Representation and Error Detection** In groups, students complete the Mobile CSP "Representing Images" and the CS Unplugged "Image Representation" activities, which describe the Run Length Encoding (RLE) method of representing data as bits. The American Standard Code for Information Interchange (ASCII) Wikipedia page explains that bits can have different meanings in different contexts. As a class, we analyze the representation of different pixels and discuss lossy and lossless compression. Student groups work in Mobile CSP 3.8 and CS Unplugged "Error Detection" activities, which show videos discussing data corruption and the detection of errors in stored or transmitted data. In Mobile CSP 3.10, the concept of parity bits and check sum are illustrated. Students complete numerous quizzes in 3.10 supporting the mastery of the concepts of error detection and correction. **Essential knowledge addressed: 2.1.1** B, C, E; **2.1.2** B, D, F; **3.1.2** A-C; **3.3.1** C-E

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

- Paint Pot App and Projects
- Image Representation and Error Detection
- Electronic Documents
- The Map Tour App

Guiding Questions

▸ How can different types of data be represented in binary form? ▸ What happens to data when they are deleted from a computer? ▸ How is abstraction used in computer programming? ▸ What might errors in stored or transmitted data look like?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 2.1.1: Describe the variety of abstractions used to represent data. [P3] **LO 2.3.1:** Use models and simulations to represent phenomena. [P3] **LO 3.2.1:** Extract information from data to discover and explain connections or trends. [P1] **LO 3.3.1:** Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4]	**Print** Abelson, Ledeen, and Lewis, chapter 3 **Web** Mobile CSP, 3.5: "BB: Electronic Documents" "ASCII"	**Instructional Activity: Electronic Documents** In this activity we discuss how the computer represents data as bits, and we explore the concepts of image modeling and rendering. Student groups read *Blown to Bits* chapter 3 and reflect on the following questions: 1. What is metadata? Give an example. 2. What is a model? 3. What is the difference between a raster image and an ASCII representation of a text document? 4. What are filename extensions? What are they used for? 5. What are lossy and lossless representations? What are the trades-offs in using each representation? 6. What is steganography, and what is it used for? 7. What would you have to do to delete a document from your computer so that it could not possibly be read by anyone else? **Essential knowledge addressed: 2.1.1** B, C; **2.3.1** A, B; **3.2.1** G, H; **3.3.1** A, C	*This activity may take up to three lessons to complete. Students often do not read assigned texts even when printed, so allow time in class for reading and sharing. You may put students in six groups and assign each group pages and questions to answer. After each group shares, regroup and share as necessary until every student has an answer to all the questions. Mobile CSP section 3.5 on the teacher-facing site provides more conversation strategies for this chapter.*
	Print Abelson, Ledeen, and Lewis, chapter 3 **Web** Mobile CSP, 3.5: "BB: Electronic Documents" Google Sites	**Formative Assessment: Electronic Documents** I assess my students' understanding of the concepts in *Blown to Bits* chapter 3 by having them answer interactive questions and write reflection assignments from Mobile CSP section 3.5. Students post their reflections to their portfolios on Google Sites. **Essential knowledge addressed: 2.1.1** B, C; **2.3.1** A, B; **3.2.1** G, H; **3.3.1** A, C	*When students post their reflections to their Google Sites portfolios, I can see each student's level of understanding and progress with the concepts at hand and provide personalized feedback.*

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

▶ Paint Pot App and Projects ▶ Image Representation and Error Detection ▶ Electronic Documents ▶ The Map Tour App

Guiding Questions

▶ How can different types of data be represented in binary form? ▶ What happens to data when they are deleted from a computer? ▶ How is abstraction used in computer programming? ▶ What might errors in stored or transmitted data look like?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 1.3.1: Use computing tools and techniques for creative expression. [P2] **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]	**Web** Mobile CSP, 3.9: "Magic 8 Ball Tutorial and Projects" Google Sites	**Instructional Activity: Magic 8 Ball App and Projects** I lead students through Mobile CSP section 3.9 in the development of the Magic 8 Ball app, which is a mobile version of the classic fortune-telling app. I use this activity to introduce lists, the indexing of lists, and how to randomly select an element from a list. The app and its enhancements enable the exploration of the Accelerometer sensor, TextToSpeech, Clock, and Speech Recognizer components of App Inventor. Students can work individually or in pairs to develop the app using the course video in Mobile CSP section 3.9 as a guide. **Essential knowledge addressed: 1.3.1** E; **5.3.1** L; **5.5.1** J
	Web Mobile CSP, 3.9: "Magic 8 Ball Tutorial and Projects" Google Sites	**Formative Assessment: Magic 8 Ball** Students complete interactive questions provided on the Mobile CSP site for this section. **Essential knowledge addressed: 1.3.1** E; **5.3.1** L; **5.5.1** J
LO 1.2.1: Create a computational artifact for creative expression. [P2] **LO 1.3.1:** Use computing tools and techniques for creative expression. [P2] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4]	**Web** Mobile CSP, 3.11: "Map Tour Tutorial" Google Sites	**Instructional Activity: The Map Tour App** The Map Tour app shows how to use App Inventor with existing Web applications. The activity in Mobile CSP section 3.11 introduces the Google Maps API (Application Program Interface) and explores the idea of how software programs interact, including the use of the Activity Starter to launch other applications in App Inventor. I also introduce the idea of location awareness through this activity. Depending on the class, the students can work on their own, work in pairs, or be led through the activity by the teacher. My students prefer to work on their own and ask questions when they get stuck. Students follow directions on the student-facing Mobile CSP page to produce an app that a tourist can use to locate specified attractions. **Essential knowledge addressed: 1.2.1** B; **1.3.1** E; **7.1.1** I

The interactive questions test students' understanding of lists and list indexing. The questions are self-correcting and provide students with immediate feedback.

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

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Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

- Paint Pot App and Projects
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Guiding Questions

- **How can different types of data be represented in binary form?**
- **What happens to data when they are deleted from a computer?**
- **How is abstraction used in computer programming?**
- **What might errors in stored or transmitted data look like?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
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 1.2.4:** Collaborate in the creation of computational artifacts. [P6] **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 5.1.1:** Develop a program for creative expression, to satisfy personal curiosity, or to create new knowledge. [P2] **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 5.4.1:** Evaluate the correctness of a program. [P4] **LO 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]	**Web** Mobile CSP, "Create: Programming Performance Task #1"	**Instructional Activity: Practice Create Task** Students use the knowledge acquired in Units 1–3 to develop a simple game and learn to write it up for presentation to the school community, using College Board guidelines. By following instructions on the Mobile CSP page, students collaboratively develop a mobile app, design, implement, and debug a mobile app, and create a portfolio write-up and an oral presentation about their app. Over the course of two and a half weeks, student groups work on their apps and present them to the class on presentation day. Students also have the option of sharing their app with other Mobile CSP classes across the country for feedback. **Essential knowledge addressed: 1.1.1** A, B; **1.2.1** A-E; **1.2.2** A, B; **1.2.4** A-F; **4.1.1** A-I; **4.1.2** A-C; **5.1.1** A-F; **5.1.2** A-E, H; **5.2.1** A-D, K; **5.3.1** A-G; **5.4.1** A-I; **5.5.1** D-F, H

Student work can be showcased during CSEdWeek. The Create Task is one of two AP Computer Science Principles performance tasks to be submitted by each student. Because the tasks form part of the AP Exam, teachers should use an example to show their students how a Create Task can be completed. This activity is a practice Create Task that allows students to understand what is expected of them when it comes time to do the actual Create Task.

UNIT 3: GRAPHICS AND DRAWING

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 1.3, EU 2.1, EU 2.2, EU 2.3, EU 3.1, EU 3.2, EU 3.3, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5, EU 7.1

Projects and Major Assignments:

▶ Paint Pot App and Projects ▶ Image Representation and Error Detection ▶ Electronic Documents ▶ The Map Tour App

Guiding Questions

▶ **How can different types of data be represented in binary form?** ▶ **What happens to data when they are deleted from a computer?** ▶ **How is abstraction used in computer programming?** ▶ **What might errors in stored or transmitted data look like?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
All of the learning objectives in this unit are addressed.	**Web** "Mobile CSP Quiz 3"	**Summative Assessment: Unit Test** This summative test, hosted on Google Drive, includes 20 multiple-choice and five free-response questions. Questions focus on features of App Inventor, lists, error detection, parity, and the impact of computing. **All of the unit's essential knowledge statements are addressed.**	*This summative assessment addresses all of the guiding questions for this unit.*

UNIT 4: ANIMATIONS, SIMULATIONS, AND MODELING

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 1.3, EU 2.2, EU 2.3, EU 3.1, EU 3.3, EU 4.1, EU 5.1, EU 5.3, EU 5.5, EU 7.1, EU 7.3, EU 7.4

Projects and Major Assignments:

▶ Android Mash App and Projects ▶ Coin Flip Simulation and Experiment ▶ Privacy ▶ Phone-Monitoring App (Practice Explore Performance Task)

Guiding Questions

▶ **What are models, and why are they important?** ▶ **What are the different ways in which computing affects our lives?** ▶ **How possible is it for a computer to generate a truly random number?** ▶ **How can one protect one's privacy in today's digital world?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 1.2.1: Create a computational artifact for creative expression. [P2] **LO 1.2.3:** Create a new computational artifact by combining or modifying existing artifacts. [P2] **LO 2.2.1:** Develop an abstraction when writing a program or creating other computational artifacts. [P2] **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 5.1.2:** Develop a correct program to solve problems. [P2] **LO 5.3.1:** Use abstraction to manage complexity in programs. [P3] **LO 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]	**Web** Mobile CSP, 4.1: "Android Mash" and 4.2: "Android Mash Projects"	**Instructional Activity: Android Mash App and Projects** In this activity, students develop the Android Mash app, which simulates the traditional Whac-a-Mole game using the Image Sprite and random number features of App Inventor. Students may work individually or in pairs. I lead students through Mobile CSP section 4.1 and the development of the Android Mash app through showing tutorial videos and assisting in the process. Students deepen their understanding of how animation and randomness are programmed using the clock component. Once students have created their app, they have the opportunity to enhance it in Mobile CSP section 4.2, which includes introducing variables that monitor and update scores. Procedures and procedural abstractions are also introduced as reusable programming tools. **Essential knowledge addressed: 1.2.1** B, E; **1.2.3** C; **2.2.1** A, B; **4.1.1** B; **4.1.2** C; **5.1.2** C; **5.3.1** A-C; **5.5.1** A

UNIT 4: ANIMATIONS, SIMULATIONS, AND MODELING

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.2, EU 2.3, EU 3.1, EU 3.3, EU 4.1, EU 5.1, EU 5.3, EU 5.5, EU 7.1, EU 7.3, EU 7.4

Projects and Major Assignments:

- Android Mash App and Projects ▶ Coin Flip Simulation and Experiment ▶ Privacy ▶ Phone-Monitoring App (Practice Explore Performance Task)

Guiding Questions

▶ **What are models, and why are they important?** ▶ **What are the different ways in which computing affects our lives?** ▶ **How possible is it for a computer to generate a truly random number?** ▶ **How can one protect one's privacy in today's digital world?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 2.3.1: Use models and simulations to represent phenomena. [P3] **LO 2.3.2:** Use models and simulations to formulate, refine, and test hypotheses. [P3] **LO 3.1.2:** Collaborate when processing information to gain insight and knowledge. [P6] **LO 4.1.1:** Develop an algorithm for implementation in a program. [P2] **LO 5.1.2:** Develop a correct program to solve problems. [P2] **LO 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]	**Web** Mobile CSP, 4.4: "Coin Flip Simulation," 4.5: "Coin Flip Experiment," and 4.6: "Pseudo Random Numbers (Optional)"	**Instructional Activity: Coin Flip Simulation and Experiment** This activity illustrates how the App Inventor random number functions can be used to model a coin flip. I show a simulation from Mobile CSP section 4.4 to stimulate a class discussion on fairness and bias. This discussion leads to a coin flip experiment in section 4.5, which estimates the distribution of heads and tails outcomes in a coin flip. In pairs, students use a prebuilt app to determine how good App Inventor is at generating random numbers. The app lets students "flip a coin" *N* times and displays the results. Students record and tally the results and calculate the average percentage of heads. As *N* gets large, the average should approach 50 percent. **Essential knowledge addressed: 2.3.1** B, C; **2.3.2** A-H; **3.1.2** C, D, F; **4.1.1** C; **5.1.2** C; **5.5.1** A
LO 1.3.1: Use computing tools and techniques for creative expression. [P2] **LO 2.3.1:** Use models and simulations to represent phenomena. [P3] **LO 2.3.2:** Use models and simulations to formulate, refine, and test hypotheses. [P3]	**Web** Mobile CSP 4.8 "Real World Models" *CS Bits & Bytes*, "Cosmic Slurp" and "Computer Science Enables the Design of Safer Chemicals"	**Instructional Activity: Real-World Models** In this activity I project videos of two different models of the solar system in Mobile CSP section 4.8 to show that as an abstraction, a model focuses on essential aspects of the problem being addressed. After projecting the videos, I lead a class discussion of the differences highlighting the abstractions. I then break the class into two groups, with one group reading "Cosmic Slurp" and the other "Computer Science Enables the Design of Safer Chemicals." The groups then share and explain to each other what they have learned. We continue our discussion of real-world models through a bridge-building exercise, a model of the movement of hair, global climate and weather forecasting, or other activities from *CS Bits & Bytes*. **Essential knowledge addressed: 1.3.1** A, E; **2.3.1** A, C, D; **2.3.2** F-H

An optional discussion of how a computer simulates randomness can be explored in Mobile CSP section 4.6.

UNIT 4: ANIMATIONS, SIMULATIONS, AND MODELING

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.2, EU 2.3, EU 3.1, EU 3.3, EU 4.1, EU 5.1, EU 5.3, EU 5.5, EU 7.1, EU 7.3, EU 7.4

Projects and Major Assignments:

- Android Mash App and Projects
- Coin Flip Simulation and Experiment
- Privacy
- Phone-Monitoring App (Practice Explore Performance Task)

Guiding Questions

- What are models, and why are they important?
- What are the different ways in which computing affects our lives?
- How possible is it for a computer to generate a truly random number?
- How can one protect one's privacy in today's digital world?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 3.3.1: Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4] **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 real-world contexts, including economic, social, and cultural contexts. [P1]	**Print** Abelson, Ledeen, and Lewis, chapter 2 **Web** Mobile CSP, 4.9: "BB: Privacy"	**Instructional Activity: Privacy** *Blown to Bits,* chapter 2, discusses how modern technology has affected people's privacy, perceived or otherwise. Although this chapter compares "little brother-ism" and "big brother-ism," it uses real-life examples that show how technology can be a force for both good and evil. Convenience and mobile technology (e.g., the use of radiofrequency identification [RFID] or an event data recorder [EDR]) are discussed in terms of their effect on the loss of privacy. I divide the class into six groups and assign each group pages to read and questions to answer, listed on the Mobile CSP section 4.9 student page. After each group shares its findings, we regroup as a class and share as necessary until every student has an answer to all the questions. **Essential knowledge addressed: 3.3.1** A, F; **7.1.1** M, N; **7.3.1** G-I, K; **7.4.1** A, B
	Print Abelson, Ledeen, and Lewis, chapter 2 **Web** Mobile CSP, 4.9: "BB: Privacy" Google Sites	**Formative Assessment: Privacy** Students create a page called "*Blown to Bits* Chapter 2" on their Google Sites and answer the questions in Mobile CSP section 4.9. Students post their responses to their portfolios. **Essential knowledge addressed: 3.3.1** A, F; **7.1.1** M, N; **7.3.1** G-I, K; **7.4.1** A, B

The pages to be read and the associated questions are on the student-facing page. Depending on the class, book chapters can be assigned as homework. Students often do not read assigned sections even when printed, so I allow time in class for reading and sharing.

When students post their answers to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.1, EU 1.2, EU 1.3, EU 2.2, EU 2.3, EU 3.1, EU 3.3, EU 4.1, EU 5.1, EU 5.3, EU 5.5, EU 7.1, EU 7.3, EU 7.4

Projects and Major Assignments:

- Android Mash App and Projects
- Coin Flip Simulation and Experiment
- Privacy
- Phone-Monitoring App (Practice Explore Performance Task)

Guiding Questions

- What are models, and why are they important?
- What are the different ways in which computing affects our lives?
- How possible is it for a computer to generate a truly random number?
- How can one protect one's privacy in today's digital world?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
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 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 3.3.1:** Analyze how data representation, storage, security, and transmission of data involve computational manipulation of information. [P4] **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 real-world contexts, including economic, social, and cultural contexts. [P1]	**Web** Mobile CSP, "Explore: Impact of Computing Innovations Performance Task #1 (Optional)" "Android Monitoring App" Google Sites "My Mobile Watchdog" "Net Nanny for Android" "TeenSafe"	**Instructional Activity: Phone-Monitoring App (Practice Explore Performance Task)** This activity is a practice version of the Explore Performance Task. To enable a discussion and practice of the Explore Performance Task, students select one of four suggested phone-monitoring apps as an innovation and explore it following the College Board guidelines to practice developing a computational artifact. Following instructions from Mobile CSP, students download one of the referenced apps of their choice, explore the app, and document their findings as a computational artifact. The rubric for grading the Explore Performance Task is shared with students with the hope that they will reflect on the lessons via their Google Sites when they complete their final Explore Performance Task. **Essential knowledge addressed:** **1.1.1** A, B; **1.2.1** A-E; **1.2.2** A, B; **1.2.3** A-C; **1.2.5** A-D; **3.3.1** A-C, F, G; **7.1.1** A-D; **7.3.1** A-D, M, Q; **7.4.1** A-E

The Explore Performance Task is an individual task, and students should do it without collaboration. However, for this practice task, I prompt students with guiding questions such as, What is your work about? Where did you write that? Could you expand it or explain it further? Is there any data to support your statement? Where did you get that — have you cited it?," *etc.*

UNIT 4: ANIMATIONS, SIMULATIONS, AND MODELING

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 2 Abstraction
BIG IDEA 3 Data and Information
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 1.3, EU 2.2, EU 2.3, EU 3.1, EU 3.3, EU 4.1, EU 5.1, EU 5.3, EU 5.5, EU 7.1, EU 7.3, EU 7.4

Projects and Major Assignments:

▶ Android Mash App and Projects ▶ Coin Flip Simulation and Experiment ▶ Privacy ▶ Phone-Monitoring App (Practice Explore Performance Task)

Guiding Questions

▶ **What are models, and why are they important?** ▶ **What are the different ways in which computing affects our lives?** ▶ **How possible is it for a computer to generate a truly random number?** ▶ **How can one protect one's privacy in today's digital world?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
All of the learning objectives in this unit are addressed.	**Web** "Mobile CSP Quiz 4"	**Summative Assessment: Unit Test** This summative test, hosted on Google Drive, includes 20 multiple-choice and five free-response questions. Questions focus on modular arithmetic, pseudorandom number generation, animation features of App Inventor, and the impact of computing on privacy. **All of the unit's essential knowledge statements are addressed.**

This summative assessment addresses all of the guiding questions for this unit.

UNIT 5: ALGORITHMS AND PROCEDURAL ABSTRACTIONS

Estimated Time: 10 Hours

BIG IDEA 2 Abstraction
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 2.2, EU 3.1, EU 4.1, EU 4.2, EU 5.1, EU 5.3, EU 5.4, EU 7.1

Projects and Major Assignments:

- Logo ▶ Searching and Sorting Algorithms ▶ Pong App and Projects ▶ Web Searches

Guiding Questions

- What is the fastest way to sort a deck of cards?
- When should a loop within a loop be used?
- How does the Google search engine work?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
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 4.2.4:** Evaluate algorithms analytically and empirically for efficiency, correctness, and clarity. [P4]	**Web** Mobile CSP, 5.2: "What Is an Algorithm?"	**Instructional Activity: Algorithms** Students revisit algorithms in Mobile CSP section 5.2 through the completion of the "Blockly Maze" game. They also visit the algorithm for converting numbers between bases. The importance of unambiguity, clarity, and readability is emphasized. I note that an algorithm is a list of steps for accomplishing a task. For this activity, I choose a simple task that students know very well and ask the students to write an algorithm for it (e.g., opening a combination locker, eating lunch, brushing teeth). Students then pair up to act out their partners' descriptions. This activity is meant to show students that directions need to be clear and unambiguous. **Essential knowledge addressed: 4.1.1** A-E; **4.1.2** A-C, E-G; **4.2.4** C; **5.1.3** A-F
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 4.2.4:** Evaluate algorithms analytically and empirically for efficiency, correctness, and clarity. [P4] **LO 5.1.3:** Collaborate to develop a program. [P6] **LO 5.3.1:** Use abstraction to manage complexity in programs. [P3]	**Web** Mobile CSP, 5.3: "Logo Part 1" and 5.4: "Logo Part 2"	**Instructional Activity: Logo** In this activity, students write logo-type algorithms that draw polygons and their enhancements, as described in Mobile CSP sections 5.3 and 5.4, and use them to create complex structures. Students get extensive practice with the use of sequences, selection, and repetition, which are the only control structures needed to write an algorithm. After this activity, students have all the tools needed to write any algorithm. Procedures are introduced as a way to capture steps in a task that need to be repeated often. **Essential knowledge addressed: 2.2.1** C; **2.2.2** A; **4.1.1** A-E; **4.1.2** A-C, E-G; **4.2.4** C; **5.1.3** A-F; **5.3.1** A, B, D, E
	Web Mobile CSP, 5.3: "Logo Part 1" and 5.4: "Logo Part 2" Google Sites	**Formative Assessment: Logo** Students complete the interactive quizzes at the end of Mobile CSP sections 5.3 and 5.4 and then create a page called "Logo Parts 1 and 2" on their Google Sites. They then answer the reflection questions in these Mobile CSP sections and post their responses to their portfolios. **Essential knowledge addressed: 2.2.1** C; **2.2.2** A; **4.1.1** A-E, **4.1.2** A-C, E-G; **4.2.4** C; **5.1.3** A-F; **5.3.1** A, B, D, E

When students post their reflections to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.

UNIT 5: ALGORITHMS AND PROCEDURAL ABSTRACTIONS

Estimated Time: 10 Hours

BIG IDEA 2 Abstraction
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:
- EU 2.2, EU 3.1, EU 4.1, EU 4.2, EU 5.1, EU 5.3, EU 5.4, EU 7.1

Projects and Major Assignments:
- Logo ▶ Searching and Sorting Algorithms ▶ Pong App and Projects ▶ Web Searches

Guiding Questions

- What is the fastest way to sort a deck of cards?
- When should a loop within a loop be used?
- How does the Google search engine work?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 3.1.2: Collaborate when processing information to gain insight and knowledge. [P6] **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 4.2.4:** Evaluate algorithms analytically and empirically for efficiency, correctness, and clarity. [P4]	**Web** Mobile CSP, 5.5: "Search Algorithms" and 5.6: "Sorting Algorithms"	**Instructional Activity: Searching and Sorting Algorithms** I use interactive activities to illustrate the binary and sequential search algorithms. I ask the class "What does searching mean? Suppose you are given a bag of coins from different countries. How do you know if a particular item is in the bag?" and we discuss as a class. Then in Mobile CSP section 5.5, we look at sequential and binary search algorithms. For sorting, covered in section 5.6, I use hands-on activities, such as sorting cards, to illustrate different sorting algorithms (bubble, merge, and bucket sorts). I split a deck of cards into four suits, shuffle the cards, and give them to four students to sort competitively. We discuss the different algorithms used and relate them to standard algorithms such as the bubble sort. **Essential knowledge addressed: 3.1.2** A-E; **4.1.1** H; **4.1.2** B; **4.2.4** H
LO 3.1.2: Collaborate when processing information to gain insight and knowledge. [P6] **LO 4.1.1:** Develop an algorithm for implementation in a program. [P2] **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] **LO 4.2.2:** Explain the difference between solvable and unsolvable problems in computer science. [P1] **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]	**Web** Mobile CSP, 5.7: "Analyzing Algorithms" and 5.9: "Limits of Algorithms"	**Instructional Activity: Analysis and Limits of Algorithms** Students are provided with the Search Experiment app in Mobile CSP section 5.7, which enables them to characterize mystery algorithms in terms of their run time. Individually or in pairs, students use empirical data to analyze the efficiency of each of the different searching and sorting algorithms previously studied and generalize to other algorithms. Students graph and categorize the efficiencies, then upload their graphs to their portfolios for my review. In section 5.9, students conduct a similar experiment on empirical classification. They download another experiment app and follow instructions on the student-facing page to conduct the experiment, record their findings in graphs, and upload their graphs to their portfolios. Throughout these experiments, students take in and understand concepts such as intractable problems and undecidable problems. **Essential knowledge addressed: 3.1.2** E, F; **4.1.1** I; **4.2.1** A-D; **4.2.2** A-D; **4.2.3** A-C; **4.2.4** A, B, D-G

Mobile CSP provides several video tutorials and activities for its lessons. After our discussion, we often review the video tutorials to solidify learning.

UNIT 5: ALGORITHMS AND PROCEDURAL ABSTRACTIONS

Estimated Time: 10 Hours

BIG IDEA 2 Abstraction
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 2.2, EU 3.1, EU 4.1, EU 4.2, EU 5.1, EU 5.3, EU 5.4, EU 7.1

Projects and Major Assignments:

- Logo
- Searching and Sorting Algorithms
- Pong App and Projects
- Web Searches

Guiding Questions

- What is the fastest way to sort a deck of cards?
- When should a loop within a loop be used?
- How does the Google search engine work?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 2.2.1: Develop an abstraction when writing a program or creating other computational artifacts. [P2] **LO 4.1.1:** Develop an algorithm for implementation in a program. [P2] **LO 5.1.2:** Express an algorithm in a language. [P5] **LO 5.3.1:** Use abstraction to manage complexity in programs. [P3] **LO 5.4.1:** Use abstraction to manage complexity in programs. [P3]	**Web** Mobile CSP, 5.8: "The Pong Game" and 5.10: "Debugging Pong"	**Instructional Activity: Pong App and Projects** Students revisit selection structures and procedures through the development of a Pong app. Students choose to develop the Pong app from scratch or modify an existing Pong app game. I show a demonstration of the Pong game on Mobile CSP and ask students to work in small groups to brainstorm the types of components they will need to develop the app, the events that can be seen, and other functionality. I have groups share their ideas with the class and examine the starter app. I also give students a buggy Pong game to debug and enhance. The activity emphasizes different types of errors and provides tips on identifying, fixing, and preventing bugs. **Essential knowledge addressed: 2.2.1** C; **4.1.1** C; **5.1.2** C-E; **5.3.1** A-C; **5.4.1** A-H	*The debugging exercise lends itself to Think-Pair-Share activities.*
LO 4.1.1: Develop an algorithm for implementation in a program. [P2] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4] **LO 7.1.2:** Explain how people participate in a problem-solving process that scales. [P4]	**Print** Abelson, Ledeen, and Lewis, chapter 4 **Web** Mobile CSP, 5.11: "BB: Web Searches" *CS Bits & Bytes*, "Human Computation"	**Instructional Activity: Web Searches** This activity focuses on Google's search algorithm and introduces concepts such as caching, CAPTCHAs, and the PageRank algorithm through reading chapter 4 of *Blown to Bits*. I introduce students to reCAPTCHA in "Human Computation," in which, through crowdsourcing, texts are digitized to search information in a written document. I divide the class into six groups and assign each group pages to read and questions to answer, listed on the Mobile CSP, section 5.11, student page. After each group shares its findings, we regroup as a class and share as necessary until every student has an answer to all the questions. **Essential knowledge addressed: 4.1.1** H; **7.1.1** G, H; **7.1.2** D, E	*The pages to be read and the associated questions are on the student-facing page in Mobile CSP section 5.11. Depending on the class, I might assign book chapters as homework. Students often do not read assigned sections even when printed, so I allow time in class for reading and sharing.*

UNIT 5: ALGORITHMS AND PROCEDURAL ABSTRACTIONS

Estimated Time: 10 Hours

BIG IDEA 2 Abstraction
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 2.2, EU 3.1, EU 4.1, EU 4.2, EU 5.1, EU 5.3, EU 5.4, EU 7.1

Projects and Major Assignments:

- Logo
- Searching and Sorting Algorithms
- Pong App and Projects
- Web Searches

Guiding Questions

- What is the fastest way to sort a deck of cards?
- When should a loop within a loop be used?
- How does the Google search engine work?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 4.1.1: Develop an algorithm for implementation in a program. [P2] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4] **LO 7.1.2:** Explain how people participate in a problem-solving process that scales. [P4]	**Print** Abelson, Ledeen, and Lewis, chapter 4 **Web** Mobile CSP, 5.11: "BB: Web Searches" Google Sites *CS Bits & Bytes*, "Human Computation"	**Formative Assessment: Web Searches** Students create a page called "*Blown to Bits* Chapter 4" on their Google Sites and answer the questions in Mobile CSP, section 5.11. Students post their responses to their portfolios. **Essential knowledge addressed: 4.1.1** H; **7.1.1** G, H; **7.1.2** D, E	*When students post their answers to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.*
All of the learning objectives in this unit are addressed.	**Web** "Mobile CSP Quiz 5"	**Summative Assessment: Unit Test** This summative test, hosted on Google Drive, includes 25 multiple-choice and 5 free-response questions. Questions focus on features of App Inventor, abstraction, search algorithms, and sorting algorithms. **All of the unit's essential knowledge statements are addressed.**	*This summative assessment addresses all of the guiding questions for this unit.*

AP Performance Task

ESTIMATED TIME:
8 hours

Explore — Impact of Computing Innovations

The Explore Performance Task is an independent summative assessment from the College Board that will contribute to a student's AP Exam score. Students complete the Explore Performance Task on their own, following College Board requirements. Students need to bear in mind the rubrics for grading the performance task.

I give students the Explore Performance Task at this time because by now they have read and discussed four chapters of *Blown to Bits* as well as some *CS Bites & Bytes* articles, and they have completed the practice Explore Performance Task. They also have participated in discussions on ethical behavior and how to search for resources. At this time my students are well prepared for success on the Explore Performance Task.

UNIT 6: LISTS, DATABASES, DATA, AND INFORMATION

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 3.1, EU 3.2, EU 3.3, EU 5.1, EU 5.2, EU 5.3, EU 5.5, EU 7.2, EU 7.3, EU 7.5

Projects and Major Assignments:

- Lists and the President's Quiz App
- Data Persistence
- Who Owns the Bits?
- Big Data and Data Visualization

Guiding Questions

- **How do we interact with data?**
- **Is there any difference between data and information?**
- **What does the adage "A picture is worth a thousand words" mean in terms of data visualization?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 1.2.1: Create a computational artifact for creative expression. [P2] **LO 1.2.2:** Create a computational artifact using 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:** Find patterns and test hypotheses about digitally processed information to gain insight and knowledge. [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 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]	**Web** Mobile CSP, 6.2: "Presidents Quiz" and 6.3: "Presidents Quiz Projects"	**Instructional Activity: Lists and President's Quiz App** This activity should be conducted over two lessons. In the first lesson students watch an instructional video in Mobile CSP section 6.2 and develop the President Quiz app, a multiple-choice quiz app. Students learn how to manage two lists (one containing the questions and the other the answers), design an appropriate user interface, monitor and handle the end of the quiz, and check answers. Students consolidate the indexing of lists and the tracking of position in a list. In the second lesson students modify the quiz and create a new quiz on a topic of personal interest. They can follow the video in Mobile CSP section 6.3 as a guide, working individually or in pairs. ListPicker is used to provide choices to the user. **Essential knowledge addressed:** **1.2.1** A; **1.2.2** A; **1.2.3** B; **3.1.1** A; **5.1.2** B, C; **5.3.1** K, L; **5.5.1** H-J

UNIT 6: LISTS, DATABASES, DATA, AND INFORMATION

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:
- EU 1.2, EU 3.1, EU 3.2, EU 3.3, EU 5.1, EU 5.2, EU 5.3, EU 5.5, EU 7.2, EU 7.3, EU 7.5

Projects and Major Assignments:
- Lists and the President's Quiz App
- Data Persistence
- Who Owns the Bits?
- Big Data and Data Visualization

Guiding Questions

- How do we interact with data?
- Is there any difference between data and information?
- What does the adage "A picture is worth a thousand words" mean in terms of data visualization?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 1.2.1: Create a computational artifact for creative expression. [P2] **LO 3.1.3:** Explain the insight and knowledge gained from digitally processed data by using appropriate visualizations, notation, and precise language. [P5] **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]	**Web** Mobile CSP, 6.6: "Persistent Data," 6.7: "Sharing Data on the Web," and 6.8: "Data Persistence Projects"	**Instructional Activity: Data Persistence** Mobile CSP section 6.6 introduces students to App Inventor's mechanisms for allowing data generated in a program to be used later, namely, the TinyDB and the TinyWebDB components. Students revisit the Android Mash app, and I remind them that their score is lost every time they start a new game. We have class discussions exploring databases and the difference between storing data on a phone and on the cloud. I lead students through the process of enhancing their Android Mash app to retain scores between applications. I emphasize how Web data is shared and the differences between synchronous and asynchronous operations. **Essential knowledge addressed: 1.2.1** E; **3.1.3** E; **3.3.1** G-I; **5.1.2** C; **5.2.1** C
LO 7.2.1: Explain how computing has impacted innovations in other fields. [P1] **LO 7.3.1:** Analyze the beneficial and harmful effects of computing. [P4] **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. [P5]	**Print** Abelson, Ledeen, and Lewis, chapter 6 **Web** Mobile CSP, 6.4: "BB: Who Owns the Bits?"	**Instructional Activity: Who Owns the Bits?** This unit focuses on the ethics of sharing legal and digital information with the question, Who owns the bits? We carry out discussions of file-sharing algorithms used in the music industry and elsewhere. I put students in six groups and assign each group a set of pages from *Blown to Bits* chapter 6 and questions to answer. After each group shares, we regroup and share as necessary until every student has an answer to all the questions. **Essential knowledge addressed: 7.2.1** C, D; **7.3.1** A-C, O, P; **7.5.1** A-C; **7.5.2** A, B

Students can develop the app using the course video or the text version of the course material. They may work individually or in pairs.

Students often do not read assigned sections even when printed, so I allow time in class for reading and sharing.

UNIT 6: LISTS, DATABASES, DATA, AND INFORMATION

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:

▸ EU 1.2, EU 3.1, EU 3.2, EU 3.3, EU 5.1, EU 5.2, EU 5.3, EU 5.5, EU 7.2, EU 7.3, EU 7.5

Projects and Major Assignments:

▸ Lists and the President's Quiz App ▸ Data Persistence ▸ Who Owns the Bits? ▸ Big Data and Data Visualization

Guiding Questions

▸ How do we interact with data? ▸ Is there any difference between data and information? ▸ What does the adage "A picture is worth a thousand words" mean in terms of data visualization?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 7.2.1: Explain how computing has impacted innovations in other fields. [P1] **LO 7.3.1:** Analyze the beneficial and harmful effects of computing. [P4] **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. [P5]	**Print** Abelson, Ledeen, and Lewis, chapter 6 **Web** Mobile CSP, 6.4: "BB: Who Owns the Bits?" Google Sites	**Formative Assessment: Who Owns the Bits?** Students create a page called "*Blown to Bits* Chapter 6" on their Google Sites and answer the questions in Mobile CSP section 6.4. Students post their responses to their portfolios. **Essential knowledge addressed: 7.2.1** C, D; **7.3.1** A-C, O, P; **7.5.1** A-C; **7.5.2** A, B
LO 3.1.1: 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, notation, and precise language. [P5] **LO 3.2.1:** Extract information from data to discover and explain connections or trends. [P1] **LO 3.2.2:** Determine how large data sets impact the use of computational processes to discover information and knowledge. [P3]	**Web** Mobile CSP, 6.9: "Big Data" and 6.10: "Using Fusion Tables to Visualize Data" "Fusion Tables Example Gallery"	**Instructional Activity: Big Data and Data Visualization** By discussing the number of tweets made per day and using several pieces of video footage, students try to come up with a definition for big data. In Mobile CSP section 6.10, students explore data visualization tools, including the Google Fusion Table, and work in pairs to create a visualization of downloaded credit card data. Depending on the students' background, it may be necessary to teach how data are collected and analyzed using Google Forms and Google Spreadsheet or Microsoft Excel. **Essential knowledge addressed: 3.1.1** A, E; **3.1.2** A, F; **3.1.3** A-E; **3.2.1** A-C, F; **3.2.2** A-H

When students post their answers to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.

UNIT 6: LISTS, DATABASES, DATA, AND INFORMATION

Estimated Time: 13 Hours

BIG IDEA 1 Creativity
BIG IDEA 3 Data and Information
BIG IDEA 5 Programming
BIG IDEA 7 Global Impact

Enduring Understandings:
- EU 1.2, EU 3.1, EU 3.2, EU 3.3, EU 5.1, EU 5.2, EU 5.3, EU 5.5, EU 7.2, EU 7.3, EU 7.5

Projects and Major Assignments:
- Lists and the President's Quiz App
- Data Persistence
- Who Owns the Bits?
- Big Data and Data Visualization

Guiding Questions

▸ How do we interact with data? ▸ Is there any difference between data and information? ▸ What does the adage "A picture is worth a thousand words" mean in terms of data visualization?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 3.1.1: 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, notation, and precise language. [P5] **LO 3.2.1:** Extract information from data to discover and explain connections or trends. [P1] **LO 3.2.2:** Determine how large data sets impact the use of computational processes to discover information and knowledge. [P3]	**Web** Mobile CSP, "Data Project (Optional)" Google Sites	**Instructional Activity: Data Performance Task (Optional)** Students work with partners to research, investigate, and analyze a big data set that interests them. Students work in pairs and choose a set containing at least a thousand values or cells and create three to five questions they believe can be answered using the set. They can use visuals to illustrate answers where needed. Using a Google Fusion Table, students answer their questions with the data and produce a collaborative write-up explaining their investigation. They also prepare a PowerPoint presentation that is 5–10 minutes long to present to the class. On completion, students produce individual write-ups explaining their project and the collaborative process used to complete the project. **Essential knowledge addressed: 3.1.1** A, B; **3.1.2** A, B; **3.1.3** B; **3.2.1** A; **3.2.2** A, B	*This optional activity gives students a deeper understanding of how data are analyzed and visualized.*
All of the learning objectives in this unit are addressed.	**Web** "Mobile CSP Quiz 6"	**Summative Assessment: Unit Test** This summative test hosted on Google Drive includes 25 multiple-choice and 5 free-response questions. Questions focus on lists, list indexing, lists of lists, and data persistence using TinyDB and TinyWebDB. **All of the unit's essential knowledge statements are addressed.**	*This summative assessment addresses all of the guiding questions for this unit.*

UNIT 7: THE INTERNET

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 5.3, EU 6.1, EU 6.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Cloud Computing and Ethics
- How the Internet Works
- Socially Useful Apps (No Texting While Busy, My Directions, Broadcast Hub)
- Cryptography

Guiding Questions

- **Is the Internet the same as the World Wide Web?**
- **How does an email go from one computer to the other?**
- **What activities and tools support a secure Web experience?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 6.1.1: Explain the abstractions in the Internet and how the Internet functions. [P3] **LO 6.2.2:** Explain how the characteristics of the Internet influence the systems built on it. [P4]	**Web** Mobile CSP, 7.2: "What Is the Internet?"	**Instructional Activity: What Is the Internet?** In this activity, students learn the distinction between the Internet and the World Wide Web. In Mobile CSP section 7.2, students watch video lectures about the Internet. They then complete the activities in this section in pairs and answer follow-up questions to create a concept map of new terms such as *LAN*, *WAN*, and *router*, as well as to measure bandwidth and latency. **Essential knowledge addressed: 6.1.1** A-D, I; **6.2.2** D, E, H, J, K
LO 6.1.1: Explain the abstractions in the Internet and how the Internet functions. [P3] **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 7.5.1:** Access, manage, and attribute information using effective strategies. [P1] **LO 7.5.2:** Evaluate online and print sources for appropriateness and credibility. [P5]	**Web** Mobile CSP, 7.4: "Cloud Computing and Ethics" "Ten Commandments of Computer Ethics"	**Instructional Activity: Cloud Computing and Ethics** In Mobile CSP, section 7.4, we revisit cloud computing, as well as computer ethics. I lead a lecture on cloud services and the client–server model and then split the students into groups to read the Wikipedia article "Ten Commandments of Computer Ethics" and answer questions about the text from Mobile CSP. We then regroup as a class to discuss cloud computing and the many ethical issues around it. **Essential knowledge addressed: 6.1.1** D; **7.1.1** D; **7.3.1** A, B; **7.5.1** A-C; **7.5.2** A, B

UNIT 7: THE INTERNET

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 5.3, EU 6.1, EU 6.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Cloud Computing and Ethics
- How the Internet Works
- Socially Useful Apps (No Texting While Busy, My Directions, Broadcast Hub)
- Cryptography

Guiding Questions

- Is the Internet the same as the World Wide Web?
- How does an email go from one computer to the other?
- What activities and tools support a secure Web experience?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
LO 6.1.1: Explain the abstractions in the Internet and how the Internet functions. [P3] **LO 6.2.1:** Explain characteristics of the Internet and the systems built on it. [P5] **LO 6.2.2:** Explain how the characteristics of the Internet influence the systems built on it. [P4]	**Web** Mobile CSP, 7.5: "How the Internet Works"	**Instructional Activity: How the Internet Works** In this lesson we dive deeper into the mechanics of the Internet as we explore CP/IP and the protocol hierarchy, as well as IP addresses and domain names. Students learn some protocols that allow the Internet to function and explore relevant command-line tools, such as Traceroute and Ping. They watch a video lecture on public networks and data protection and discuss the topic in groups. At the end of the activity students look up IP addresses for various websites and their subdomains, then their school's domain name and IP address, and then the IP address for their home computers and mobile devices, noting any patterns they see. Students finish by answering interactive questions from Mobile CSP that sum up the key points of the lesson. **Essential knowledge addressed: 6.1.1** A-D, I; **6.2.1** A-D; **6.2.2** D, E, H, J, K
LO 6.1.1: Explain the abstractions in the Internet and how the Internet functions. [P3] **LO 6.2.1:** Explain characteristics of the Internet and the systems built on it. [P5] **LO 6.2.2:** Explain how the characteristics of the Internet influence the systems built on it. [P4] **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]	**Web** Mobile CSP, 7.2: "What Is the Internet?," 7.4: "Cloud Computing and Ethics," and 7.5: "How the Internet Works" Google Sites	**Formative Assessment: The Internet and Cloud Computing** Students complete the interactive questions in Mobile CSP sections 7.2, 7.4, and 7.5. Then they create a page called "The Internet and Cloud Computing" on their Google Sites and answer the reflection questions in these sections. Students post their responses to their portfolios. **Essential knowledge addressed: 6.1.1** A-D, I; **6.2.1** A-D; **6.2.2** D, E, H, J, K; **7.1.1** D; **7.3.1** A, B

When students post their answers to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.

UNIT 7: THE INTERNET

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 5.3, EU 6.1, EU 6.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Cloud Computing and Ethics
- How the Internet Works
- Socially Useful Apps (No Texting While Busy, My Directions, Broadcast Hub)
- Cryptography

Guiding Questions

- **Is the Internet the same as the World Wide Web?**
- **How does an email go from one computer to the other?**
- **What activities and tools support a secure Web experience?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 1.2.2: Create a computational artifact using computing tools and techniques to solve a problem. [P2] **LO 5.3.1:** Use abstraction to manage complexity in programs. [P3] **LO 7.1.1:** Explain how computing innovations affect communication, interaction, and cognition. [P4] **LO 7.4.1:** Explain the connections between computing and real-world contexts, including economic, social, and cultural contexts. [P1]	**Web** Mobile CSP, 7.3: "No Texting While Busy Tutorial," 7.6: "My Directions Tutorial," and 7.10: "Socially Aware App: Broadcast Hub Tutorial"	**Instructional Activity: Socially Useful Apps (No Texting While Busy, My Directions, Broadcast Hub)** The focus here is on socially useful apps to enable a discussion of the impact of computing. Students develop an app of their choice that is socially useful from Mobile CSP. An example is No Texting While Busy, which uses the texting function of App Inventor to reply to a text message when someone is driving so the person does not have to respond. Other examples are My Directions, which uses the Location sensor and the Google API to find local directions, and Broadcast Hub, which allows groups of individuals to share information. Students work individually or in pairs as they follow the tutorials on Mobile CSP and apply creative enhancements such as abstractions, customization, and persistence. **Essential knowledge addressed: 1.2.2** A; **5.3.1** M-O; **7.1.1** A, I-L; **7.4.1** A, B	*Students can develop the app using the course video or the text version of the course material. They may work individually or in pairs. The teacher may also lead the activity. Some teachers may choose to have students develop all three apps over time.*
LO 6.3.1: Identify existing cybersecurity concerns and potential options that address these issues with the Internet and the systems built on it. [P1]	**Print** Abelson, Ledeen, and Lewis, chapter 5 **Web** Mobile CSP, 7.7: "Cryptography Basics," 7.8: "Cryptography: Securing the Internet," and 7.9: "BB: Cryptography"	**Instructional Activity: Cryptography and Cybersecurity** This activity introduces substitution ciphers and explores simple encryption methods in relation to the security of information being transmitted. It covers the relationship among encryption, cryptography, and cybersecurity. I lead students through the video lectures and interactive activities in Mobile CSP sections 7.7 and 7.8. I then put students in six groups and assign each group pages to read from *Blown to Bits* chapter 5 and questions to answer from Mobile CSP section 7.9. After each group shares its thoughts and answers, we regroup as a class and share as necessary until every student has an answer to all the questions. **Essential knowledge addressed: 6.3.1** A-C, F-M	*Students often do not read assigned sections even when printed, so I allow time in class for reading and sharing.*

UNIT 7: THE INTERNET

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 5 Programming
BIG IDEA 6 The Internet
BIG IDEA 7 Global Impact

Enduring Understandings:

- EU 1.2, EU 5.3, EU 6.1, EU 6.2, EU 6.3, EU 7.1, EU 7.3, EU 7.4, EU 7.5

Projects and Major Assignments:

- Cloud Computing and Ethics
- How the Internet Works
- Socially Useful Apps (No Texting While Busy, My Directions, Broadcast Hub)
- Cryptography

Guiding Questions

- Is the Internet the same as the World Wide Web?
- How does an email go from one computer to the other?
- What activities and tools support a secure Web experience?

Learning Objectives	Materials	Instructional Activities and Classroom Assessments	
LO 6.3.1: Identify existing cybersecurity concerns and potential options that address these issues with the Internet and the systems built on it. [P1]	**Print** Abelson, Ledeen, and Lewis, chapter 5 **Web** Mobile CSP, 7.9: "BB: Cryptography"	**Formative Assessment: Cryptography and Cybersecurity** Students create a page called "*Blown to Bits* Chapter 5" on their Google Sites and answer the reflection questions in Mobile CSP, section 7.9. Students post their responses to their portfolios. **Essential knowledge addressed: 6.3.1** A-C, F-M	*When students post their answers to their portfolios, I can assess each student's level of understanding and progress with the concepts at hand and provide personalized feedback.*
All of the learning objectives in this unit are addressed.	**Web** "Mobile CSP Quiz 7"	**Summative Assessment: Unit Test** This summative test hosted on Google Drive includes 25 multiple-choice and 5 free-response questions. Questions focus on the differences between the Worldwide Web and the Internet, cloud computing, and cybersecurity. **All of the unit's essential knowledge statements are addressed.**	*This summative assessment addresses all of the guiding questions for this unit.*

AP Performance Task

ESTIMATED TIME:
15 hours

Create – Applications from Ideas

Students complete the Create Performance Task on their own using College Board guidelines. It is important to highlight that there are two parts to the task. First there is a collaborative section in which students develop an artifact in pairs and submit individual reflections. The second is an individual part in which students develop and reflect on their artifact on their own. Be sure to allow enough time for the tasks.

The performance tasks form part of the College Board's summative assessment of the course and contribute 50 percent of the students' AP score. Students complete a performance task without the help of the teacher, but they will have completed a practice performance task for our class. I provide the students a copy of the task description from the College Board, and then they read and complete the task. When the task is given to students may vary between projects.

At this time, students will have written enough apps that they should think of ways to modify an app or two to produce something unique. They will have knowledge of the control structures that are needed to write algorithms for tasks and will have seen different user interfaces to accomplish both the individual and collaborative tasks.

UNIT 8: FURTHER EXPLORATIONS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming

Enduring Understandings:

▶ EU 1.1, EU 1.2, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5

Projects and Major Assignments:

▶ Further Explorations ▶ Project Research ▶ Project Artifact and Presentation

Guiding Questions

▶ **What computer science tool or activity would you want to investigate?** ▶ **How would you share your idea with the world?** ▶ **How has your view of computer science evolved?**

Learning Objectives

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 1.2.4: Collaborate in the creation of computational artifacts. [P6]

LO 1.2.5: Analyze the correctness, usability, functionality, and suitability of computational artifacts. [P4]

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 5.1.1: Develop a program for creative expression, to satisfy personal curiosity, or to create new knowledge. [P2]

LO 5.2.1: Explain how programs implement algorithms. [P3]

Materials

Web

Arduino

Code in the Browser

"Code Combat"

"Game Maker: Studio"

"Greenfoot"

"Hour of Code"

"Learn to Build a Game with Code Avengers"

"Learn an Hour of Code"

"Lunch: O Say Can You See"

"Raspberry Pi: Quick Start Guide"

"SPRK Education Program"

"Use Makey Makey to Design a Video Game Controller"

"Welcome to Hour of Code!"

Instructional Activities and Classroom Assessments

Instructional Activity: Further Explorations

In this activity, I give an overview of the tools listed here in hopes that students will investigate topics of personal interest. I transition students from block-based coding to text-based coding using Hour of Code activities, Code in the Browser, Greenfoot, or a combination.

Students who express an interest in continuing to AP Computer Science A could work on Code in the Browser, which gently introduces them to text-based programming and has a sandbox in which they can play.

Students can work in groups, pairs, or alone and write a short blurb about the concepts they are interested in for a final exploration project. They will eventually create a digital artifact and present it to the class. I usually approve anything that is CS focused.

Essential knowledge addressed: **1.1.1** A, B; **1.2.1** A-E; **1.2.2** A, B; **1.2.3** A-C; **1.2.4** A-F; **1.2.5** A-D; **4.1.1** A-I; **4.1.2** A-C; **5.1.1** A-F; **5.1.2** A-H; **5.2.1** A-D, K; **5.3.1** A-G; **5.4.1** A-I; **5.5.1** D-F, H

This activity is usually done within the month after the AP Computer Science Principles Exam. I ask students to submit a brief description of the project that they plan to work on for approval. This is their chance to explore any computing hardware or software they would like to examine. At this time students' energy is winding down, and students will work on only what interests them. The Materials list shows some of the things my students have studied in the past.

BIG IDEA 1 Creativity
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming

Enduring Understandings:
- EU 1.1, EU 1.2, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5

Projects and Major Assignments:
- Further Explorations
- Project Research
- Project Artifact and Presentation

Guiding Questions

- **What computer science tool or activity would you want to investigate?**
- **How would you share your idea with the world?**
- **How has your view of computer science evolved?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
(continued from previous page) **LO 5.3.1:** Use abstraction to manage complexity in programs. [P3] **LO 5.4.1:** Evaluate the correctness of a program. [P4] **LO 5.5.1:** Employ appropriate mathematical and logical concepts in programming. [P1]		**Instructional Activity: Further Explorations** In this activity, I give an overview of the tools listed here in hopes that students will investigate topics of personal interest. I transition students from block-based coding to text-based coding using Hour of Code activities, Code in the Browser, Greenfoot, or a combination. Students who express an interest in continuing to AP Computer Science A could work on Code in the Browser, which gently introduces them to text-based programming and has a sandbox in which they can play. Students can work in groups, pairs, or alone and write a short blurb about the concepts they are interested in for a final exploration project. They will eventually create a digital artifact and present it to the class. I usually approve anything that is CS focused. **Essential knowledge addressed:** **1.1.1** A, B; **1.2.1** A-E; **1.2.2** A, B; **1.2.3** A-C; **1.2.4** A-F; **1.2.5** A-D; **4.1.1** A-I; **4.1.2** A-C; **5.1.1** A-F; **5.1.2** A-H; **5.2.1** A-D, K; **5.3.1** A-G; **5.4.1** A-I; **5.5.1** D-F, H *(continued)*
	Web Google Sites	**Instructional Activity: Project Research** Students can work independently, in pairs, or in groups as they continue to research and explore their topics and tools of interest. I circulate around the room throughout these three weeks to provide insight and feedback on what they are doing, and I encourage students to keep track of their work by posting on their portfolios reflections of the things they are learning and what they find interesting as they work. Doing so helps students as they plan the digital artifacts that they will present to the class during the final week of the course. During this time they prepare what to present in a poster, a PowerPoint presentation, etc. **Essential knowledge addressed:** **1.1.1** A, B; **1.2.1** A-E; **1.2.2** A, B; **1.2.3** A-C; **1.2.4** A-F; **1.2.5** A-D; **4.1.1** A-I; **4.1.2** A-C; **5.1.1** A-F; **5.1.2** A-H; **5.2.1** A-D, K; **5.3.1** A-G; **5.4.1** A-I; **5.5.1** D-F, H

UNIT 8: FURTHER EXPLORATIONS

Estimated Time: 10 Hours

BIG IDEA 1 Creativity
BIG IDEA 4 Algorithms
BIG IDEA 5 Programming

Enduring Understandings:

- EU 1.1, EU 1.2, EU 4.1, EU 5.1, EU 5.2, EU 5.3, EU 5.4, EU 5.5

Projects and Major Assignments:

- Further Explorations
- Project Research
- Project Artifact and Presentation

Guiding Questions

- **What computer science tool or activity would you want to investigate?**
- **How would you share your idea with the world?**
- **How has your view of computer science evolved?**

Learning Objectives	Materials	Instructional Activities and Classroom Assessments
All of the learning objectives in this unit are addressed.		**Summative Assessment: Project Artifact and Presentation** Students present their research and digital artifacts in a final presentation that reflects their personal interests. Students should present a poster, PowerPoint presentation, or other visual medium and explain the tool or artifact and any insight they have gained over the month. If the opportunity arises, we share these presentations with the school community. **All of the unit's essential knowledge statements are addressed.**

This summative assessment addresses all of the guiding questions for this unit.

This is an opportunity for students to share their chosen activity with their classmates or the school community. Because this is a post-exam activity, I award points based on the completion of some artifact that addresses their interest.

Resources

All links to online resources were verified before publication. In cases where links are no longer working, we suggest that you try to find the resource by doing a keyword Web search.

General Resources

Abelson, Hal, Ken Ledeen, and Harry Lewis. *Blown to Bits: Your Life, Liberty, and Happiness After the Digital Explosion*. New York: Addison-Wesley, 2008. Accessed June 15, 2015. **http://www.bitsbook.com.**

App Inventor. Accessed June 17, 2015. **http://appinventor.mit.edu**.

Google Sites. Accessed June 17, 2015. **https://sites.google.com**.

Morelli, Ralph, Jen Rosato, Chery Takkunen, Chinma Uche, and Dave Wolber. Mobile CSP. Accessed June 9, 2015. **https://ram8647.appspot.com/mobileCSP/course**.

———. "Teaching Mobile CSP Principles." Mobile CSP. Accessed June 9, 2015. **https://ram8647.appspot.com/teach_mobileCSP/course**.

Unit 1 (Creativity and Computing: Preview and Setup) Resources

"Diversity in Computing." *CS Bits & Bytes* 2, no 12 (February 25, 2013). National Science Foundation. Accessed June 19, 2015. **http://www.nsf.gov/cise/csbytes/newsletter/vol2/vol2i12.html**.

"Hour of Code: Maze #1." Code.org. Accessed June 15, 2015. **http://studio.code.org/hoc/1**.

"Instructional Videos." Flubaroo. Accessed June 15, 2015. **http://www.flubaroo.com/instructional-videos**.

"Power to Change the World." University of Washington Computer Science & Engineering. YouTube. Video, 5:27. Accessed June 15, 2015. **https://youtu.be/3g8ud6kCjxw**.

"Self Driving Cars." *CS Bits & Bytes* 1, no 3 (January 9, 2012). National Science Foundation. Accessed June 19, 2015. **http://www.nsf.gov/cise/csbytes/newsletter/vol1/vol1i3.html**.

"Unit 1 Review." Google Docs. Accessed June 15, 2015. **https://docs.google.com/forms/d/1k9kY6yNfmrpxnb2Mrmz85-KvVUO3gxF6GtZ2I3vIebU/viewform?pli=1**.

"What Most Schools Don't Teach." Code.org. YouTube. Video, 5:43. Accessed June 15, 2015. **https://youtu.be/nKIu9yen5nc**.

"Who Is Grace Hopper?" Women's Stories. YouTube. Video, 2:23. Accessed June 19, 2015. **https://youtu.be/Fg82iV-L8ZY**.

"Why Diversity in Computer Science Is Important." National Science Foundation. Video, 4:05. Accessed June 15, 2015. **http://www.nsf.gov/news/mmg/mmg_disp.jsp?med_id=73862&from=mmg**.

"Women of the Digital Age." Simon & Schuster. YouTube. Video, 1:52. Accessed June 19, 2015. **https://youtu.be/evVU2-qdMgY**.

Unit 2 (Mobile Computers and Mobile Apps) Resources

"Binary Numbers." CS Unplugged. Accessed June 15, 2015. **http://csunplugged.org/binary-numbers**.

"Binary Numbers." Khan Academy. YouTube. Video, 10:33. Accessed June 15, 2015. **https://youtu.be/ry1hpm1GXVI**.

"Computer Basics." Learn Free. Accessed June 15, 2015. **http://www.gcflearnfree.org/computerbasics**.

"Pair Programming." Code.org. YouTube. Video, 2:50. Accessed June 17, 2015. **https://youtu.be/vgkahOzFH2Q**.

"Unit 2 Review — Uche." Google Docs. Accessed June 15, 2015. **http://goo.gl/forms/llf2qPahzc**.

Unit 3 (Graphics and Drawing) Resources

"ASCII." Wikipedia. Accessed June 15, 2015. **https://en.wikipedia.org/wiki/ASCII**.

"Error Detection." CS Unplugged. Accessed June 15, 2015. **http://csunplugged.org/error-detection**.

"Image Representation." CS Unplugged. Accessed June 15, 2015. **http://csunplugged.org/image-representation**.

Litvin, Maria, and Gary Litvin. "Appendix F: Computing in Context: Responsible and Ethical Computer Use." In *Java Methods A & AB: Object-Oriented Programming and Data Structures*. Andover, MA: Skylight Publishing, 2006. Accessed June 15, 2015. **http://www.skylit.com/javamethods-old/JM-Appendix-F.pdf**.

"Mobile CSP Quiz 3." Google Docs. Accessed June 15, 2015. **https://docs.google.com/forms/d/1yZPAksqyzrtvt66-cK5QkvCxVU__FiWPHij0PZcjmY0/viewform?usp=send_form**.

Unit 4 (Animations, Simulations, and Modeling) Resources

"Android Monitoring App." Mobile Spy. Accessed June 22, 2015. **http://www.mobile-spy.com/android.html**.

"Computer Science Enables the Design of Safer Chemicals." *CS Bits & Bytes* 2, no 16 (April 29, 2013). Accessed June 15, 2015. **http://www.nsf.gov/cise/csbytes/newsletter/vol2/vol2i16.html**.

"Cosmic Slurp." *CS Bits & Bytes* 3, no 4 (May 21, 2014). Accessed June 15, 2015. **http://www.nsf.gov/cise/csbytes/newsletter/vol3/pdf/csbb-vol3-i4.pdf**.

"Mobile CSP Quiz 4." Google Docs. Accessed June 15, 2015. **https://docs.google.com/forms/d/1TEsJ3Py0Oydvd1nmnp4ueJt00UEsMWx-dEK8U2o0tOw/viewform?pli=1**.

Resources (continued)

My Mobile Watchdog. Accessed June 22, 2015. **https://www.mymobilewatchdog.com/signup.shtml**.

"Net Nanny for Android." Net Nanny. Accessed June 22, 2015. **http://www.netnanny.com/mobile**.

TeenSafe. Accessed June 22, 2015. **http://www.teensafe.com**.

Unit 5 (Algorithms and Procedural Abstractions) Resources

"Human Computation." *CS Bits & Bytes*, 1, no 1 (December 1, 2011). Accessed June 15, 2015. **http://www.nsf.gov/cise/csbytes/newsletter/vol1/vol1i1.html**.

"Mobile CSP Quiz 5." Google Docs. Accessed June 15, 2015. **http://goo.gl/forms/bPRMZgZfQC**.

Unit 6 (Lists, Databases, Data, and Information) Resources

"Fusion Tables Example Gallery." Google Drive. Accessed June 15, 2015. **https://sites.google.com/site/fusiontablestalks/stories**.

"Mobile CSP Quiz 6." Google Docs. Accessed June 15, 2015. **http://goo.gl/forms/rSvlmrxYdg**.

Unit 7 (The Internet) Resources

"Mobile CSP Quiz 7." Google Docs. Accessed June 15, 2015. **http://goo.gl/forms/xbFlrJM6zB**.

"Ten Commandments of Computer Ethics." Wikipedia. Accessed June 15, 2015. **https://en.wikipedia.org/wiki/Ten_Commandments_of_Computer_Ethics**.

Unit 8 (Further Explorations) Resources

Arduino. Accessed June 15, 2015. **http://www.arduino.cc**.

Code in the Browser. Accessed June 15, 2015. **http://codeinthebrowser.org**.

"Code Combat." Code Combat. Accessed June 15, 2015. **http://codecombat.com/?hour_of_code=true**.

"Game Maker: Studio." YoYo Games. Accessed June 15, 2015. **https://www.yoyogames.com/studio**.

Greenfoot. Accessed June 15, 2015. **http://www.greenfoot.org/door**.

"Hour of Code." Code Academy. Accessed June 15, 2015. **http://www.codecademy.com/courses/hour-of-code/0/1**.

"Learn to Build a Game with Code Avengers." Code Avengers. Accessed June 15, 2015. **http://www.codeavengers.com/javascript/17#1.1**.

"Learn an Hour of Code." Code.org. Accessed June 15, 2015. **http://code.org/learn**.

"Lunch: O Say Can You See." SMUVideo. YouTube. Video, 5:09. Accessed June 15, 2015. **https://youtu.be/Uiq0DTCJvy0**.

"Raspberry Pi: Quick Start Guide." Raspberry Pi. Accessed June 15, 2015. **https://www.raspberrypi.org/help/quick-start-guide**.

"SPRK Education Program" Sphero. Accessed June 17, 2015. **http://www.sphero.com/education**.

"Use Makey Makey to Design a Video Game Controller." Educade. Accessed June 15, 2015. **http://educade.org/lesson_plans/use-makey-makey-to-design-a-videogame-controller**.

"Welcome to Hour of Code!" Khan Academy. Accessed June 15, 2015. **https://www.khanacademy.org/computing/hour-of-code/hour-of-code-tutorial/v/welcome-hour-of-code**.