Unit 5: Big Data

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Status: **Published**

Computer Science Principles, Big Data

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Computer Science Principles, Grades 9-12 High School

Big Data

Belleville Board of Education

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Board Approved:

Unit Overview

Discover new knowledge through the use of large data sets.

Enduring Understanding

- Computers are used in an iterative and interactive way when processing digital information to gain insight and knowledge.
- Computing facilitates exploration and the discovery of connections in information.
- Transforming information can be effective in communicating knowledge gained from data.

Essential Questions

- How can computational models and simulations help generate new understanding and knowledge?
- Do considerations and trade-offs arise in the computational manipulation of data?

Exit Skills

- Assess the risks and benefits of drawing conclusions from patterns found in large data sets.
- Combine visuals, content knowledge, and interaction to create a dynamic infographic that clearly communicates discrete information about a data set.
- Differentiate usable and useful data from unusable data and useless data based on the characteristics of each.
- Extract structured information from unstructured data.
- Extract information from online sources, including structured and unstructured search engines, screen scrapers, and spiders.
- Examine features and functions of modern relational databases.
- Explore the use of data mining in the discovery of patterns in large data sets.
- Examine the use of cluster analysis and data classification in the processing of large data sets.
- Examine the causes and impact of data breaches involving sensitive personal data.

New Jersey Student Learning Standards (NJSLS)

CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.CS	Computing Systems
CS.9-12.NI	Networks and the Internet
TECH.9.4.12.CI	Creativity and Innovation
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT	Critical Thinking and Problem-solving
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
	The scalability and reliability of the Internet are enabled by the hierarchy and redundancy in networks. Network topology is determined by many characteristics.
	The usability, dependability, security, and accessibility of devices within integrated systems are important considerations in their design as they evolve.
	With a growth mindset, failure is an important part of success.
	Innovative ideas or innovation can lead to career opportunities.
	A computing system involves interaction among the user, hardware, application software, and system software.

Interdisciplinary Connections

LA.RL.11-12	Reading Literature
	Key Ideas and Details
LA.RL.11-12.1	Cite strong and thorough textual evidence and make relevant connections to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.

LA.RL.11-12.2	Determine two or more themes or central ideas of a text and analyze their development over the course of the text, including how they interact and build on one another to produce a complex account; provide an objective summary of the text.
LA.RL.11-12.3	Analyze the impact of the author's choices regarding how to develop and relate elements of a story or drama (e.g., where a story is set, how the action is ordered, how the characters are introduced and developed).
	Craft and Structure
	Integration of Knowledge and Ideas
LA.L.11-12.4	Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grades 11–12 reading and content, choosing flexibly from a range of strategies.
LA.L.11-12.4.A	Use context (e.g., the overall meaning of a sentence, paragraph, or text; a word's position or function in a sentence) as a clue to the meaning of a word or phrase.
LA.L.11-12.4.B	Identify and correctly use patterns of word changes that indicate different meanings or parts of speech (e.g., conceive, conception, conceivable).
LA.L.11-12.4.C	Consult general and specialized reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation of a word or determine or clarify its precise meaning, its part of speech, its etymology, or its standard usage.
LA.L.11-12.4.D	Verify the preliminary determination of the meaning of a word or phrase (e.g., by checking the inferred meaning in context or in a dictionary).
9-12.HS-ETS1-1.1	Asking Questions and Defining Problems
	Functions

Learning Objectives

Data Science:

- Relate the impact of computing to large-scale data processing.
- Discover the ways that patterns within large data sets can be used in a predictive manner.
- Assess the risks and benefits of drawing conclusions from patterns found in large data sets.
- Combine visuals, content knowledge, and interaction to create a dynamic infographic that clearly communicates discrete information about a data set.
- Differentiate usable and useful data from unusable data and useless data based on the characteristics of each.

Data Aggregation:

- Explore the purposes of processing tasks, including collection, knowledge extraction, and data storage.
- Identify multiple techniques for data collection, both on and off of the Internet.
- Extract structured information from unstructured data.
- Extract information from online sources, including structured and unstructured search engines, screen scrapers, and spiders.
- Examine features and functions of modern relational databases.

Data Analysis:

- Analyze the trade-off of utility and confidence in descriptive, predictive, and prescriptive data analysis.
- Investigate traditional statistical hypothesis testing and exploratory data analysis.
- Explore the use of data mining in the discovery of patterns in large data sets.

- Examine the use of cluster analysis and data classification in the processing of large data sets.

Global Impact:

- Debate the benefits and costs of large-scale data storage and data persistence on privacy and utility.
- Explore security risks and responsibilities assumed by companies that collect and store sensitive personal data.
- Examine the causes and impact of data breaches involving sensitive personal data.

Suggested Activities & Best Practices

Exploration and Research:

- Investigate a computing innovation that has had a significant impact on society, economy, or culture.
- Produce a computational artifact that describes the intended purpose and function of the computing innovation and demonstrates how it fulfills that purpose.
- Document the development process, tools, and techniques used in creating the computational artifact.
- Analyze the beneficial and harmful effects of the computing innovation on society, economy, or culture.
- Identify and discuss how the computing innovation consumes, produces, and/or transforms data and address concerns about data storage, data privacy, or data security..
- Design, research, and create a computational artifact.
- Student will be able to identify famous African Americans in the field of computer programming

- Students will also be introduced to the basic energy efficient models in the programming field to help reduce global warmin

Creative Development:

- Design, implement, and test a program that solves a problem of personal interest to the student.
- Summarize, describe, and reflect on the development process of the program.

- Create a video demonstrating the use and functionality of the program.

Assessment Evidence - Checking for Understanding (CFU)

• Think, pair, share review questions from text.-formative assessment

Unit test-summative assessment

Web-based assessment-alternate assessment

Design, research, and create a computational artifact.-benchmark assessment

• Practice mini-programs to strengthen concepts as taught.
• Teacher Observation

- Admit Tickets
- Anticipation Guide
- Common Benchmarks
- Compare & Contrast

- Create a Multimedia Poster
- DBQ's
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Learning Center Activities
- Multimedia Reports
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Surveys
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List
- Unit review/Test prep
- Unit tests
- Web-Based Assessments
- Written Reports

Primary Resources & Materials

Online Edhesive Computer Science Program.

Ancillary Resources

General Resources:

- Computers and Internet Access
- AP Central at Collegeboard.org
- Massive Open Online Course
- Code.org
- Multimedia Applications Tools
- Abelson, H., Ledeen, K., and Lewis, H. R. Blown to Bits: your life, liberty, and happiness after the digital explosion. Upper Saddle River, N.J.: Addison-Wesley, 2008.

AP Approved Programming Resources:

(may choose one or more)

- Alice - This 3-D modeling environment allows students to create and animate 3-D worlds. This environment lends itself well to creating stories and games.
- App Inventor - This open-source Web application allows students to create their own applications on mobile devices. App Lab - This is a programming environment for creating web applications with JavaScript. It allows students to develop programs and toggle back and forth between block-based and text-based programming modes.
- EarSketch - This browser-based application allows students to create their own music using either JavaScript or Python. Greenfoot - This Java IDE is designed for use in education to create two-dimensional graphic applications, such as simulations and interactive games.
- Java - There are several IDEs that can be used to write in Java. The Java language allows students to create and solve problems that vary widely in difficulty.
- JavaScript - This language is commonly used to create interactive effects within Web browsers.
- Lego Mindstorms NXT - This product integrates programming with Lego bricks and sensors to create and program robots. The instructions are assembled by linking together function blocks.
- Processing - This programming language was initially created to serve as a software sketchbook, and it can be used to teach programming using a visual context.
- Python - This language has the benefit of readability that might be helpful to new programmers.
- Scratch - This blocks-based programming language allows students to build scripts to run animations. This product can be downloaded and installed on a computer or run in the browser.
- Snap! - This Scratch-style programming language is block-based and allows users to define new primitives in JavaScript. Users can read and write information from the Internet using server-defined APIs and make mobile applications.
- Swift - This programming language is designed for use with iOS, OS X, tvOS and watchOS. This environment allows students to create their own Apple apps and includes interactive environments that allow students to see the effects of changes or additions to code as they type.

Design and Development Process:

- “What Is the Software Development Life Cycle?” Official Blog Airbrake Bug Tracker. https://airbrake.io/blog/insight/what-is-the-software-development-life-cycle
- “Engineering Design Process.” https://www.teachengineering.org/ engrdesignprocess.php
- “The Engineering Design Process.” http://www.eie.org/overview/engineeringdesign-process Mohammed, Nabil, Ali Munassar, and A. Govardhan.
- “A Comparison Between Five Models of Software Engineering.” IJCSI International Journal of Computer Science 7.5 (2010): 94-101.Open Source:
- “What Is Open Source?” Opensource.com. https://opensource.com/resources/whatopen-source
- Open Source Initiative. http://opensource.org/

Technology Infusion

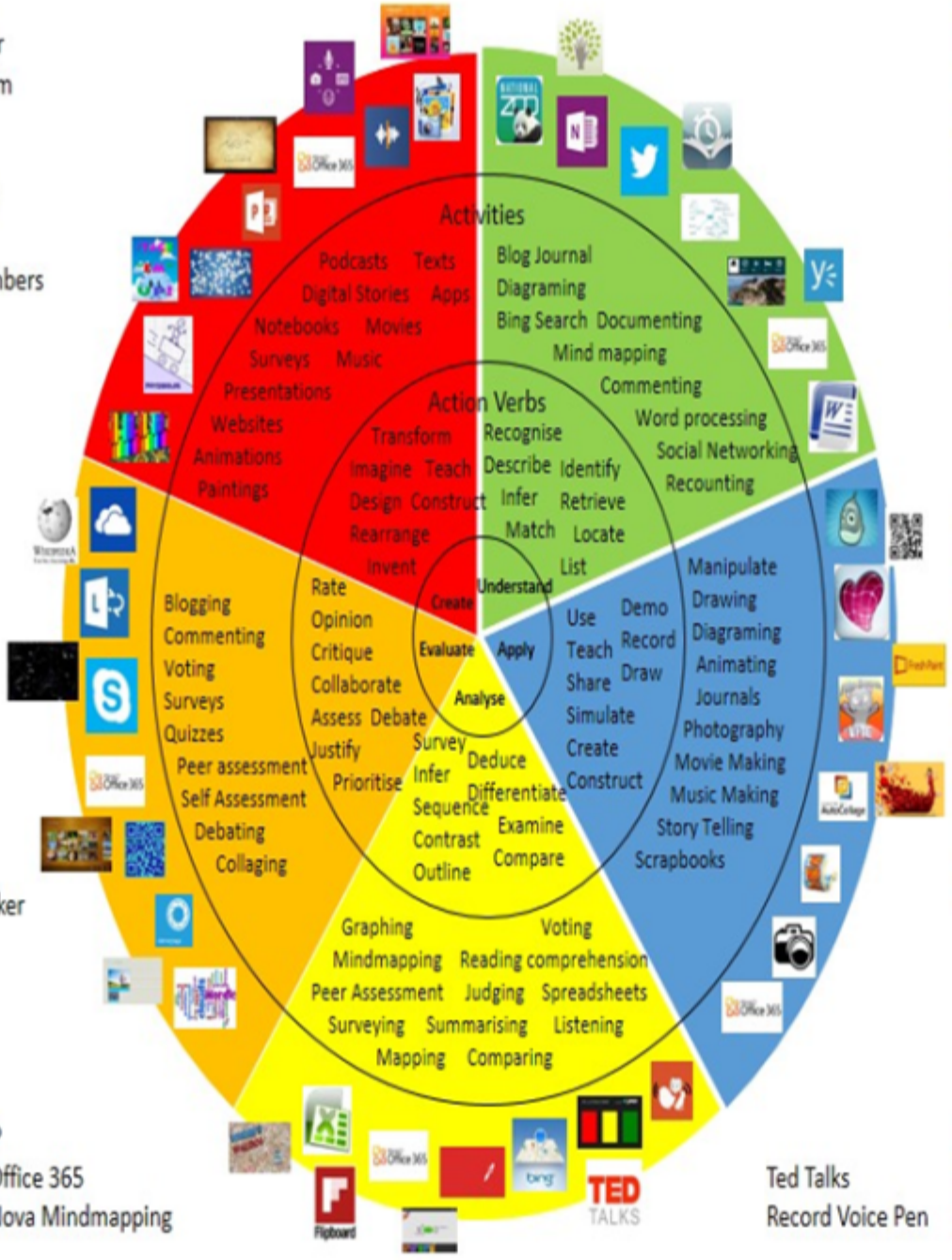
Please reference video links and websites listed under Ancillary Resources and Suggested Activities & Best Practices.

Technology Infusion and/or strategies include chromebooks online materials google/powerpoint slides

Win 8.1 Apps/Tools Pedagogy Wheel

Podcasts
Photostory 3
Kid Story Builder
Music Maker Jam
Paint A Story
Office 365
MS PowerPoint
Stack 'Em Up
NqSquared Numbers
Physamajig
Xylophone 8

Wikipedia
Skydrive
Lync
SkyMap
Skype
Office 365
Puzzle Touch
Easy QR
Memorylage
Life Moments
Word Cloud Maker



Where's Waldo?
MS Excel Office 365
Flipboard Nova Mindmapping

Ted Talks
Record Voice Pen

Originally taken from http://www.coetail.com/vzimmer/files/2013/02/iPadagogy-Wheel.001.jpg
And adapted for Windows 8.1 devices by Charlotte Beckhurst @CharBeckhurst

Alignment to 21st Century Skills & Technology

WRK.9.2.12.CAP	Career Awareness and Planning
WRK.9.2.12.CAP.1	Analyze unemployment rates for workers with different levels of education and how the economic, social, and political conditions of a time period are affected by a recession.
WRK.9.2.12.CAP.2	Develop college and career readiness skills by participating in opportunities such as structured learning experiences, apprenticeships, and dual enrollment programs.
WRK.9.2.12.CAP.3	Investigate how continuing education contributes to one's career and personal growth.
WRK.9.2.12.CAP.4	Evaluate different careers and develop various plans (e.g., costs of public, private, training schools) and timetables for achieving them, including educational/training requirements, costs, loans, and debt repayment.
WRK.9.2.12.CAP.5	Assess and modify a personal plan to support current interests and post-secondary plans.
WRK.9.2.12.CAP.6	Identify transferable skills in career choices and design alternative career plans based on those skills.
TECH.9.4.12.CI	Creativity and Innovation
TECH.9.4.12.CI.1	Demonstrate the ability to reflect, analyze, and use creative skills and ideas (e.g., 1.1.12prof.CR3a).
TECH.9.4.12.CI.2	Identify career pathways that highlight personal talents, skills, and abilities (e.g., 1.4.12prof.CR2b, 2.2.12.LF.8).
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).
TECH.9.4.12.CT	Critical Thinking and Problem-solving
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
	With a growth mindset, failure is an important part of success.

21st Century Skills/Interdisciplinary Themes

Upon completion of this section, please remove all remaining descriptions, notes, outlines, examples and/or illustrations that are not needed or used.

Please list only the **21st Century/Interdisciplinary Themes** that will be incorporated into this unit.

- Communication and Collaboration
- Creativity and Innovation
- Critical thinking and Problem Solving
- ICT (Information, Communications and Technology) Literacy
- Information Literacy
- Life and Career Skills
- Media Literacy

TECH.K-12.1.2	Digital Citizen
TECH.K-12.1.3	Knowledge Constructor
TECH.K-12.1.4	Innovative Designer
TECH.K-12.1.5	Computational Thinker
TECH.K-12.1.5.a	formulate problem definitions suited for technology-assisted methods such as data analysis, abstract models and algorithmic thinking in exploring and finding solutions.
TECH.K-12.1.5.b	collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making.
TECH.K-12.1.5.c	break problems into component parts, extract key information, and develop descriptive models to understand complex systems or facilitate problem-solving.

Differentiation

Exemplar: Peer Tutoring along with meeting with small groups to re-teach an idea or skill for struggling learners, or to extend the thinking or skills of advanced learners.

. Varying the length of time a student may take to complete a task in order to provide additional support for a struggling learner or to encourage an advanced learner to pursue a topic in greater depth.

Using rubrics that match and extend students' varied skills levels;

Helping students understand that some learners need to move around to learn, while others do better sitting quietly (Tomlinson, 1995, 1999; Winebrenner, 1992, 1996).

Differentiations:

- Small group instruction
- Small group assignments
- Extra time to complete assignments
- Pairing oral instruction with visuals

- Repeat directions
- Use manipulatives
- Center-based instruction
- Token economy
- Study guides
- Teacher reads assessments allowed
- Scheduled breaks
- Rephrase written directions
- Multisensory approaches
- Additional time
- Preview vocabulary
- Preview content & concepts
- Story guides
- Behavior management plan
- Highlight text
- Student(s) work with assigned partner
- Visual presentation
- Assistive technology
- Auditory presentations
- Large print edition
- Dictation to scribe
- Small group setting

Hi-Prep Differentiations:

- Alternative formative and summative assessments
- Choice boards
- Games and tournaments
- Group investigations
- Guided Reading
- Independent research and projects
- Interest groups
- Learning contracts
- Leveled rubrics
- Literature circles
- Multiple intelligence options
- Multiple texts
- Personal agendas
- Project-based learning
- Problem-based learning
- Stations/centers
- Think-Tac-Toes
- Tiered activities/assignments
- Tiered products
- Varying organizers for instructions

Lo-Prep Differentiations

- Choice of books or activities
- Cubing activities
- Exploration by interest
- Flexible grouping
- Goal setting with students

- Jigsaw
- Mini workshops to re-teach or extend skills
- Open-ended activities
- Think-Pair-Share
- Reading buddies
- Varied journal prompts
- Varied supplemental materials

Special Education Learning (IEP's & 504's)

Exemplars:

Adherence to the students' Individualized Learning Plan.

Students will have extra time or fewer assignments, one-to-one assistance, and group work will often be enlisted.

- **Adjust** the method of presentation or content.
- **Develop** supplemental material.

Special Education Learning adaptations that can be employed in the unit, using the ones identified below.

- printed copy of board work/notes provided
- additional time for skill mastery
- assistive technology
- behavior management plan
- Center-Based Instruction
- check work frequently for understanding
- computer or electronic device utilizes
- extended time on tests/ quizzes
- have student repeat directions to check for understanding
- highlighted text visual presentation
- modified assignment format
- modified test content
- modified test format
- modified test length

- multi-sensory presentation
- multiple test sessions
- preferential seating
- preview of content, concepts, and vocabulary
- Provide modifications as dictated in the student's IEP/504 plan
- reduced/shortened reading assignments
- Reduced/shortened written assignments
- secure attention before giving instruction/directions
- shortened assignments
- student working with an assigned partner
- teacher initiated weekly assignment sheet
- Use open book, study guides, test prototypes

English Language Learning (ELL)

Exemplar: Sheltered Instruction Observation Protocol (SIOP) – instructional model that helps teachers plan and deliver lessons that allow English learners the ability to acquire academic knowledge as they develop English language proficiency.

English Language Learning adaptations that can be employed in the unit, using the ones identified below.

- teaching key aspects of a topic. Eliminate nonessential information
- using videos, illustrations, pictures, and drawings to explain or clarif
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student's learning;
- allowing students to correct errors (looking for understanding)
- allowing the use of note cards or open-book during testing
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher's notes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using computer word processing spell check and grammar check features
- using true/false, matching, or fill in the blank tests in lieu of essay tests

At Risk

Exemplar:

Classes will be largely activity-focused. One-to-one assistance will be available during class time.

Students will have access to “How To” videos and tutorials that they many review multiple times if they don’t get the information the first time.

Additionally, Parental Involvement

Planned intervention means involving parents.

Intervention Strategies that can be employed in the unit, using the ones identified below.

- allowing students to correct errors (looking for understanding)
- teaching key aspects of a topic. Eliminate nonessential information
- allowing products (projects, timelines, demonstrations, models, drawings, dioramas, poster boards, charts, graphs, slide shows, videos, etc.) to demonstrate student’s learning
- allowing students to select from given choices
- allowing the use of note cards or open-book during testing
- collaborating (general education teacher and specialist) to modify vocabulary, omit or modify items to reflect objectives for the student, eliminate sections of the test, and determine how the grade will be determined prior to giving the test.
- decreasing the amount of workpresented or required
- having peers take notes or providing a copy of the teacher’s notes
- marking students’ correct and acceptable work, not the mistakes
- modifying tests to reflect selected objectives
- providing study guides
- reducing or omitting lengthy outside reading assignments
- reducing the number of answer choices on a multiple choice test
- tutoring by peers
- using authentic assessments with real-life problem-solving
- using true/false, matching, or fill in the blank tests in lieu of essay tests
- using videos, illustrations, pictures, and drawings to explain or clarify

Talented and Gifted Learning (T&G)

Exemplar: Compact lesson

http://www.grandviewlibrary.org/CurriculumAdaptations/General_Gifted.pdf

Grouping • Group gifted students with other gifted students or higher-level learners. • Refrain from grouping

gifted students with lower-level students for remediation.

Talented and Gifted adaptations that can be employed in the unit, using the ones identified below.

- Above grade level placement option for qualified students
- Advanced problem-solving
- Allow students to work at a faster pace
- Cluster grouping
- Complete activities aligned with above grade level text using Benchmark results
- Create a blog or social media page about their unit
- Create a plan to solve an issue presented in the class or in a text
- Debate issues with research to support arguments
- Flexible skill grouping within a class or across grade level for rigor
- Higher order, critical & creative thinking skills, and discovery
- Multi-disciplinary unit and/or project
- Teacher-selected instructional strategies that are focused to provide challenge, engagement, and growth opportunities
- Utilize exploratory connections to higher-grade concepts
- Utilize project-based learning for greater depth of knowledge

Sample Lesson

Lesson Plan – Data & Privacy

Teacher:	Corey Woodring	Time Frame:	21 days
Grade:	9-12	School:	Belleville High School
Subject:	AP Computer Science Principles		

AP Essential Knowledge

(Referenced from CollegeBoard AP CS P Course & Exam Description)
DAT-2 Programs can be used to process data, which allows users to discover information and create new knowledge.

A. Describe what information can be extracted from data.

1. Information is the collection of facts and patterns extracted from data.
2. Data provide opportunities for identifying trends, making connections, and addressing problems.
3. Digitally processed data may show correlation between variables. A correlation found in data does not necessarily indicate that a causal relationship exists. Additional research is needed to understand the exact nature of the relationship.
4. Often, a single source does not contain the data needed to draw a conclusion. It may be necessary to

combine data from a variety of sources to formulate a conclusion.

A. Describe what information can be extracted from metadata.

1. Metadata are data about data. For example, the piece of data may be an image, while the metadata may include the date of creation or the file size of the image.
2. Changes and deletions made to metadata do not change the primary data.
3. Metadata are used for finding, organizing, and managing information.
4. Metadata can increase the effective use of data or data sets by providing additional information.
5. Metadata allow data to be structured and organized.

A. Identify the challenges associated with processing data.

1. The ability to process data depends on the capabilities of the users and their tools.
2. Data sets pose challenges regardless of size, such as:

- the need to clean data
- incomplete data
- invalid data
- the need to combine data sources

1. Depending on how data were collected, they may not be uniform. For example, if users enter data into an open field, the way they choose to abbreviate, spell, or capitalize something may vary from user to user.
2. Cleaning data is a process that makes the data uniform without changing their meaning (e.g., replacing all equivalent abbreviations, spellings, and capitalizations with the same word).
3. Problems of bias are often created by the type or source of data being collected. Bias is not eliminated by simply collecting more data.
4. The size of a data set affects the amount of information that can be extracted from it.
5. Large data sets are difficult to process using a single computer and may require parallel systems.
6. Scalability of systems is an important consideration when working with data sets, as the computational capacity of a system affects how data sets can be processed and stored..

A. Extract information from data using a program.

1. Programs can be used to process data to acquire information.
2. Tables, diagrams, text, and other visual tools can be used to communicate insight and knowledge gained from data.

3. Search tools are useful for efficiently finding information.

4. Data filtering systems are important tools for finding information and recognizing patterns in data.

5. Programs such as spreadsheets help efficiently organize and find trends in information.

6. Some processes that can be used to extract or modify information from data include the following:

- transforming every element of a data set, such as doubling every element in a list, or adding a parent's email to every student record
- filtering a data set, such as keeping only the positive numbers from a list, or keeping only students who signed up for band from a record of all the students
- combining or comparing data in some way, such as adding up a list of numbers, or finding the student who has the highest GPA
- visualizing a data set through a chart, graph, or other visual representation

A. Explain how programs can be used to gain insight and knowledge from data.

1. Programs are used in an iterative and interactive way when processing information to allow users to gain insight and knowledge about data.

2. Programmers can use programs to filter and clean digital data, thereby gaining insight and knowledge.

3. Combining data sources, clustering data, and classifying data are parts of the process of using programs to gain insight and knowledge from data.

4. Insight and knowledge can be obtained from translating and transforming digitally represented information.

5. Patterns can emerge when data are transformed using programs.

IOC-2 The use of computing innovations may involve risks to personal safety and identity.

A. Explain how computing resources can be protected and can be misused.

1. Authentication measures protect devices and information from unauthorized access. Examples of authentication measures include strong passwords and multifactor authentication.

2. A strong password is something that is easy for a user to remember but would be difficult for someone else to guess based on knowledge of that user.

3. Multifactor authentication is a method of computer access control in which a user is only granted access after successfully presenting several separate pieces of evidence to an authentication mechanism, typically in at least two of the following categories: knowledge (something they know); possession (something they have), and inherence (something they are).

4. Multifactor authentication requires at least two steps to unlock protected information; each step adds a new layer of security that must be broken to gain unauthorized access.

5. Encryption is the process of encoding data to prevent unauthorized access. Decryption is the process of

decoding the data. Two common encryption approaches are:

- Symmetric key encryption involves one key for both encryption and decryption.
- Public key encryption pairs a public key for encryption and a private key for decryption. The sender does not need the receiver's private key to encrypt a message, but the receiver's private key is required to decrypt the message.
- EXCLUSION STATEMENT: Specific mathematical procedures for encryption and decryption are beyond the scope of this course and the AP Exam.

1. Certificate authorities issue digital certificates that validate the ownership of encryption keys used in secure communications and are based on a trust model.
2. Computer virus and malware scanning software can help protect a computing system against infection.
3. A computer virus is a malicious program that can copy itself and gain access to a computer in an unauthorized way. Computer viruses often attach themselves to legitimate programs and start running independently on a computer.
4. Malware is software intended to damage a computing system or to take partial control over its operation.
5. All real-world systems have errors or design flaws that can be exploited to compromise them. Regular software updates help fix errors that could compromise a computing system.
6. Users can control the permissions programs have for collecting user information. Users should review the permission settings of programs to protect their privacy.

A. Explain how unauthorized access to computing resources is gained.

1. Phishing is a technique that attempts to trick a user into providing personal information. That personal information can then be used to access sensitive online resources, such as bank accounts and emails.
2. Keylogging is the use of a program to record every keystroke made by a computer user in order to gain fraudulent access to passwords and other confidential information.
3. Data sent over public networks can be intercepted, analyzed, and modified. One way that this can happen is through a rogue access point.
4. A rogue access point is a wireless access point that gives unauthorized access to secure networks.
5. A malicious link can be disguised on a web page or in an email message.
6. Unsolicited emails, attachments, links, and forms in emails can be used to compromise the security of a computing system. These can come from unknown senders or from known senders whose security has been compromised.
7. Untrustworthy (often free) downloads from freeware or shareware sites can contain malware.

CRD – 1

A. Explain how computing innovations are improved through collaboration

1. A computing innovation includes a program as an integral part of its function.

2. A computing innovation can be physical (e.g. self-driving car), nonphysical computing software (e.g. picture editing software), or a nonphysical computing concept (e,g. e-commerce).

3. Effective collaboration produces a computing innovation that reflects the diversity of talents and perspectives of those who designed it.

4. Collaboration that includes diverse perspectives helps avoid bias in the development of computing innovations.

5. Consultation and communication with users are important aspects of the development computing innovations.

6. Information gathered from potential users can be used to understand the purpose of a program from diverse perspectives and to develop a program that fully incorporates these perspectives.

B. Explain how computing innovations are developed by groups of people.

1. Online tools support collaboration by allowing programmers to share and provide feedback on ideas and documents.

2. Common models such as pair programming exist to facilitate collaboration.

C. Demonstrate effective interpersonal skills during collaboration.

1. Effective collaborative teams practice interpersonal skills, including gbut not limited to:

   i. Communication

   ii. Consensus building

   iii. Conflict resolution

   iv. negotiation

CRD – 2

A. Explain how a program or code segment functions.

1. A program is a collection of program statements that performs a specific task when run by a computer. A program is often referred to as software.

2. A code segment is a collection of program statements that is part of a program.

3. A program needs to work for a variety of inputs and situations.

4. The behavior of a program is how a program functions during execution and is often described by how a user interacts with it.

5. A program can be described broadly by what it does or in more detail by both what the program does and how the program statements accomplish this function.

B. Identify input(s) to a program

1. Program inputs are data sent to a computer for processing by a program. Input can come in a variety of forms, such as tactile, audio, visual, or text

2. An event is associated with an action and supplies input data to a program.

3. Events can be generated when a key is pressed, a mouse is clicked, a program is started, or any other defined action occurs that affects the flow of execution.

4. Inputs usually affect the output produced by a program.

5. In event-driven programming, program statements are executed when triggered rathe rthan through the sequential flow of control.

6. Input can come from a user or other programs.

C. Identify output(s) produced by a program.

1. Program outputs are any data sent from a program to a device. Program output can come in a variety of forms, such as tactile, audio, visual, or text.

2. Program output is usually based on a program's input or prior state (e.g. internal values).

D. Develop a program using a development process.

1. A development process can be ordered and intentional, or exploratory in nature.

2. There are multiple development processes. The following phases are commonly used when developing a program:

    i. Investigating and reflecting

    ii. Designing

    iii. Prototyping

    iv. Testing

3. A development process that is iterative requires refinement and revision based on feedback, testing, or reflection throughout the process. This may require revisiting earlier phases of the process.

4. A development process that is incremental is one that breaks the problem into smaller pieces and makes sure each piece works before adding it to the whole.

E. Design a program and its user interface.

1. The design of a program incorporates investigation to determine its requirements.

2. Investigation in a development process is useful for understanding and identifying the program constraints, as well as the concerns and interests of the people who will use the program.

3. Some ways investigation can be performed are as follows:
    i. Collecting data through surveys
    ii. User testing
    iii. Interviews
    iv. Direct observations
4. Program requirements describe how a program functions and may include a description of user interactions that a program must provide.
5. A program's specification defines the requirements for the program.
6. In a development process, the design phase outlines how to accomplish a given program specification.
7. The design phase of a program may include:
    i. Brainstorming
    ii. Planning and storyboarding
    iii. Organizing the program into modules and functional components
    iv. Creation of diagrams that represent the layouts of the user interface
    v. Development of a testing strategy for the program

I. For errors in an algorithm or program: Identify the error and correct the error.

1. A logic error is a mistake in the algorithm or program that causes it to behave incorrectly or unexpectedly.
2. A syntax error is a mistake in the program where the rules of the programming language are not followed.
3. A run-time error is a mistake in the program that occurs during the execution of a program. Programming languages define their own run-time errors.
4. An overflow error is an error that occurs when a computer attempts to handle a number that is outside of the defined range of values.
5. The following are effective ways to find and correct errors:
    i. Test cases
    ii. Hand tracing
    iii. Visualizations
    iv. Debuggers

v. Adding extra output statement(s)

J. Identify inputs and corresponding expected outputs or behaviors that can be used to check the correctness of an algorithm or program

1. In the development process, testing uses defined inputs to ensure tha tan algorithm or program is producing the expected outcomes. Programmers use the results from testing to revise their algorithms or programs.

2. Defined inputs used to test a program should demonstrate the different expected outcomes that are at or just beyond the extremes (minimum and maximum) of input data.

3. Program requirements are needed to identify appropriate defined inputs for testing.

Enduring Understanding & CTP Skills

(Referenced from CollegeBoard AP CS P Course & Exam Description)

1. Computing Innovations

   A. Explain how computing systems work.

   C. Describe the impact of a computing innovation.

E. Evaluate the use of computing based on legal and ethical factors.

1. Responsible Computing

   A. Collaborate in the development of solutions.

   B. Use safe and secure methods when using computing devices.

   C. Acknowledge the intellectual property of others.

Essential Questions

(Some referenced from CollegeBoard AP CS P Course & Exam Description)

(What questions will the student be able to answer as a result of the instruction?)

1. What is big data?

2. How is data acquired, stored and processed on a computer?

3. How can visualizations predict trends and patterns?

4. How do you secure information online/on a device?
5. What are some types of cyber-attacks and how do you protect yourself from them?
6. How do you leave a positive digital footprint?

Assessment

(What is acceptable evidence to show desired results (rubrics, exam, etc.)? Attach Copy

- Complete various written checkpoint exercises that focus on the explanation and description of computer programming, pseudocode, and python.
- Develop a visual representation of the communication processes within a computer using appropriate terminology.
- Properly document a program using correct indentation, spacing, and comment style.
- Debug programs and determine the types of errors in the program.
- Create programs based on programming exercises.
- Unit 3 Assessment

Formative Evaluations:

Formative Assessment with polling

Classwork/Homework

Quizzes

AP Classroom Big Idea 2 and Big Idea 5 Formative Topic Questions (see Sequence and Scope for when to assign problems)

Lab work

Summative Evaluations:

Unit 8 Test/ReTest

Sequence and Scope

Day	Topic/Activities	CW-HW
1	• What is Data?	Questions 1-4
2	• Data Acquisition	Questions 5-8
3	• Data Storage	Questions 9-15
4	• Data Processing (Data Processing)	
5	• Data Processing (Big Data)	Questions 16-21
6	• Data Visualization	Questions 22-28

7	• Quiz 1	
8	• Python 3 Programming Visualizations	Questions 29-30
9	• Python 3 Programming Visualizations	Questions 31-32
10	• Python 3 Programming Visualizations • codeIt! Now	Questions 33-34, AP Classroom Topic Questions 2.4
11	• Quiz 2	
12	• Cryptography	Questions 35-39
13	• Cryptography	Questions 40-45
14	• Cybersecurity	Questions 46-49
15	• Cybersecurity	Questions 50-61
16	• Cybersecurity Attacks	
17	• Cybersecurity Attacks	Questions 62-67, AP Classroom Topic Questions 5.6
18-20	• Labs	Study for Test
21	• Unit 8 Assessment	None

CS.9-12.8.1.12.CS.1	Describe ways in which integrated systems hide underlying implementation details to simplify user experiences.
CS.9-12.8.1.12.CS.2	Model interactions between application software, system software, and hardware.
CS.9-12.8.1.12.CS.3	Compare the functions of application software, system software, and hardware.
CS.9-12.8.1.12.CS.4	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.
CS.9-12.8.1.12.NI.1	Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.
CS.9-12.CS	Computing Systems
CS.9-12.NI	Networks and the Internet
TECH.9.4.12.CI	Creativity and Innovation
TECH.9.4.12.CI.3	Investigate new challenges and opportunities for personal growth, advancement, and transition (e.g., 2.1.12.PGD.1).

TECH.9.4.12.CT	Critical Thinking and Problem-solving
TECH.9.4.12.CT.1	Identify problem-solving strategies used in the development of an innovative product or practice (e.g., 1.1.12acc.C1b, 2.2.12.PF.3).
TECH.9.4.12.CT.2	Explain the potential benefits of collaborating to enhance critical thinking and problem solving (e.g., 1.3E.12profCR3.a).
TECH.9.4.12.CT.3	Enlist input from a variety of stakeholders (e.g., community members, experts in the field) to design a service learning activity that addresses a local or global issue (e.g., environmental justice).
TECH.9.4.12.CT.4	Participate in online strategy and planning sessions for course-based, school-based, or other project and determine the strategies that contribute to effective outcomes.
	Innovative ideas or innovation can lead to career opportunities.
	A computing system involves interaction among the user, hardware, application software, and system software.
	Successful troubleshooting of complex problems involves multiple approaches including research, analysis, reflection, interaction with peers, and drawing on past experiences.
	With a growth mindset, failure is an important part of success.
	The usability, dependability, security, and accessibility of devices within integrated systems are important considerations in their design as they evolve.