Unit 3: Data Representation

Content Area: **Technology**
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Computer Science Principles

Department of Curriculum and Instruction

Belleville Public Schools

Curriculum Guide

Computer Science Principles, Grades 9-12

Data Representation

Belleville Board of Education

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Unit Overview

Explore the different means of representing information digitally.

Enduring Understanding

- Multiple levels of abstraction are used to write programs or create other computational artifacts.
- Models and simulations use abstraction to generate new understanding and knowledge.
- There are trade-offs when representing information as digital data.
- Digital data representations involve trade-offs related to storage, security, and privacy concerns.
- Programming uses mathematical and logical concepts

Essential Questions

- How can computing extend traditional forms of human expression and experience?
- How are vastly different kinds of data, physical phenomena, and mathematical concepts represented on a computer?
- How can computation be employed to help people process data and information to gain insight and knowledge?
- How can computation be employed to facilitate exploration and discovery when working with data?

Exit Skills

Students will be able to:

- Examine how numerical values are represented using different bases, including decimal and binary.
- Perform calculations for converting values from decimal to binary and binary to decimal as well as methods of counting in binary.
- Examine the exponential relationship between the number of digits and their range of representable values.
- Investigate how alphanumeric characters and symbols may be represented using ASCII and Unicode character mappings.
- Compare and contrast the implications of variable-width encodings (e.g., Morse code) vs. fixed-width encodings (e.g., Baudot code).
- Explore how the interpretation of binary data is dependent upon its intended format and use.
- Explore ways in which natural phenomena may be represented digitally.
- Analyze the extent to which digital approximations accurately reflect the reality that they represent.
- Compare and contrast discrete (digital) and continuous (analog) representations of natural phenomena.
- Examine the social implications of the ease with which perfect digital copies can be made.
- Examine the use of lists as ordered data structures that may contain multiple values.
- Implement the use of index values to represent the position of an item in a list.
- Analyze the implications of accessing an index position beyond the bounds of a list as well as the implications of case-sensitivity on ordered lists of strings.
- Investigate common operations for processing elements of a list, including searching for an element, removing an element, swapping the positions of two elements, or sorting an entire list into ascending or descending order.

New Jersey Student Learning Standards (NJSLS-S)

8.1 Educational Technology

8.1.12.A.1, 8.1.12.E.1, 8.1.12.F.1

8.2 Technology, Engineering, Design and Computational Thinking

8.2.12.A.1, 8.2.12.C.4, 8.2.12.D.1, 8.2.12.D.4, 8.2.12.D.5, 8.2.12.D.6

TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.
TECH.8.1.12	All students will use digital tools to access, manage, evaluate, and synthesize information in order to solve problems individually and collaborate and to create and communicate knowledge.
TECH.8.1.12.A	Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.2.12.E	Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.

TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.2.12.E.3	Use a programming language to solve problems or accomplish a task (e.g., robotic functions, website designs, applications, and games).
TECH.8.1.12.A.CS2	Select and use applications effectively and productively.

Interdisciplinary Connections

21st century life and careers

Technology

Digital Literacy

English Language Arts

Reading

Writing

Speaking and Listening (communication skills)

Mathematics

Social science

Science and the Engineering Practices

Career Ready Practices

CRP4. Communicate clearly and effectively and with reason.

CRP5. Consider the environmental, social and economic impacts of decisions.

CRP6. Demonstrate creativity and innovation.

CRP7. Employ valid and reliable research strategies.

CRP8. Utilize critical thinking to make sense of problems and persevere in solving them.

CRP11. Use technology to enhance productivity.

CRP.K-12.CRP2	Apply appropriate academic and technical skills.
CRP.K-12.CRP11	Use technology to enhance productivity.
MA.F-IF.C	Analyze functions using different representations
CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.

Learning Objectives

Binary Encoding of Information:

1. Examine how numerical values are represented using different bases, including decimal and binary.
2. Perform calculations for converting values from decimal to binary and binary to decimal as well as methods of counting in binary.
3. Examine the exponential relationship between the number of digits and their range of representable values.
4. Investigate how alphanumeric characters and symbols may be represented using ASCII and Unicode

character mappings.
5. Compare and contrast the implications of variable-width encodings (e.g., Morse code) vs. fixed-width encodings (e.g., Baudot code).
6. Explore how the interpretation of binary data is dependent upon its intended format and use.

Digital Approximations:

1. Explore ways in which natural phenomena may be represented digitally.
2. Analyze the extent to which digital approximations accurately reflect the reality that they represent.
3. Compare and contrast discrete (digital) and continuous (analog) representations of natural phenomena.
4. Examine the social implications of the ease with which perfect digital copies can be made.

Lists:

1. Examine the use of lists as ordered data structures that may contain multiple values.
2. Implement the use of index values to represent the position of an item in a list.
3. Analyze the implications of accessing an index position beyond the bounds of a list as well as the implications of case-sensitivity on ordered lists of strings.
4. Investigate common operations for processing elements of a list, including searching for an element, removing an element, swapping the positions of two elements, or sorting an entire list into ascending or descending order.

Suggested Activities & Best Practices

Case Studies

Refer to AP Classroom Resources for Computer Science Test A

Use online modules through Code. Org, Edhesive and BJC, Snap.

Evidence of Student Learning - Checking for Understanding (CFU)

- Minor exercises and short formative assessments addressing specific unit topics and objectives
- Formally assessed, multiple-choice test addressing unit objectives (single- and multiple- select questions) in preparation for advanced placement exam
- Rubric-assessed, individual and/or collaborative unit project demonstrating mastery of unit objectives

- Admit Tickets
- Anticipation Guide
- Common benchmarks
- Compare & Contrast
- Create a Multimedia Poster
- Define
- Describe
- Evaluate
- Evaluation rubrics
- Exit Tickets
- Explaining
- Fist- to-Five or Thumb-Ometer
- Illustration
- Journals
- KWL Chart
- Newspaper Headline
- Outline
- Question Stems
- Quickwrite
- Quizzes
- Red Light, Green Light
- Self- assessments
- Socratic Seminar
- Study Guide
- Teacher Observation Checklist
- Think, Pair, Share
- Think, Write, Pair, Share
- Top 10 List

- Unit tests

Primary Resources & Materials

Edhesive Online Curriculum

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

Alignment to 21st Century Skills & Technology

21st century life and careers

Technology

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21st Century Skills/Interdisciplinary Themes

21st Century/Interdisciplinary Themes that could 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

21st Century Skills

21st Century Skills that could be incorporated into this unit.

- Civic Literacy
- Environmental Literacy
- Financial, Economic, Business and Entrepreneurial Literacy
- Global Awareness
- Health Literacy

Differentiation

- Project Based Learning
- Highlighting key vocabulary.
- Additional testing time.
- Using paired/cooperative learning.
- Using hands-on learning.
- Making curricular and personal connections.
- Developing oral, reading, and writing skills.
- Using graphic organizer and/note taking guides
- Use of technology for class
- Use of scaffolding and tiered assessments
- Other differentiation based on IEP and 504 accommodations

Intervention Strategies

Intervention Strategies that could be employed in this 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

Special Education Learning

Special Education Learning adaptations that could be employed in this 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
- multiple test sessions
- multi-sensory presentation
- preferential seating
- preview of content, concepts, and vocabulary
- 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)

English Language Learning adaptations that could be employed in this 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

Sample Lesson