Unit 3: Data Representation

Content Area: **Technology**
Course(s): **Sample Course**
Time Period: **NovDec**
Length: **Full year, Grades 9-12**
Status: **Published**

Data Representation, Computer Science

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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Board Approved:

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)

TECH.8.2.12.E	Computational Thinking: Programming: Computational thinking builds and enhances problem solving, allowing students to move beyond using knowledge to creating knowledge.
TECH.8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
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.8.2.12.E.4	Use appropriate terms in conversation (e.g., troubleshooting, peripherals, diagnostic software, GUI, abstraction, variables, data types and conditional statements).

Interdisciplinary Connections

Primary interdisciplinary connections:

Infused within the unit are connections to the 2009 NJCCCS for Language Arts Literacy and Business, Science and Technology.

Critical reading, writing, and mathematical modeling skills are promoted within the problem solving process and as a means to explain solutions.

LA.RH.6-8.7	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
LA.RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
LA.RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
LA.WHST.6-8.2.A	Introduce a topic and organize ideas, concepts, and information using text structures (e.g., definition, classification, comparison/contrast, cause/effect, etc.) and text features (e.g., headings, graphics, and multimedia) when useful to aiding comprehension.

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

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

Assignment Ideas/Suggested Activities

- **CS Unplugged**
- **CS Fundamentals Unplugged** from Code.org
- **CS4K12** **C**ollection of handouts, worksheets and other documents to help teach Computer Science and Engineering concepts. Materials primarily target middle-school students (6th - 8th grade), but most can be used without modification for younger or older students.
- **Code.org YouTube Channel** > Learn about computer science
- **Nifty Assignments** Collection of fun, inspirational, or thought-provoking assignments for CS1 and CS2 shared at the annual SIGCSE conference
- **EngageCSEdu** Collection of activities and programming assignments designed to engage ALL students in CS1- and CS2-level courses. Materials have been reviewed by computer science educators and experts in student engagement and pedagogy.
- **Websheets** A system for creating and solving programming assignments **About Websheets**
- **Stanford CS Education Library** Education CS material from Stanford CS classes
- **Learn Java in N Games** Collection of game-based activities (including POGIL-style activities) for

learning about Java programming. Can be used individually or as a complete curriculum. CS2 level.

Best Practices

- **CS Teaching Tips** Tips to help teachers anticipate students' difficulties and build upon students' strengths. Funded by a National Science Foundation Grant.

Assessment Evidence - Checking for Understanding (CFU)

Formative Assessments

• Think, pair, share review questions from text.

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

• Utilizing Gliffy.com to flowchart programs to represent data within the unit.
Summative Assessments

• Chapter Test

• End of Chapter Projects from book.

Alternate Assessment

* Written reports

Benchmark Assessment

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

- 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

Edhesive Online Curriculum, Code.Org

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

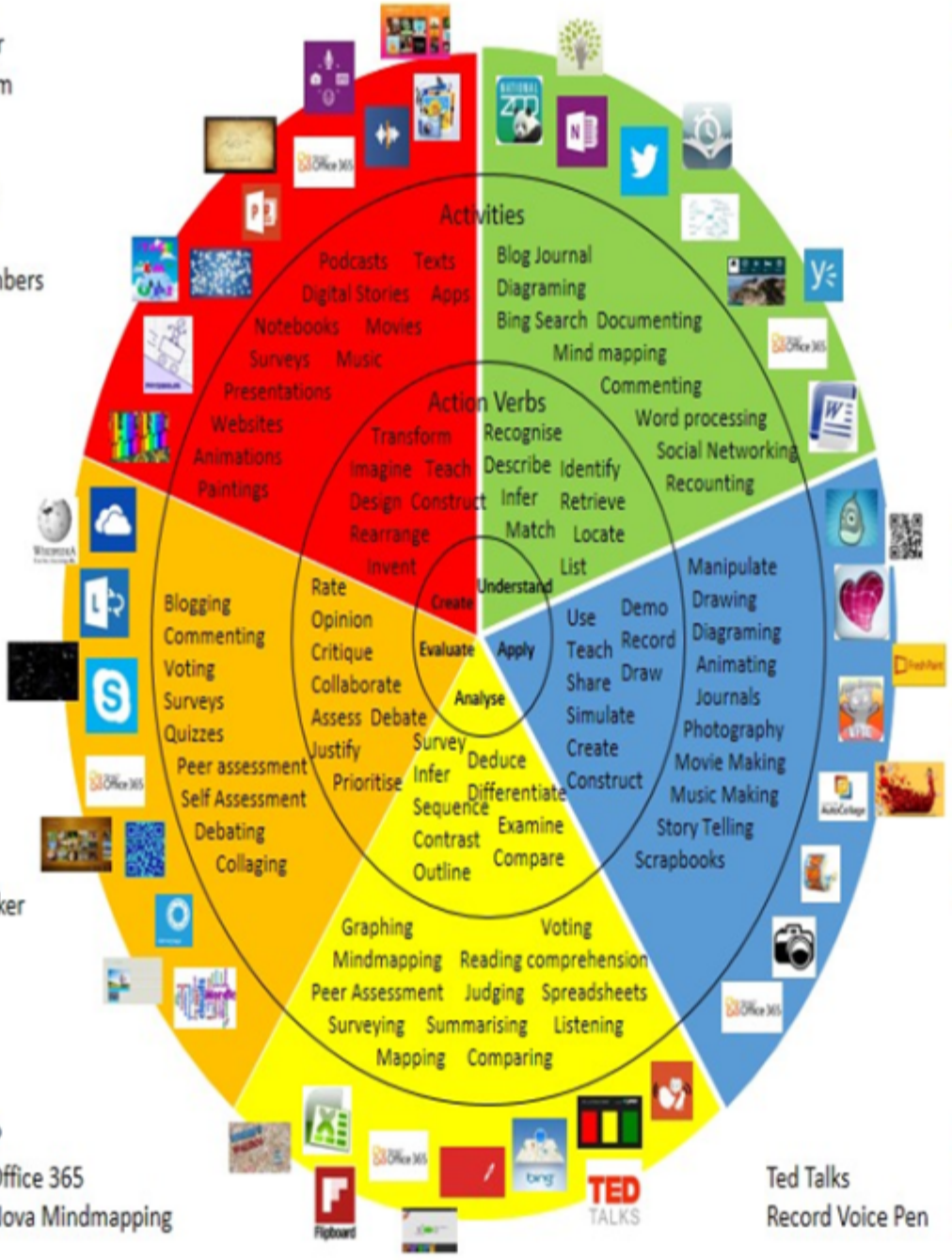
Please reference video links and websites listed under Ancillary Resources and Suggested Activities & Best Practices.

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

21st century themes: The unit will integrate the 21st Century Life and career standard 9.1 strands A-D. These strands include: critical thinking and problem solving, creativity and innovation, collaboration, teamwork, and leadership, and cross cultural understanding and interpersonal communication

Mastery and infusion of **21st Century Skills & Technology** and their Alignment to the core content areas is essential to student learning. The core content areas include:

- English Language Arts;
- Mathematics;
- Science and Scientific Inquiry (Next Generation);
- Social Studies, including American History, World History, Geography, Government and Civics, and Economics;
- World languages;
- Technology;
- Visual and Performing Arts.

CRP.K-12.CRP1	Act as a responsible and contributing citizen and employee.
CRP.K-12.CRP6	Demonstrate creativity and innovation.
CAEP.9.2.12.C.2	Modify Personalized Student Learning Plans to support declared career goals.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.
CAEP.9.2.12.C.5	Research career opportunities in the United States and abroad that require knowledge of world languages and diverse cultures.

21st Century Skills/Interdisciplinary Themes

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

LA.RH.6-8.7	Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.
	Functions presented as expressions can model many important phenomena. Two

important families of functions characterized by laws of growth are linear functions, which grow at a constant rate, and exponential functions, which grow at a constant percent rate. Linear functions with a constant term of zero describe proportional relationships.

Functions

In school mathematics, functions usually have numerical inputs and outputs and are often defined by an algebraic expression. For example, the time in hours it takes for a car to drive 100 miles is a function of the car's speed in miles per hour, v; the rule T(v) = 100/v expresses this relationship algebraically and defines a function whose name is T.

21st Century Skills

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

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

CAEP.9.2.12.C	Career Preparation
CAEP.9.2.12.C.1	Review career goals and determine steps necessary for attainment.
CAEP.9.2.12.C.2	Modify Personalized Student Learning Plans to support declared career goals.
CAEP.9.2.12.C.3	Identify transferable career skills and design alternate career plans.

Differentiation

• **Exemplar** - Technology Resources will be tailored for better student understanding of course material and objectives to understand abstraction through models and visuals.

Additionally, 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)

Exemplar: Adapting existing materials, simplifying or supplementing materials for Special Education Learning other options are below.

***Adjust** the method of presentation or content.*

- **Develop** supplemental material

- 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
- 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: Extended Time

It's obvious that response time for ELLs is significantly greater than it is for students proficient in English. Given this, we know that ELLs may require more time to process and communicate information on assessments. To support your students in this area, give them additional time on tests to help.

English Language Learning adaptations that will 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: Seating

Where are your students at risk? Hopefully, they are near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.

Intervention Strategies that will 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 :Talented and Gifted adaptations that will be employed in the unit, using the ones identified below.

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.

- 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

Using the template below, please develop a **Sample Lesson** for the first unit only.

Unit Name:

NJSLS:

Interdisciplinary Connection:

Statement of Objective:

Anticipatory Set/Do Now:

Learning Activity:

Student Assessment/CFU's:

Materials:

21st Century Themes and Skills:

Differentiation/Modifications:

Integration of Technology: