Unit 2: Digital Information

Content Area: **Science**
Course(s):
Time Period: **MP1**
Length: **25 days**
Status: **Published**

NJSLS - Science

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.DA.1	Create interactive data visualizations using software tools to help others better understand real world phenomena, including climate change.
CS.9-12.8.1.12.DA.5	Create data visualizations from large data sets to summarize, communicate, and support different interpretations of real-world phenomena.
CS.9-12.8.1.12.DA.6	Create and refine computational models to better represent the relationships among different elements of data collected from a phenomenon or process.
CS.9-12.8.1.12.IC.1	Evaluate the ways computing impacts personal, ethical, social, economic, and cultural practices.
CS.9-12.8.1.12.IC.3	Predict the potential impacts and implications of emerging technologies on larger social, economic, and political structures, using evidence from credible sources.
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.9-12.8.1.12.NI.4	Explain how decisions on methods to protect data are influenced by whether the data is at rest, in transit, or in use.

Rationale and Transfer Goals

This unit explores the technical challenges and questions that arise from the need to represent digital information in computers and transfer it between people and computational devices. Topics include: the digital representation of information - This unit further explores the ways that digital information is encoded, represented, and manipulated. In this unit, students will use a variety of tools including Code.org widgets and external data manipulation and visualization tools (such as Excel or Google Sheets).

Enduring Understandings

- Creave development can be an essential process for creating computational artifacts.
- Compung can extend traditional forms of human expression and experience.
- A variety of abstractions built upon binary sequences can be used to represent all digital data.
- There are trade-offs when representing information as digital data.
- Compung can extend traditional forms of human expression and experience.
- People use computer programs to process information to gain insight and knowledge.
- Computing facilitates exploration and the discovery of connections in information.
- There are trade-offs when representing information as digital data.
- Computing enhances communication, interaction, and cognition.

- Compung has a global affect -- both beneficial and harmful -- on people and society

Essential Questions

- Are how digital information encoded more laws of nature or man-made?
- What kinds of limitations does the binary encoding of information impose on what can be represented inside a computer?
- How accurately can human experience and perception be captured or reflected in digital information?
- What is the relationship between data, information and knowledge?
- What are the best ways to find, see, and extract meaningful trends and paerns from raw data?
- Where and how does human bias affect the collection, processing, and interpretation of data?

Content - What will students know?

- A variety of abstractions built upon binary sequences can be used to represent all digital data.
- There are trade-offs when representing information as digital data.
- Multiple levels of abstraction are used to write programs or create other computational artifacts
- People use computer programs to process information to gain insight and knowledge.
- Algorithms can solve many but not all computational problems.
- Creative development can be an essential process for creating computational artifacts.
- Computing enables people to use creative development processes to create computational artifacts for creative expression or to solve a problem.
- Compung can extend traditional forms of human expression and experience.
- Models and simulations use abstraction to generate new understanding and knowledge.
- Computing facilitates exploration and the discovery of connections in information.
- Compung has a global effect -- both beneficial and harmful -- on people and society.
- Computing innovations influence and are influenced by the economic, social, and cultural contexts in which they are designed and used.
- Computing enhances communication, interaction, and cognition.

Skills - What will students be able to do?

- Use appropriate terminology when describing the size of digital files.
- Identify and compare the size of familiar digital media.
- Solve small word problems that require reasoning about file sizes.
- Collaborate with a peer to find a solution to a text compression problem using the Text Compression Widget (lossless compression scheme).
- Explain why the optimal amount of compression is impossible or “hard” to identify.
- Explain some factors that make compression challenging.
- Develop a strategy (heuristic algorithm) for compressing text.

- Describe the purpose and rationale for lossless compression.
- Explain how images are encoded with pixel data.
- Describe a pixel as an element of a digital image.
- Encode a B&W image in binary representing both the pixel data (intensity) and metadata (width, height).
- Create the necessary metadata to represent the width and height of a digital image, using a computational tool.
- Explain why image width and height are metadata for a digital image.
- Use the Pixelation Tool to encode small color images with varying bits-per-pixel settings.
- Explain the color encoding scheme for digital images.
- Use the Pixelaon Tool to encode an image of the student's design.
- Explain the benefits of using hexadecimal numbers for representing long streams of bits.
- Explain the difference between lossy and lossless compression.
- Identify common computer file types, whether they are compressed or not, and whether compression is lossy or lossless.
- Read a technical article on the web and si its contents for targeted information.
- Break a complex piece of information down into its parts such that it can be represented on a computer.
- Choose appropriate binary encodings for specific pieces of information and justify those choices.
- Develop a hypothesis about student behavior over me, based on a small sample of data.
- Describe sources of data appropriate for performing computations.
- Use Google Trends to identify and explore concepts and paerns within a data visualization.
- Accurately describe what a data visualization of a trend is showing.
- Provide plausible explanations of trends and paerns observed within a data visualization.
- Define the digital divide as the variety in access or use of technology by various demographic characteristics
- Identify assumptions made when concluding data and data visualizations
- Identify an effective data visualization and give suspicion.
- Collaborate to investigate and evaluate a data visualization.
- Suggest an appropriate visualization for some data.
- Evaluate a data visualization for the effectiveness of communication.
- Idenfy a poor data visualizaon and give jusficaon.
- Select the appropriate type of data visualization to discover trends and paerns within a dataset.
- Create a bar, line, and scatter chart from a dataset using a computational tool.
- Use the songs of a data visualization tool to manipulate and refine the features of a data visualization.
- Collaboravely investigate a dataset.
- Create a visualization (chart) from the provided data.
- Identify possible trends or concerns in a data set by creating visualizations of it.
- Accurately communicate about a visualization of their creation.
- Filter and sort a dataset using a spreadsheet tool.
- Identify and correct invalid values in a dataset with the aid of computational tools
- Jusfy the need to clean data before analyzing it with computational tools.
- Create a pivot table with at least one aggregation and calculation when given a data set.
- Describe the benefits a summary table has over a raw dataset.
- Collaboratively investigate a dataset by creating summary tables.
- Explain the meaning of a summary table they created.
- Create summaries of a dataset using a pivot table.
- Manipulate and clean data to prepare it for analysis.
- Explain the process used to create a visualization.
- Design a visualization that presents a trend, pattern, or relationship within a dataset.

- Create visualizations of a dataset to discover trends and patterns.
- Draw conclusions from the contents of a data visualization.

Activities - How will we teach the content and skills?

- Research
- Widget - Text Compression
- Individual and Group Discovery
- Widget - Pixelation
- Concept Invention
- Individual Creation
- Performance Task
- Unplugged Activities
- External Tools
- Presentation
- Class Discussion
- Analyzing Artifacts
- Group Discovery
- Class Discussion
- Individual Skill Building
- Tutorial
- Collaborave Artifact Creation
- Writing
- Analyzing
- Group Skill Building
- Artifact Creation
- Performance Task

Evidence/Assessments - How will we know what students have learned?

- If you send the compressed poem, will your friend will be able to read it? Why is the dictionary important?
- Why do you want to compress anything? What's the point?
- For a piece of text, what is a "good" amount of compression? Is there a way to know when you've compressed it the most? Explain how you would know, or why you can't know.
- What would happen if we didn't include width and height bits in our protocol? Assume your friend just sent you 32 bits of pixel data (just the 0s and 1s for black and white pixels). Could you recover the original image? If so, how?
- How many bits (or bytes) are required to encode an image that is 25 pixels wide and 50 pixels tall, if you encode it with 24 bits per pixel?
- Imagine that you have an image that is too dark or too bright. Describe how you would alter the RGB settings to brighten or darken it. Give an example. Consider the following statement from the CS Principles course framework: C The global distribution of computing resources raises issues of equity

access and power. Briefly describe one of these issues that you learned about in the lesson and how it affects your life or the lives of people you know. Keep your response to about 100 words (about 3-5 sentences)
- Show students a visualization and have them analyze it, using the table of characteristics of good/bad visualizations to justify their opinion
- Describe the development process of discovering your data story and creating a visualization. Describe the difficulties and/or opportunities you encountered along the way and describe the collaborative process between you and your partner.

Spiraling for Mastery

Content or Skill for this Unit	Spiral Focus from Previous Unit	Instructional Activity
• Computing devices are oen integrated with other systems, including biological, mechanical, and social systems. These devices can share data. The usability, dependability, security, and accessibility of these devices, and the systems they are integrated with, are important considerations in their design as they evolve. • Troubleshooting complex problems involves the use of multiple sources when researching, evaluating, and implementing potential soluons. Troubleshooting also relies on experience, such as when people recognize that a problem is similar to one they have seen before or adapt soluons that have worked in the past.	• The interaction between humans and computer devices presents advantages, disadvantages, and unintended consequences. The study of human-computer interaction can improve the design of devices and extend the abilities of humans. • Comprehensive troubleshooting requires knowledge of how computing devices and components work and interact. A systematic process will identify the source of a problem, whether within a device or in a larger system of connected devices.	• Encoding B&W Images • Lossy Compression and File Formats

Key Resources

Unit 2 - Code.org Computer Science Principles Curriculum

Widget - Text Compression

Widget - Color Pixelaon

Career Readiness, Life Literacies, & Key Skills

CAEP.9.2.12.C.7	Examine the professional, legal, and ethical responsibilities for both employers and employees in the global workplace.
TECH.9.4.12.CI	Creativity and Innovation
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). Collaboration with individuals with diverse experiences can aid in the problem-solving process, particularly for global issues where diverse solutions are needed.

Interdisciplinary Connections/Companion Standards

LA.RST.11-12.1	Accurately cite strong and thorough evidence from the text to support analysis of science and technical texts, attending to precise details for explanations or descriptions.
LA.WHST.11-12.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.