Unit II: Digital Information and Physical Computing

Content Area: **Business**
Course(s): **Introduction to Computer Science and Programing**
Time Period: **4 weeks**
Length: **Weeks**
Status: **Published**

Unit Overview

In this unit, students will learn the basic facts and terminology and relating to data storage and compression (including terms such as byte, kilobyte, megabytes, etc.) and the examine roles of fundamental hardware and software components of a computer system

Transfer

Students will be able to independently use their learning to...

- apply basic facts and terminology of data storage in analyzing computer and network resource usage
- explain how data compression reduces resource usage, and analyze tradeoffs (decompression speed, lossless vs. lossy compression) of different compressed file formats
- understand the roles of various hardware and software components of a computer system
- explain how data is stored as bits in hardware
- make use of digital tools to analyze, generate, and manipulate data
- explain in general terms how text and image compression work
- explain the difference between lossless and lossy compression
- understand the functions performed by the operating system

Meaning

Understandings

Students will understand that...

- Data is stored in computer memory or on permanent storage devices as a sequence of bits
- Numbers are represented as a sequence of bits using the binary number system
- Text is represented using a character encoding and is often compressed, using the redundancy of the data, to reduce the file size
- Images are represented using an encoding of the data representing each pixel's RGB (red/green/blue) intensities
- Operating systems provide the interface between computer hardware and application software

Essential Questions

Students will keep considering...

- Why do computers use binary to represent digital information?
- How does software interact with hardware?
- How can computers communicate information with simple hardware outputs?
- How can programs be made to repeat tasks?
- How can computers sense and respond to their environment?
- How can complex real-world information be represented in code?
- How can simple hardware be used to develop innovative new products?

Application of Knowledge and Skill

Students will know...

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- Data is stored in computer memory or on permanent storage devices as a sequence of bits
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- Text is represented using a character encoding and is often compressed, using the redundancy of the data, to reduce the file size
- Images are represented using an encoding of the data representing each pixel's RGB (red/green/blue) intensities
- Operating systems provide the interface between computer hardware and application software

Students will be skilled at...

Students will be skilled at...

- Converting numbers and text into binary
- Converting a black-and-white (1-bit) image into binary
- Explaining how text and image compression schemes work
- Analyzing the functions performed by an operating system

Academic Vocabulary

- Binary
- Bit, byte, kilobyte, megabyte, gigabyte
- Digital vs. analog
- ASCII
- Pixel
- Metadata
- RGB
- Data compression
- Lossless vs. lossy compression
- Operating system
- Types of storage device (hard disk, solid-state drive, cloud storage)
- Run-length encoding compression

Learning Goal 1

Students will explore ways to solve problems involving encoding and transmitting data

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.A.CS1	Understand and use technology systems.
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.2	Analyze the relationships between internal and external computer components.
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.CS1	Computational thinking and computer programming as tools used in design and engineering.

Target 1

Students will become familiar with the binary number system and conversion to and from binary

Learning Goal 2

Students will understand the basic facts and terminology of data storage

CRP.K-12.CRP4	Communicate clearly and effectively and with reason.
TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.D.4	Research and understand the positive and negative impact of one's digital footprint.
TECH.8.1.12.D.5	Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.
TECH.8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
TECH.8.2.12.E.2	Analyze the relationships between internal and external computer components.
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).

Target 1

Students will understand how data is stored as bits in hardware (either in RAM or on disk)

Target 2

Students will understand bytes and file sizes and the units for measuring these (bytes, kilobytes, megabytes, gigabytes, etc.) and research the sizes of files they make use of every day.

Target 3

Students will use variety of digital tools to analyze, generate and manipulate data, and identify patterns and trends

Learning Goal 3

Students will examine the roles of various hardware and software elements comprising a computer system

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.1.12.A.CS1	Understand and use technology systems.
TECH.8.1.12.D.5	Analyze the capabilities and limitations of current and emerging technology resources and assess their potential to address personal, social, lifelong learning, and career needs.
TECH.8.2.12.C.1	Explain how open source technologies follow the design process.
TECH.8.2.12.C.4	Explain and identify interdependent systems and their functions.

TECH.8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.

Target 1

Students will understand the relationship between hardware and software

Target 2

Students will understand the role of operating systems in interfacing between the hardware and application software

Learning Goal 4

Students will explore the concept of data compression in various domains (text, images, sound).

TECH.8.1.12.A	Technology Operations and Concepts: Students demonstrate a sound understanding of technology concepts, systems and operations.
TECH.8.2.12.E.1	Demonstrate an understanding of the problem-solving capacity of computers in our world.
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).
TECH.8.2.12.E.CS1	Computational thinking and computer programming as tools used in design and engineering.

Target 1

Students will understand the role of text compression in reducing resource usage and speeding up data transfer of text

Target 2

Students will understand the difference between lossless and lossy compression

Target 3

Students will research real compression schemes used for images, text, or sound, and determine what kind of

compression it uses - lossy or lossless - explaining the ideas behind it.

Target 4

Students will explore methods of encoding black & white images in binary, including using a *run-length encoding* compression scheme

Summative Assessment

- Quizzes & Tests
- Applied Projects
- Classroom Survey

Formative Assessment and Performance Opportunities

- Applied Activities/Projects
- Guided Practice
- Peer Review
- Reflective Discussion
- Teacher Observation
- Oral Questioning

Accommodations/Modifications

- Application problems for extra practice
- Scenarios for critical thinking
- Optional research project on historical hardware

Unit Resources

Internet Resources

- Code.org's Computer Science Discoveries-Unit 6 curriculum
- Code.org's Computer Science Principles-Unit 2 curriculum
    - *Some of the language in the Learning Goals, Targets and Essential Questions in these units*

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Technology Software & Hardware

- Desktop computers
- Python programming language and IDE (Integrated Development Environment)

Textbooks (Online, pdf or print)

- Downey, Allen. *Think Python: How to Think Like a Computer Scientist* (2nd Edition). Needham, Massachusetts: Green Tea Press, 2015. http://www.thinkpython2.com.

Relevant Videos

- Code.org's video library

Interdisciplinary Connections

LA.RST.11-12.3	Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.
LA.RST.11-12.4	Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.
LA.RST.11-12.10	By the end of grade 12, read and comprehend science/technical texts in the grades 11-CCR text complexity band independently and proficiently.
MA.K-12.2	Reason abstractly and quantitatively.
MA.K-12.4	Model with mathematics.
MA.K-12.6	Attend to precision.