

(<http://csmatters.org>) 3 - 14

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# Data on the Internet

## Unit 3. Information and the Internet

**Revision Date:** Jan 05, 2020

**Duration:** 1 50-minute session



### Lesson Summary

Data is stored and transmitted online efficiently using many different kinds of hardware and software to send it quickly and accurately. Data can be compressed to take up less storage room and transmission time and, at the core, the entire system is made up of simple circuits that work with binary information that flows at an incredible speed all around the world. The security and privacy of this constant flow of data deserve understanding and attention. Students will investigate different areas of privacy and share with the class.

This flexible lesson includes additional material if the teacher would like the opportunity to reteach key concepts such as binary, abstraction, Internet functionality and also teaches the layers of hardware abstraction from transistors and logic gates up to computing devices.

The accompanying assessment can be used in class *or as homework*. (20 min) *optional*

### Learning Objectives

#### CSP Objectives

- *EU DAT-1 - The way a computer represents data internally is different from the way the data is interpreted and displayed for the user. Programs are used to translate data into a representation more easily understood by people.*
  - LO DAT-1.A - Explain how data can be represented using bits.
  - LO DAT-1.C - For binary numbers: a. Calculate the binary (base 2) equivalent of a positive integer (base 10) and vice versa. b. Compare and order binary numbers.
  - LO DAT-1.D - Compare data compression algorithms to determine which is best in a particular context.
- *EU CSN-1 - Computer systems and networks facilitate how data are transferred.*

- LO CSN-1.B - Explain how the Internet works.
- LO CSN-1.C - Explain how data are sent through the Internet via packets.
- LO CSN-1.E - For fault-tolerant systems, like the Internet: a. Describe the benefits of fault tolerance. b. Explain how a given system is fault-tolerant. c. Identify vulnerabilities to failure in a system.

## Math Common Core Practice:

- MP2: Reason abstractly and quantitatively.
- MP6: Attend to precision.
- MP7: Look for and make use of structure.

## Common Core Math:

- N-Q.1-3: Reason quantitatively and use units to solve problems
- A-CED.1-4: Create equations that describe numbers or relationships

## Common Core ELA:

- RST 12.3 - Precisely follow a complex multistep procedure

## NGSS Practices:

- 4. Analyzing and interpreting data
- 5. Using mathematics and computational thinking

## NGSS Content:

- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

## Teacher Resources

Student computer usage for this lesson is: **required**

The Computer Science Field Guide <http://csfieldguide.org.nz> (<http://csfieldguide.org.nz>)

Coding and compression: <http://csfieldguide.org.nz/en/chapters/coding-compression.html>  
(<http://csfieldguide.org.nz/en/chapters/coding-compression.html>)

Data representation: <http://csfieldguide.org.nz/en/chapters/data-representation.html>  
(<http://csfieldguide.org.nz/en/chapters/data-representation.html>)

Use the binary number calculator (<http://csfieldguide.org.nz/en/interactives/base-calculator/index.html>) to check conversion calculations

**How computer memory works (5:05)** <http://ed.ted.com/lessons/how-computer-memory-works-kanawat-senanan>  
(<http://ed.ted.com/lessons/how-computer-memory-works-kanawat-senanan>)

Presentations: Unit3Lesson14\_InternetData\_Presentation, Unit3Lesson14LogicGates\_Presentation.

Worksheets: Accompanying student notes to be filled in.  
Unit3Lesson14\_InternetData\_StudentHandout, Unit3Lesson14LogicGates\_Handout.  
Also Unit3Lesson14\_InternetData\_ReviewSection

## Lesson Plan

### Journal (5 min)

How does information get from one computing device to another using the Internet? (also on Slide 1 of the Unit3 Lesson14\_InternetData\_Presentation)

Slides 2-3 review the basic steps to sending information online:

- Information is encoded in binary, then, (check to see if students remember how to do decimal to binary conversions)
- divided up into packets and sent
- decoded into words, pictures, etc when it arrives.

This is a review of unit 3. Pair, share and discuss. Identify weak areas of student understanding.

### Review Presentation on Binary and the Internet ( 20 min)

If students need additional review: provide the handout:

Unit3Lesson14\_InternetData\_ReviewSection (to accompany slides 4-9) and continue with the presentation, otherwise use the handout as an assessment.

- SLIDE 4: Fill in the blanks using words on the handout to describe the important features of internet communication.
- SLIDE 5: define protocol and ISP
- SLIDE 6: each device has an IP address that is looked up using the DNS
- SLIDE 7: packets are routed, paths are redundant
- SLIDE 8: review binary codes and number conversion
- SLIDE 9: answers to binary questions from SLIDE 8

### Activity 1: Data compression (10 min)

Distribute Unit3Lesson14internetData\_StudentHandout (slides 10-11) on data compression and abstractions from low level to high level with notes to accompany the video how computer memory works (5:05)

- SLIDE 10: compression saves time and storage. Look up lossy and lossless compressions (Lossless compression reduces the number of bits used and transmitted, which can be reconstructed to the original data without any approximation; Lossy compression *significantly* reduces the number of bits at the cost of accurately reconstructing the original data)
- SLIDE 11: abstractions from low level to high level
- SLIDE 12: different file formats have characteristics for their intended uses and different media have advantages and disadvantages for their intended use (cost, stability, performance, size, etc)

## Activity 2: Data Security and Privacy

Say: To protect ourselves online we need to understand some facts about how data is collected and used. Assign each of the following to a pair of students. Each pair is to prepare and present a 30 second (2 or 3 sentences) explanation for why their fact is most important. After two minutes give each pair a chance to present their explanation.

1. Devices like cell phones and IoT sensors collect user information including their locations, travel patterns, and the time spent in a location.
2. Data may be collected and used by governments, corporations or other institutions.
3. Information about users can be obtained by aggregating data from multiple sources building a multi-dimensional understanding of the person, their habits, their health, and more.
4. Information about a user including PII can be used to provide a better service on the internet such as simplified online purchases.
5. Governments have established laws requiring commercial and governmental organizations to protect user privacy.
6. User privacy is at greater risk when the protections offered by these laws are ignored.
7. Information placed online such as in social media may be reposted and disseminated in harmful ways the original user never intended.
8. Information placed online may be very difficult to control or delete.
9. Information about a person from different online sources might be combined in a way to identify the person and to determine additional facts about the person.
10. A person's PII can be used to steal that person's identity, their money or even to stalk or threaten them.

## Activity 3: Presentation on Logic gates and hardware abstractions (20 min)

Present Unit3Lesson14\_LogicGates\_Presentation about hardware abstraction.pptx

Distribute Student handout: Unit3Lesson14LogicGatesHandout.docx

1. Prompt: Ask what really goes on inside of computers.
2. Computers are fast and accurate. To show how quickly they can do calculations, demonstrate google search engine's ability to instantly provide the answer to complicated calculations like  $271839$  to the  $23^{\text{rd}}$  power
3. All data is in binary so all calculations must be in binary
4. Inside each chip are circuits.
5. If you could see inside a chip you'd see the communication lines for the bits, like roadways, and the processing units like buildings
6. Abstractions: the CPU is made of circuits, circuits are made of logic gates.
7. Follow bits through a calculation. The number 7 is pressed on the keyboard sending 00000111 to the CPU to be processed
8. The algorithm for addition is invoked when the "+" sign is pressed and will start up when the  $2^{\text{nd}}$  number is entered.
9. 21 is pressed followed by = and the addition algorithm starts with the rightmost bits and adds up each column
10. addition is done with logic circuits. Logic circuits are made up of logic gates. There are picture symbols for each gate

11. looking at the AND gate, how many different input values can A have? How many different output values can Q have?
12. Use a truth table to show the inputs and outputs of a logic gate
13. The not gate, or inverter, changes a signal to its opposite
14. There are logic gates in an addition circuit
15. How logic gates add 2 digits
16. How logic gates add 3 digits
17. How the OR gate works
18. The deeper you look into what is happening the better you can understand what is really going on inside of a computing device.
19. Diagram of layers of abstraction from transistors up to computing devices.
20. Sample logic questions
21. Sample AP ® type question
22. Career connections in circuit design

### Wrap Up (5 min)

Assessment (20 min) *optional or can be used as homework.*

Also available Logic Gates additional practice handout and informational article.

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## Options for Differentiated Instruction

More than any other lesson so far, this lesson should be customized to meet the needs of the students. If they have a background in electronics and logic circuits from science or STEM classes, or have a firm grasp of binary number conversion and how the internet works, these sections of the lesson can serve as a very quick review skipping past the slides with extra detail.

For advanced students: Use the Unit 3 Lesson 14 assessment and the Unit 3 Lesson 14 Data on the Internet - Review Section as summative assessments after a brief review.

For students who do not have this background knowledge, use the presentations and notes.

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## Evidence of Learning

### Formative Assessment

Notes and exercises for binary encoding, data compression, logic circuits, how the internet works and layers of hardware abstraction.

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### Summative Assessment

Unit 3 Lesson 14 Summative Assessment

and

Unit 3 Lesson 14 Data on the Internet - Review Section

can be used as a formative or summative assessment.



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