Unit 0: Computers and Computing (Completion Time: 3 weeks)

Modules:

0 What is a computer?

- What makes a computer a computer and the common bonds that unify all those things, which we call computers

1 What is computing?

- A look at algorithms and the techniques used for solving problems

2 How computers work

- Technical information about what's going on underneath the hood, so students are able to speak competently about it in conversations with others

3 Bits and bytes

- Data and storage on a computer all boils down to a fundamental unit of measure -- the bit, which can only take on two possible values. By combining bits into larger and larger groups we can become substantially more expressive

4 Hardware (Optional)

- A deeper look into hardware giving us a consumer-oriented perspective on things to consider when we are purchasing or building our own machines

5 Memory

- Five major types of memory that are part of nearly every computer system are discussed -- hard disk drives (HDD), random-access memory (RAM), L2 and L1 cache, and the small bank of memory inside of a CPU.

6 Binary numbers

- Introduction of binary numbers showing analogies to the decimal number system with the purpose to not only introduce students to binary numbers, but also prepare them for encountering other number systems.

7 ASCII

- A look at how binary numbers can represent characters and punctuation as well as the standardization of such values in ASCII.

8 Algorithms

- Expressing algorithms using spoken or written language, and learn of the importance of defining algorithms precisely in order to have the desired effect(s) occur.

Central Focus:

Students will engage in real world problems to analyze and create algorithms. Students will also explore the role of computers in today's society and how they pertain to developments other fields.

Assignments:

Writing Problem 0-0: Around the House
To be completed with module 1
Learning Objectives:
LO 7.1.1 - Explain how computing innovations affect communication, interaction, and cognition.
LO 7.3.1 - Analyze the beneficial and harmful effects of computing.
In no more than 400 words describe a device or object that meets the courses description of what a computer is.
Consider:

- What does the device look like?

- What kind of data does it accept?
- How does it process that data?
- What is the result of that processing?

Writing Problem 0-1: Tech Spotlight
To be completed with module 4
Learning Objectives:
LO 1.2.5 - Analyze the correctness, usability, functionality, and suitability of computational artifacts.
LO 7.1.1 - Explain how computing innovations affect communication, interaction, and cognition.
LO 7.2.1 - Explain how computing has impacted innovations in other fields.
LO 7.3.1 - Analyze the beneficial and harmful effects of computing.
In no more than 600 words, expound on a piece of technology with which you are familiar and that you might use everyday. It needn't be a piece of hardware; software, websites, and the like are perfectly fine too. Explore it in depth. Assume for the purposes of this assignment that your audience is someone who has no prior knowledge about the technology.
Consider these questions:
- What is this technology called?
- What does it do?
- How does someone use this technology?
- How is its quality of performance commonly measured? (e.g. in megabytes (MB), gigahertz (GHz), etc.)
- How does the recent news about the technology change the product or service?
- What older form of technology does it replace, if any?
- How has this technology impacted your life, for better or worse?
- How has this technology impacted society at large, for better or worse?

Writing Problem 0-2: Everyday Algorithms
To be completed with module 8
LO 4.1.1 - Develop an algorithm for implementation in a program.
LO 4.1.2 - Express an algorithm in a language.
Write three algorithms describing daily processes, namely, brushing one's teeth, eating an orange and one algorithm of choice. Algorithms should be written out in sentence form as well as pseudocode.

Learning Objectives:
I can identify inputs and outputs
I can describe and give examples of computers
I can describe the algorithms I use to solve problems
I can differentiate between programming and computing
I can explain the basic parts of my computer
I can define the different types of memory and the purposes that they serve
I can convert numbers in the decimal system to binary
I can identify patterns in the ASCII table
I can devise step-by-step instructions for completing a task

I can propose modifications to make algorithms more efficient

Essential Questions:
What characteristics define a computer?
What is programming?
Are there ways of "programming" a machine that do not involve writing code?
What devices in your life are computers? Encourage your students to think outside the box.
What is computing and is it exclusive to computers?
Is it still considered computing if you get the wrong answer?
What are the essential components of computing and computation?
Why are there so many different levels of memory?
Are base-2 and base-10 the only possible number systems?
What would a base-3 system look like?
Why do we need ASCII at all?
What problems might we face if we didn't have it?
How do we know if an algorithm works?
What are some problems we see in the real world that require algorithmic solutions?
Can every problem be solved with an algorithm?

Ways to Launch the Lesson:
Module 0- https://www.youtube.com/watch?v=Rs-Eub0-cRk,
https://www.youtube.com/v/LHdVkPrdRYg,
https://www.youtube.com/v/GcDshWmhF4A
After watching the following videos, students can discuss in pairs or small groups what makes a device a computer.

Module 1- Start with a few math computations (addition, subtraction, multiplication, division, etc.) and have students try to come up with a formal definition of computation.

Module 2- Have students make predictions of what happens when a button is pressed or the mouse is clicked on their computers. Then using an old, obsolete computer, show students key components of computers and discuss their role with the system.

Module 3- Show students the development of memory storage. Some examples include floppy disks and zip disks which can be taken apart to show where things have been stored. More modern examples include CDs and external hard drives.

Module 4- Have students make a list of hardware that they have heard of, then using an old computer, disassemble and identify parts students have mentioned as well as parts they have not and discuss their purpose.

Module 5- Have students discuss memory specs of the devices that they use (i.e. iPhone, Android, MacBook Pro, etc.). Why are there two different numbers associated with memory? Have students predict what each might be and what information it stores.

Module 6- Review decimal system and the concept of place values, then show students the place values for the binary system. Discuss what patterns students notice. Using 5 sheets of paper with the following values: 1, 2, 4, 8 and 16 flip some over and have students add the numbers to determine its decimal conversion. Then switch the game and give students decimal numbers to represent using the papers.

Module 7- Review binary system from previous model. In small groups have students discuss how a computer might represent letters or symbols if can only understand 0s and 1s. Compare different groups responses. Would "a" be represented in the same way in all systems? Show students ASCII table and discuss standardization and patterns.

Module 8- Have students recreate a simple line image based on instructions given by a student. Only the student giving directions is aloud to see the original image. Display different student examples to stress the importance of using specific terminology.

Demos and Activities:

Computer or Not?

Have students discuss and/or debate whether or not a device is a computer or not. This can be used as an opportunity for collaboration. Divide students into two groups and have them come up with a persuasive defense to present to the class.

Materials:

- plethora of gadgets (some computers and some that are clearly not)
- Devices that straddle the line to initiate conversation on the definition of a computer (e.g., a set of chemical pool water testing strips, a smoke detector, an analog clock)

Phone Book Demo

Show an example of linear search. Have students discuss with a partner or group what other algorithms could be both more efficient and correct. Discuss and demonstrate binary search while comparing it to linear search. Have students reflect on why the method of ripping the phone book is called binary search (e.g. what does binary search entail).

Materials:

- phone book

Storage

Describe that a bit represents one of two values (e.g. true or false, on or off). Elaborate on the physical size various units of storage might take up, all things being

equal. For example, if a single bit were about the size of a single marble filled with water:

- 1 bit -- a marble full of water
- 1 byte -- 1/8 cup water
- 1 kilobyte -- 9 gallons of water
- 1 megabyte -- an above ground swimming pool full of water
- 1 gigabyte -- a football field sized-pool of water, three feet deep
- 1 terabyte -- a football field sized-pool of water, half a mile deep

Tech Shopping

Discuss the specs of tech items on the market. For further analysis, break students into groups and give them all a "budget" to buy a computer. Challenge them to see who can get the most bang for their buck. Have them defend their choices and sacrifices made to the rest of the class.

Materials:

- Devices for researching new technologies

Binary Bulbs

Light the way for students to understand binary with some physical representation. Have individual students represent different place values and give them numbers to represent by simply turning their light on or off.

Materials

- Lights of sort (i.e. flashlights, light bulbs, lamps, etc.)

Crack the Code

In small groups have students write secret messages in ASCII (in decimal and/or binary) and have other groups try to crack them.

Materials

- paper and pen or whiteboards

PB & J Sandwich Algorithm

Demonstrate the precision required for an algorithm to be carried out by a computer. Have one student record steps as a few student volunteers and a student teacher or principle execute the steps as literally as possible. Stop after 15-20 steps to discuss what went wrong and the importance of precision.

Materials:

- bag of bread
- peanut butter
- jam
- butter knife
- plate

Creating Algorithms

Have students write an algorithm for completing some task they do every day. Have students submit their algorithms to you during class. If an interesting one comes up, ask two other students to volunteer. Have one follow the algorithm while the other is out of the room. Then have the second come in and execute the algorithm. Did the two executions play out identically?