Chapter 5: Networking and the Internet
(Completion Time: 3 weeks)

Topics:

*Internet Basics*

An overview of how the internet works and how we as users interact with it. This topic can also be used as sort of a teaser for the rest of the chapter.

*IP Addresses*

IP (Internet Protocol) addresses are assigned to each device connected to a network. A device or web page can be identified by its IP addresses, as all are unique - like a postal address.

*DNS and DHCP*

DHCP, also known as the Dynamic Host Configuration Protocol, dynamically assigns IP addresses to devices connecting to a network. DNS, the Domain Name System, is responsible for translating URLs of websites to IP addresses and vice versa. We need both IP addresses to be able to form a successful connection from sender to receiver.

*Routers*

Routers are the components of the Internet that direct packages of data across various networks. They follow a set of rules to direct packets based upon IP address and port. Typically routers will direct individual packets on different routes to end up at the same location.

*TCP and IP*

IP is the system we’ve just seen, that works with routers to ensure packets of data are split into pieces, sent to the correct destination, and pieced back together. TCP ensures data is properly marked when it is split into pieces, so if one packet does not arrive, the sender is notified and can resend.

*HTTP*
Hypertext Transfer Protocol, or HTTP, is what web browsers use to speak to web servers. The server receives the request and either successfully executes the action (by rendering a page or submitting a form, for example) or returns an error code; these are called HTTP status codes.

**Trust Models and Open Source**

Every open source piece of software is held to an "open standard" that the software will work in the way intended and not do anything malicious. This involves a significant amount of trust on our end, that whenever we compile a program or visit a website, the pieces of software we use are not injecting malicious code into our computers.

**Cybersecurity**

The Internet is a wonderful resource, but can also occasionally make us vulnerable if we are not following good practices. While we can limit vulnerability to attacks there are many security threats we cannot control and may not even be aware of.

**HTML**

HTML, or HyperText Markup Language, forms the backbone of web pages. It is used to make any web page you see by formatting all text and images. Students will learn how to create basic web pages using the language.

**CSS**

CSS, Cascading Style Sheets, is used to style web pages. It is capable of manipulating colors, positioning, size, alignment, fonts, borders, background shading, and others.

**Central Focus:**

Students will transition from programs that exist only on their IDE to programs that can be viewed globally. They will explore the global system of interconnected computer networks that use the Internet protocol suite (TCP/IP) to link devices worldwide and the languages which enable them to express their ideas on the internet.
Assignments:

Writing Problem: Be the Teacher
To be completed with HTTP

Enduring Understandings:
EU 6.1 The Internet is a network of autonomous systems
EU 6.2 Characteristics of the Internet influence the systems built on it.

Learning Objectives:
LO 6.1.1 - Explain the abstractions in the Internet and how the Internet functions.
LO 6.2.1 - Explain characteristics of the Internet and the systems built on it.
LO 6.2.2 - Explain how the characteristics of the Internet influence the systems built on it.

The technologies of the internet can be complex, so students are challenged to explain things concisely to a lay audience, cementing their understanding of these technologies by having to discuss them more casually. In 1500 words students will explain how the internet works to 3rd graders.

Writing Problem: Defender of the Web
To be completed with Cybersecurity

Enduring Understandings:
EU 6.1 The Internet is a network of autonomous systems
EU 6.2 Characteristics of the Internet influence the systems built on it.
EU 6.3 Cybersecurity is an important concern for the Internet and the systems built on it.
EU 7.1 Computing enhances communication, interaction, and cognition.
EU 7.2 Computing enables innovation in nearly every field.
EU 7.3 Computing has a global affect — both beneficial and harmful — on people and society.
EU 7.4 Computing innovations influence and are influenced by the economic, social, and cultural contexts in which they are designed and used.
EU 7.5 An investigative process is aided by effective organization and selection of resources. Appropriate technologies and tools facilitate the accessing of information and enable the ability to evaluate the credibility of sources.
Learning Objectives:
LO 6.1.1 - Explain the abstractions in the Internet and how the Internet functions.
LO 6.2.1 - Explain characteristics of the Internet and the systems built on it.
LO 6.2.2 - Explain how the characteristics of the Internet influence the systems built on it.
LO 6.3.1 - Identify existing cybersecurity concerns and potential options to address these issues with the Internet and the systems built on it.
LO 7.1.1 - Explain how computing innovations affect communication, interaction, and cognition.
LO 7.1.2 - Explain how people participate in a problem-solving process that scales.
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.
LO 7.4.1 - Explain the connections between computing and real-world contexts, including economic, social, and cultural contexts.
LO 7.5.2 - Evaluate online and print sources for appropriateness and credibility.

Students explore the notions of cyberattacks and cybersecurity, and investigate in more detail some of the common types of attacks that impact websites today. In 750-1,000 words, students should cover the following:
What is the name of the attack? What type of attack is it?
Where did it come from? Who created it (if known), and why?
How did we find out about it - how was it caught?
What types of companies or individuals does it target?
How does it work? What components of the network does it attack, and from which end (client or server)?
What damage is it capable of doing? What information does it target?
Has a fix been found? How does it work? Has it been implemented in all websites/servers with potential vulnerabilities?
If applicable, how can we defend ourselves against this attack?

*Programming Problem: */Chapter 5>*
To be completed with CSS

Enduring Understandings:
EU 1.1 Creative development can be an essential process for creating computational artifacts.
EU 1.2 Computing enables people to use creative development processes to create computational artifacts for creative expression or to solve a problem.
EU 1.3 Computing can extend traditional forms of human expression and experience.
EU 5.1 Programs can be developed for creative expression, to satisfy personal curiosity, to create new knowledge, or to solve problems (to help people, organizations, or society).
EU 5.3 Programming is facilitated by appropriate abstractions.

Learning Objectives:
LO 1.1.1 - Apply a creative development process when creating computational artifacts.
LO 1.2.1 - Create a computational artifact for creative expression.
LO 1.2.2 - Create a computational artifact using computing tools and techniques to solve a problem.
LO 1.2.3 - Create a new computational artifact by combining or modifying existing artifacts.
LO 1.2.4 - Collaborate in the creation of computational artifacts.
LO 1.3.1 - Use computing tools and techniques for creative expression.
LO 5.1.3 - Collaborate to develop a program.
LO 5.3.1 - Use abstraction to manage complexity in programs.

Students create their own web pages, learn about permissions schemes, and make their creations accessible to the world.

Essential Questions:

Given the many different components that comprise an internet connection, how do we ensure all of them work together properly?
If you do disconnect, what are the places you should look to find the problem?
Can you think of potential problems if two devices were to have the same IP address on a network?
What do you think will happen when we run out of valid IP addresses?
Why do we need DHCP?
Why do we need (or rather, why is it nice to have) DNS?
What parameters do routers use to sort data packets?
Why do you think data will seemingly travel farther away than is necessary only to return back to a desired location (i.e. going from Seattle to Los Angeles and then back up to Palo Alto)?
How do TCP and IP work together to ensure efficient and reliable packet delivery across the Internet?
In what circumstances would you want a GET request? A POST request?
Can you list some of the common HTTP status codes?
Think of several examples of open source programs we simply "trust" to not do anything bad to us. Why do we trust these programs?
What makes us believe that they're safe?
How can we try to protect ourselves from the most blatant internet security problems?
How does SSL work to secure personal information sent over the internet?
What are the most common types of cyberattacks?
How are they caught and remedied or defended against moving forward?
What kinds of things does HTML allow us to do on web pages?
What kinds of things can't we do with HTML that we need another language to handle?
What does CSS allow you to do?
What are the different ways to incorporate CSS into HTML code?

Ways to Launch the Lesson:

Internet Basics

Have students write down their ideas of how they think the internet works. Revisit these ideas at the end of this chapter. What was correct? What was incorrect? What do students still have questions about?

IP address

Have students find their IP addresses. Why does everyone on the internet need a unique IP address? Students can switch IP addresses with peers and try to track the location using http://what-is-my-address-ip.com/ or a similar site.

DNS and DHCP

Have students think of metaphors that represent the roles that DHCP and DNS play with regards to IP addresses. Would it still be able to access websites without DHCP? or DNS? Are both necessary?

Routers

Let each student pick a unique website. Then use a site similar to http://www.yougetsignal.com/tools/visual-tracert/ to view the trace route for each site.
or do it from the command line. Which student had the furthest location in their trace route? Why do you think that is?

**TCP and IP**

Using the same tool as above have students use the same web tool to count how many locations they went to in their trace route. Did number of places correspond with distance from the previous time using this tool? Why or why not would this make sense? Which website had the least number of hops? Which had the most?

**HTTP**

Find examples of different types of requests. Load the pages with Developer Tools and display the requests to the students.

**Trust Models and Open Source**

In small groups, have students research a downloadable software or song? Let them read through the terms and conditions. What sort of things do we agree to that one would be surprised to see? Are we more trusting of certain things than others? What is this trust based on?

**Cybersecurity**

Students tend to identify with stories they’ve heard; try to find a cyberattack that has been in the news recently and talk about it! You can probably find a video and show that as well

**HTML**

Discuss the differences between a mark up language and programming languages. Why do we need two separate languages to do different things? Maybe have students play around with Khan Academy’s HTML module https://www.khanacademy.org/computing/computer-programming/html-css/intro-to-html/p/html-basics.

**CSS**
Have students discuss things that they were unable to do in HTML. Which of those things fall into a styling vs. programming language. How can CSS help? Maybe integrating aspects of Khan Academy's module on CSS https://www.khanacademy.org/computing/computer-programming/html-css/intro-to-css/p/css-basics.

**Demos and Activities:**

**Connections**

Give students all a notecard on which is written a different component of an internet connection. Some of them will be packets of data; see if the packets can get to their destination by having students place themselves in the correct order.

**Your IP Address**

Have students find their IP addresses on their computer and connect to one another's addresses using the terminal command ping or something similar.

**Your Favorite IP Addresses**

Have students find the IP addresses of their favorite websites and get to them by typing the IP address instead of the URL.

**Phone Book**

An analogy for DNS to use is a phone book - you look up a person's name, and are given their phone number if you need to contact them. This is similar to typing in a website URL, which is then translated to an IP address.

**Dynamically Assigning Numbers**

An analogy for DHCP could be anything dealing with dynamically assigning numbers to devices, i.e. numbers at a deli, characters in a board game, etc. The key is that it is possible to have the same number more than once, but that it is not guaranteed.

**Status Codes**
Find examples of the different status codes on the web (most commonly a 404 or 403), and show them to your students using Chrome’s Developer Tools or the like.

**Insecurity**

Find an insecure website (non-https) desiring input of a password or credit card number to show your students how easy it is to spoof something that looks secure.

**Permission Levels**

If you can display webpages on your localhost to students, you can demonstrate different permission levels on a simple page, talking about why it is beneficial to keep some pages private and only the necessary ones public.

**Developer Tools**

Take a look at an existing website using Chrome’s Developer Tools and have your students figure out what the individual tags do.

**Webpage 2.0**

Similar to the HTML demonstration, you can create a simple webpage, this time including a CSS sheet to stylize.

**Creativity**

Create a simple activity that allows students to be creative with their styling; they can make a basic webpage and choose colors, fonts, shading, etc.