Networks: Communication Is The Key

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Caption: People can communicate by using nonverbal signals.

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RET Site: Cyber Security Initiative for Nevada Teachers (CSINT)

Grade Level 5 (5-6)

Time Required 60 minutes

Summary
Students understand how architecture components of a network “talk” with each other to ensure the functionality of the network by engaging in a physical simulation. Students problem solve to identify malfunctioning components of a network and test solutions to allow data to continue to transmit across the network to its destination.

Engineering Connection

A goal engineers have when designing a system is to ensure the integrity of the system. Engineers develop system components that are dependent on the whole system to work, but are also capable of acting independent of the system as well. This type of design feature allows engineers to diagnose and fix problems within the system without having to shut down the whole system.

Educational Standards
State STEM Standards

Nevada,2018, K-12 Computer Science Standards,5.NI.NCO.1 (Grade 5): Explain the concept of network protocols.

Nevada,2018, K-12 Computer Science Standards,4.CS.HS.1 (Grade 4): Model how computer hardware and software work together as a system to accomplish tasks.

ITEEA Standards

ITEEA, 2000, Standard 1: The Nature of Technology, C (grades 3-5): Students will develop an understanding of the characteristics and scope of technology.

NGSS Standards

NGSS, 2012, Engineering Design ETS1-2 (grades 3-5): Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

CCSS Standards

CCSS,2010, Math, Practice MP2 Reason abstractly and quantitatively. (Grades K – 12)

Pre-Requisite Knowledge

None

Learning Objectives
After this lesson, students should be able to:

- Explain how routers communicate with each other.
- Explain why routers need to communicate with each other.

Material List US $20

- pack of index cards 5” x 8” (100)
- 2-3 pieces of chart paper or empty whiteboards
- one pack of self-stick name tags
- ink pad
- one pack of multi-colored large tip markers

* header information color: color 1 sender, color 2 receiver, color 3 total number of packets, and color 4 the sequence number for the packet.

- large tip black marker

Lesson preparation

1. Use the name tag labels to give each router a number (1, 2,3, etc.).
2. A prepared packet header information color code chart on chart paper or white board.

color 1 sender, color 2 receiver, color 3 total number of packets, and color 4 the sequence number for the packet

3. 4 prepared sets of sample message (The prepared messages will need the designated colored header information.)

sample message 1: card 1: I do, card 2: n’t k card 3: now, card 4:if I, card 5: can, card 6: go o, card 7:n Fr, card 8: ida, card 9: y be, card 10:cau, card 11: se I, card 12: hav, card 13: e so, card 14: cce, card 15: r pr, card 15: act, card 16: ice

4. A prepared direction chart on chart paper or on a whiteboard.

- Always pass the packet marker side up.
- The protocol (student in front of the sender) can only hand one packet (index card) at a time to a router.
- Each router can only hold one packet (index card) at a time.
- Each router must pass to a different neighbor router each time.
- The protocol (students in front of the receiver) can only hand the complete packet (entire message) to the receiver.
- No one can move from their spot other than to pass packets (index cards).

Introduction / Motivation

What is the internet? Can parts of the internet communicate with other parts? Why would parts of the internet need to communicate with each other? If the parts of the internet can communicate, how do the parts communicate with the other parts? (Listen to student ideas.)

Procedure

Prior to start

1. One fourth of the routers will be designated as bad routers and their identity in the network will remain hidden from the rest of the students.
2. Meet with the designated bad routers separate from the rest of the students. These students will neatly press their thumb on their non-dominate writing hand into the ink pad twice. (This will allow for up to 2-3 dark colored pressings and 1-2 light colored pressings.)
3. The students will need to keep their fingertip hidden from the other students at all times. (Holding their hand in a fist works well and helps to keep ink off their clothes.)
4. When these students receive a packet they should secretly mark their fingerprint in the header (colored dot area) of the packet if possible.

Physical simulation setup

1. Designate one sender, one receiver, two protocols, and the rest of the students will be routers.
2. Pass out the labeled name tags to the routers.
3. The sender and receiver should be at opposite ends in the designated simulation area.
4. One protocol should stand directly in front of the sender. The other protocol will be in the same position in front of the receiver.
5. The rest of the students (routers) should place themselves in between the sender and receiver. The routers should be somewhat evenly spread out in an oval/array type shape, and their arrangement should not create an obvious direct path to the receiver. The designated bad routers should be distributed throughout the network.

With students

1. Read aloud the direction chart to the students.
2. Go over the packet header color chart with the students. (The routers and protocols will need to check this information at all times. This information is needed in order to send/receive data.)
3. If at any time during the simulation you have questions or concerns please raise your hand. (If students are paying attention to the header of the packet they should notice a thumb print.)
4. (On a sheet of chart paper make a sketch of the class created network.)
5. Now our class created network will transmit the sender's message to the receiver. (Shuffle the prepared message.)
6. Hand all the packets to the sender. (The sender is allowed to hand the entire packet to the protocol. Try to encourage the students to keep the packets moving at a steady pace through the network.)
7. The protocol should hand one packet at a time to the nearest routers.
8. (Once students begin to raise their hands you will need to pause the simulation to have a problem solving session with the students.) Some of our routers have been compromised by an unauthorized person who is having the routers change the data in the header of the packets. The routers are only concerned with getting the complete message from the sender to the receiver so they have to communicate with each other. Routers cannot talk or write, but are able to communicate by using math instructions (algorithms), but we will use gestures today. Routers can communicate with their side to side (elbow) and their front to back router only.
9. Routers raise your hand if you received a thumb printed packet? (Mark this information on the class network chart.) Please break into groups of 3-4 to come up with 1-2 nonverbal communication signals the routers could use to figure out the bad routers to avoid. (Allow the students 2-3 minutes to work on this. You should circulate through the groups to address any problems or questions. (After the time is up list the students' solutions on the whiteboard or chart paper.)
10. (Create a T-chart with the labels that received a bad packet signal and possible bad router signal.) Let's sort the solutions into the two categories. Now routers discuss 1-2 signals that we should use along with a justification. (Allow 3 minutes for this.)
11. As a class we will now test the signals to make sure they work properly. Now the routers can communicate with each other and now add to their routing table, which is like our memory.
12. Now the routers need to decide which routers to bypass when the message is resent from the sender's protocol. (Give the sender and receiver 2 minutes to replace the fingerprinted packets with clean packets. You will also need to note how many bad packets there were.)

13. Remember the routers goal is to get the packets from the sender's protocol to the receiver's protocol by bypassing the bad routers. Remember to raise your hand when you see a fingerprint in the header of the packet. (Restart the simulation by having the sender give the complete packet to its protocol.)
14. (When a student raises their hand have the routers communicate with each other using the communication signals.) Okay routers now communicate with each other about who the bad routers are. (Note the location of the bad routers on the class chart.) Now routers come up with the next route for the packets.
15. (Give the sender and receiver 2 minutes to replace the fingerprinted packets with clean packets. Also note how many bad packets there were. The students will repeat steps 13-14 and make improvements.)
16. (It is okay if students cannot figure out all the bad routers by the conclusion of the physical simulation. The goals are to get as many good packets to the receiver's protocol and for the routers to communicate. During the last run of the simulation have the receiver's protocol reassemble the message for the receiver to read to the class.)

Lesson Background & Concepts for Teachers

The TCP/IP is an internet protocols suite. The TCP/IP uses information in the header of the data to find a route from the sender to the receiver. Data transmitted through the internet is split into packets, and each packet contains the header information. The header includes the sender, the receiver, and the instructions of how the packets are reassembled at the final destination. The routers serve as connection spots along the route for the packets. Routers within a network are equipped with math routing instructions (algorithms) and the ability to construct new math routing instructions (algorithms) based on the data contained in the header of the packet. When routers are unable to route a packet based on the information in the header it will ask its neighboring router. If the neighboring router knows how to route the packet it will share this information with the asking router. The asking router will then save the information for future use thus adding to its routing table. This is how routers are able to "talk" with each other within a network.

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Caption: The communication done between devices allows humans to fix problems quickly.

Vocabulary / Definitions

Word	Definition
Routing table	A data table that lists the routes to particular destinations within a router.
Packet	A piece of data (image, text, video, etc.) that is sent over the internet.
Routers	Connection points along the route that packets travel through.
Protocols	A set of rules that determine how data travels electronically.

Assessment

Post-Introduction Assessment
Informal Understanding Check: This occurs during steps 13-14.

Lesson Summary Assessment
Post-Quiz: At the conclusion of the lesson, give the Post-Quiz by handing out copies to students.

References

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Attachment
Post-Quiz(docx)

Contributors
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Supporting Program

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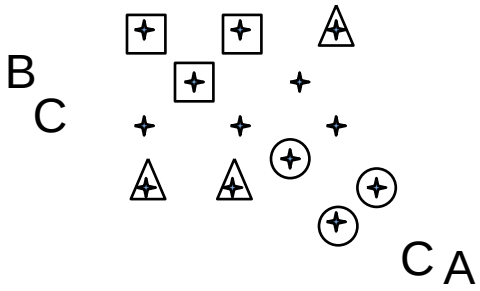
Attachment

Post-Quiz

An example of a different network.

Sender= A Receiver= B Protocol= C Router= +



Choice 1= △
Choice 2= □
Choice 3= ○

Directions: There are 3 bad routers in the network. List the three best choices for the bad routers.

Choice 1= △
Choice 2= □
Choice 3= ○

Network Picture

Sender=A Receiver= B Protocol= C Router= +