Using Raspberry Pi to Teach Networking CIT and CIS

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Session Description

- 1. Describe the demand for jobs in computing information systems and technology as companies expand their services to the cloud.
- 2. Discuss ways to include networking & computing standards in your curriculum
- 3. Watch a demonstration on how to setup a network application server that can be used in a high school classroom to teach about networking.
- 4. Describe how you could design engaging and interactive lessons using the Raspberry Pi to teach students about networking and computing concepts!







What is the slowest growing IT career in the US today?





Careers in IT Related Fields

Careers (*** In Top 30 Job Growth)	1	Median Pay (\$39,810)	Jobs in 2018	Growth Rate (5% overall)	Added Jobs (2018-28)	Jobs in 2028	Education
Software Developers ***	\$	107,510	1,365,500	21	284,100	1,652,255	BD
Computer Support Specialists ***	\$	54,760	863,100	10	83,100	949,410	Vary
Computer Systems Analysts	\$	90,920	633,900	9	56,000	690,951	BD
Computer Occupations, All Other	\$	42,200	412,800	10	5,200	454,080	BD
Network and Computer Systems Administrators	\$	83,510	383,900	5	18,200	403,095	BD
Computer Programmers	\$	86,550	250,300	-7	(17,900)	232,779	BD
Web Developers	\$	73,760	160,500	13	20,900	181,365	AD
Computer Network Architects	\$	112,690	159,300	5	8,400	167,265	BD
Information Security Analysts	\$	99,730	112,300	32	35,500	148,236	BD
Database Administrators	\$	93,750	116,900	9	10,500	127,421	BD
Computer Hardware Engineers	\$	117,220	64,400	6	4,000	68,264	BD
Computer and Information Research Scientists	\$	122,840	31,700	16	5,200	36,772	MD
Median Pay and Total Jobs in CS/IS/IT	\$	92,335	4,554,600	9.5	513,200	5,111,893	BD

155 million employed in the US https://www.bls.gov/emp/tables/occupations-most-job-growth.htm

Lots of Jobs to Choose From!

Computer Occupations, All Other

Software Quality Assurance Engineers and Testers

Computer Systems Engineers/Architects

Web Administrators

Geospatial Information Scientists and Technologists

Geographic Information Systems Technicians

Database Architects

Data Warehousing Specialists

Business Intelligence Analysts

Information Technology Project Managers

Search Marketing Strategists

Video Game Designers

Document Management Specialists

Goal: Students Learn about Academic Opportunities





https://icons8.com/icons/set/thumbs-up

Our Plan

Goals:

- increase awareness of other IT careers
- give students a hands-on
 experience with technology
- provide information on academic opportunities

One-day summer workshops for:

- 1. Computer Information Technology
- 2. Computer Information Systems
- 3. Business Information Systems



How many CSTA standards are there in Networks and the Internet?





What activities would work?

CSTA Standards

Computing Systems (14)

Concepts

Networks & the Internet (13)

Algorithms & Programming (56) Impacts of Computing (22) Data & Analysis (15)

Subconcepts

Devices (4)

Hardware & Software (5) Troubleshooting (5)

Cybersecurity (7) Network Communication & ... (6)



K12 Standards for Computing and Networking



Progression of Computer Science Teachers Association (CSTA) K-12 Computer Science Standards, Revised 2017					
Con cept	Subconcept	Level 1A (Ages 5-7) By the end of Grade 2, students will be able to	Level 1B (Ages 8-11) By the end of Grade 5, students will be able to	Level 2 (Ages 11-14)	Level 3A (Ages 14-16) By the end of Grade 10, students will be able to
ystems	Devices	1A-CS-01 Select and operate appropriate software to perform a variety of tasks, and recognize that users have different needs and preferences for the technology they use. (<i>P1.1</i>)	1B-CS-01 Describe how internal and external parts of computing devices function to form a system. (<i>P7.2</i>)	2-CS-01 Recommend improvements to the design of computing devices, based on an analysis of how users interact with the devices. (P3.3)	3A-CS-01 Explain how abstractions hide the underlying implementation details of computing systems embedded in everyday objects. (P4.1)
Computing S	Hardware & Software	1A-CS-02 Use appropriate terminology in identifying and describing the function of common physical components of computing systems (hardware). (P7.2)	1B-CS-02 Model how computer hardware and software work together as a system to accomplish tasks. (<i>P4.4</i>)	2-CS-02 Design projects that combine hardware and software components to collect and exchange data. (<i>P5.1</i>)	3A-CS-02 Compare levels of abstraction and interactions between application software, system software, and hardware layers. (<i>P4.1</i>)
	Troubleshooting	1A-CS-03 Describe basic hardware and software problems using accurate terminology. (P6.2, P7.2)	1B-CS-03 Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. (<i>P6.2</i>)	2-CS-03 Systematically identify and fix problems with computing devices and their components. (P6.2)	3A-CS-03 Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors. (<i>P6.2</i>)
Networks & The Internet	Network Communication & Organization		1B-NI-04 Model how information is broken down into smaller pieces, transmitted as packets through multiple devices over networks and the Internet, and reassembled at the destination. (<i>P4.4</i>)	2-NI-04 Model the role of protocols in transmitting data across networks and the Internet. (P4.4)	3A-NI-04 Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing. (<i>P4.1</i>)
	Cybersecurity	1A-NI-04 Explain what passwords are and why we use them, and use strong passwords to protect devices and information from unauthorized access. (P7.3)	1B-NI-05 Discuss real-world cybersecurity problems and how personal information can be protected. (P3.1)	2-NI-05 Explain how physical and digital security measures protect electronic information. (P7.2)	3A-NI-05 Give examples to illustrate how sensitive data can be affected by malware and other attacks. (<i>P7.2</i>)
				2-NI-06 Apply multiple methods of encryption to model the secure transmission of information. (<i>P4.4</i>)	3A-NI-06 Recommend security measures to address various scenarios based on factors such as efficiency, feasibility, and ethical impacts. (<i>P3.3</i>)
					3A-NI-07 Compare various security measures, considering tradeoffs between the usability and security of a computing system. (<i>P6.3</i>)
					3A-NI-08 Explain tradeoffs when selecting and implementing cybersecurity recommendations. (P7.2)



Gr 9-12 Standards for Computing and Networking

3A-CS-01	9-10	Explain how abstractions hide the underlying implementation details of computing systems embedded in everyday objects.	>	Computing Systems	Devices
3A-CS-02	9-10	Compare levels of abstraction and interactions between application software, system software, and hardware layers.	>	Computing Systems	Hardware & Software
3A-CS-03	9-10	Develop guidelines that convey systematic troubleshooting strategies that others can use to identify and fix errors.	\$	Computing Systems	Troubleshooting
3A-NI-04	9-10	Evaluate the scalability and reliability of networks, by describing the relationship between routers, switches, servers, topology, and addressing.	×	Networks & the Internet	Network Communication & Organization
3A-NI-05	9-10	Give examples to illustrate how sensitive data can be affected by malware and other attacks.	>	Networks & the Internet	Network Communication & Organization
3A-NI-06	9-10	Recommend security measures to address various scenarios based on factors such as efficiency, feasibility, and ethical impacts.	>	Networks & the Internet	Cybersecurity
3A-NI-07	9-10	Compare various security measures, considering tradeoffs between the usability and security of a computing system.	>	Networks & the Internet	Network Communication & Organization
3A-NI-08	9-10	Explain tradeoffs when selecting and implementing cybersecurity recommendations.	>	Networks & the Internet	Cybersecurity

Identify Hands-on Activities for HS Students

- Raspberry Pi's have been used in K12 for programming and engineering activities.
- Many RPi projects have been published in literature and on YouTube and magazines such as MagPi.

How can we leverage these resources and knowledge to create activities that involve networking skills?



At the same time . . .

We wanted our students:

- to learn about alternative network technologies
- to improve their critical thinking, creativity, communication, documentation, problem solving and troubleshooting skills

We wanted to expand our teaching methods to be **more engaging**.



What does POGIL stand for?





POGIL - Process Oriented Guided Inquiry Learning

POGIL is a student-centered, grouplearning instructional strategy & philosophy

- Small, self-managed teams
- Instructor is a facilitator of learning, not the source of information.
- Focus is on process skills and application of knowledge to new contexts

Students utilize 7 process skills:

- 1. Teamwork
- 2. Oral and Written Communication
- 3. Problem Solving
- 4. Critical Thinking
- 5. Management
- 6. Information Processing
- 7. Assessment (Self-Assessment and Metacognition)



The Solution: Combine Both Projects into One!

- Our students created & tested projects
- Project materials would be used later at a summer workshops (delayed for now)
- Submit **written and oral** proposals and final presentations to the class.
- Focus on *how* and *what* they learned about applying technology & troubleshooting

- Project 1: Independent
 Networking Home Server
 Project
- Project 2 & 3: Groups
 Networking Projects
 Small: 2 4 students



What is a NAS server?





Demonstration: Building a NAS Server



Rob Zwetsloot. Build a Raspberry Pi NAS. <u>https://magpi.raspberrypi.org/articles/build-a-raspberry-pi-nas</u>. *This article first appeared in <u>The MagPi 85</u> and was written by PJ Evans*

Any Questions?





Raspberry Pi Student Projects





Raspberry Pi Student Projects

- 1. **PiHole** blocking certain intrusive advertisements
- 2. Motion Rpi Webcam Server webcam with motion detector
- 3. **Personal Web Server** Buster & Apache
- 4. **PiNAS** network attached storage
- 5. **RPi NAS Server** manual configuration of Samba
- 6. **RPi Cluster** needed 4 Pi's and Switch
- 7. FreeNAS security camera
- 8. PiNet used to setup & manage a classroom set of RPIs. *



Links will be on the web site!







Pi-Hole

- Install Pi-Hole by using curl -sSL https://install.pi-hole.net | bash
- Make sure Pi can be used as a DNS server
- Disable DHCP and let the Pi-Hole handle the addressing using http://192.168.x.y/admin



Challenges:

- Raspberry did not save screenshots in the right file format
- Finding lists of Ad servers to blacklist- Companies frequently update and change the list source to bypass Ad blockers.



https://pi-hole.net/ https://pimylifeup.com/raspberry-pi-pi-hole/ https://blog.cryptoaustralia.org.au/instructions-for-setting-up-pi-hole/

Pi Web Server



Pi Web Server

- Raspberry Pi 4
- Buster
- Rufus
- Apache
- Plain index.html page

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code
posts
research
tags
And and a second second





This site contains my blog and various bits of code that I have written in my free time. I also have a page about my research.

Latest posts

Viewing .csv files on the command line	31 Oct, 2015
Altred Extensions	29 Mar, 2013
Tagger 1.6.2	22 Sep, 2012
MPlayer OSX Extended Release 2	[8 May, 2012.
Pipe output from command line tools to a text editor	2.2 Apr., 2012

11111

Latest code

emusic-sync-rating CSFLID TimerBat shellmarks

http://bilalh.github.io/





Pi Web Server

- sudo apt install apache2 -y
- No problems



File Edit Tabs Help pi@raspberrypi:~ \$ sudo apt update Hit:1 http://raspbian.raspberrypi.org/raspbian buster InRelease Hit:2 http://archive.raspberrypi.org/debian buster InRelease Reading package lists... Done Building dependency tree Reading state information... Done 118 packages can be upgraded. Run 'apt list --upgradable' to see them. pi@raspberrypi:~ \$ sudo apt install apache2 -y Reading package lists... Done Building dependency tree Reading state information... Done The following additional packages will be installed: apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap ssl-cert Suggested packages: apache2-doc apache2-suexec-pristine | apache2-suexec-custom openssl-blacklist The following NEW packages will be installed: apache2 apache2-bin apache2-data apache2-utils libapr1 libaprutil1 libaprutil1-dbd-sqlite3 libaprutil1-ldap ssl-cert upgraded, 9 newly installed, 0 to remove and 118 not upgraded. Need to get 1,992 kB of archives. After this operation, 6,229 kB of additional disk space will be used. Get:1 http://mirrors.gigenet.com/raspbian/raspbian buster/main armhf libapr1 arm-



Questions





Pi Motion Webcam Server



Motion RPi Webcam Server

Surveillance WebCam

- USB external webcam
- Raspbian
- Motion
- Edit motion.conf file
- Create folders. See tutorial.

Challenges

- Recording is dependent on storage space, requires more processing power than Raspberry Pi 3
- Must always be updated (run sudo apt get/sudo apt-upgrade commands).



Motion.config

GNU nano 3.2

/etc/motion/motion.conf

Rename this distribution example file to motion.conf

This config file was generated by motion 4.2.2 Documentation: /usr/share/doc/motion/motion guide.html

This file contains only the basic configuration options to get a system working. There are many more options available. Please consult the documentation for the complete list of all options.

System control configuration parameters

Start in daemon (background) mode and release terminal. daemon on

Start in Setup-Mode, daemon disabled. setup_mode off

pid file value

log_file value

log level 6

Replace

AK Cut Text

AU Uncut Text

AJ Justify

To Spell

AC CL

target dir /motion



W Where Is AO Write Out



Motion

Challenges

- Streamed for pi user. Video is saved on the Pi's SD card or external storage.
- Recording does require more processing power and storage space than streaming.
- Video resolution can be lowered to compensate



- Port forwarding depends on ability to access port 48461 (Firewalls might block this)
- Need a static IP address (Difficult to set up on the fly).
- Workaround to a static IP address is finding out which IP address the Pi is using and grant port forwarding in router settings.



Lessons Learned



Lessons Learned



- Many resources online and MagPi, but not always in networking or not for older Pi's.
- Limited access to equipment
- Students don't format or document activities in a reusable or consistent way.
 Directions will have to be formatted, edited and retested.
- Application of their skills and knowledge occurred in beginning and advanced students.
- Installation and technical issues can sometimes be resolved using newer methods like Docker.
- Plan to have the workshops in the Spring/Summer.



Other Projects

www.raspberrypi.cloud



