Teaching Cyber Hygiene and Awareness with Comics on the Raspberry Pi

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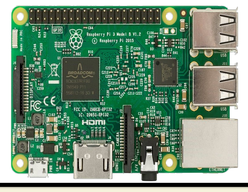
Motivation & Background

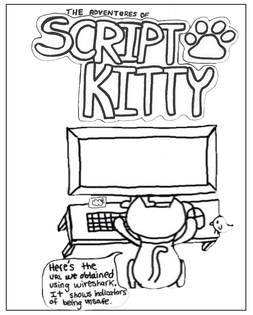
- The goal of this project is to help high school and middle school students be aware of their activities on the internet and create a culture of good cyber security practices.
- Prior work (e.g. [2]) with teaching cyber awareness typically centers around CTF exercises and/or are not freely available for public consumption.
- Our materials are freely available online, and uses the Raspberry Pi single board computer (SBC) to introduce cyber security concepts.
- The Raspberry Pi is an extremely popular SBC that costs only $35.00, and has been used successfully for
- CS education [1,3].
- We use the Kali Linux OS with the Raspberry Pi, since it is widely used in the security community and includes basic security tools

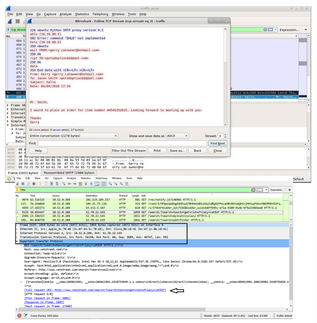


KALI LINUX

The Adventures of ScriptKitty

- *The Adventures of ScriptKitty* (AOSK) comics follow Ruby the cat, Pixel the canary, and Ed the pony as they detect security breaches in their human's activity online.
- The project objectives include understanding information transfer online, the implications of unencrypted network traffic, and developing good practices when surfing the web.





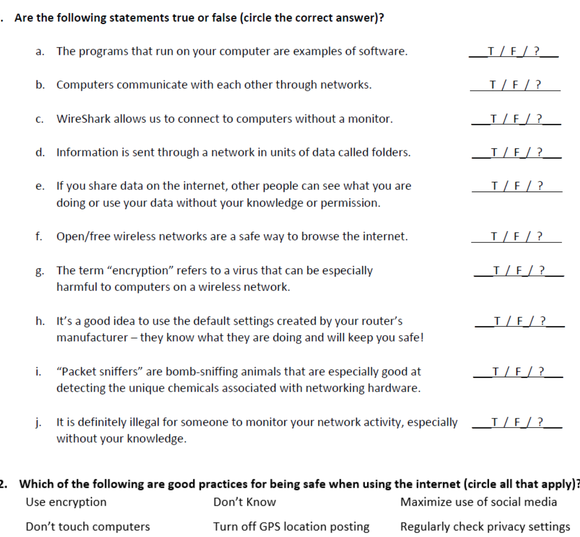
Material Overview:

Chapter 1: Raspberry Pi intro
Chapter 2: Packet Sniffing with Wireshark
Chapter 3: Weak Password cracking with John the Ripper
Chapter 4: Dangers of password reuse.

Assessment & Results

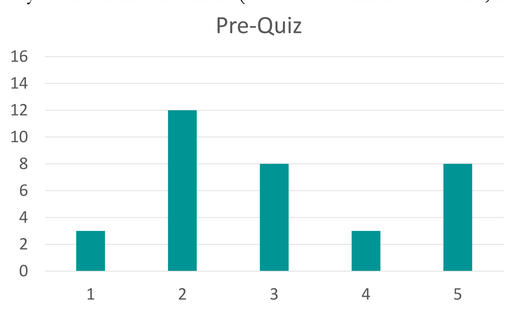
- We conducted three 60-90 minute workshops.
- Workshop 1 was a 60 minute workshop targeting middle schoolers, allowing them to read the comics and tutorials on their own. Due to limited time, there was very little discussion of ethics.
- Workshops 2 and 3 were 90 minute workshops targeted toward high school students that introduced the material as a guided presentation, with less emphasis on comics and more on ethical implications.
- Chapter 1-2 (intro to packet sniffing) was the focus of all workshops.
- We administered a pre- and post-quiz on packet sniffing and networking concepts. A student t-test is employed to measure the significance in the change of the scores.

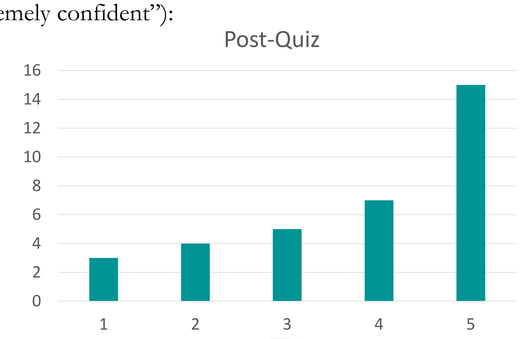
Workshop 1			
Question	Pre-Quiz (n = 23)	Post-Quiz (n = 15)	P-value
True/False	59.80%	75.50%	0.03614
Good Practices	76.67%	79.25%	0.2117
Workshop 2			
Question	Pre-Quiz (n = 16)	Post-Quiz (n = 16)	P-value
True/False	50%	63.12%	0.03974
Good Practices	56.25%	74.44%	0.06067
Workshop 3			
Question	Pre-Quiz (n = 30)	Post-Quiz (n = 30)	P-value
True/False	33.67%	53.79%	0.001725
Good Practices	50.56%	72.74%	0.01113



1. **Are the following statements true or false (circle the correct answer)?**
   a. The programs that run on your computer are examples of software. T / F / ?
   b. Computers communicate with each other through networks. T / F / ?
   c. WireShark allows us to connect to computers without a monitor. T / F / ?
   d. Information is sent through a network in units of data called folders. T / F / ?
   e. If you share data on the internet, other people can see what you are doing or use your data without your knowledge or permission. T / F / ?
   f. Open/free wireless networks are a safe way to browse the internet. T / F / ?
   g. The term "encryption" refers to a virus that can be especially harmful to computers on a wireless network. T / F / ?
   h. It's a good idea to use the default settings created by your router's manufacturer – they know what they are doing and will keep you safe! T / F / ?
   i. "Packet sniffers" are bomb-sniffing animals that are especially good at detecting the unique chemicals associated with networking hardware. T / F / ?
   j. It is definitely illegal for someone to monitor your network activity, especially without your knowledge. T / F / ?
2. **Which of the following are good practices for being safe when using the internet (circle all that apply)?**
   Use encryption | Don't Know | Maximize use of social media
   Don't touch computers | Turn off GPS location posting | Regularly check privacy settings

- Students were also asked to rate on a scale from 1-5 how confident they feel about identifying what they need to do to stay safe on the internet (1= "not confident at all", 5="extremely confident"):





- Middle school students enjoyed reading the comics.
- High school students found the packet-sniffing exercise eye-opening, and found the storyline humorous.
- Overall, the activity successfully communicated the dangers of packet sniffing, with students wanting to read additional ScriptKitty adventures.
- We summarize the open-ended comments students left on the post-quiz with a word cloud.

Conclusions & Future Work

- Our results indicate that our material had a significant impact in students' understanding of the concepts.
- Positive feedback from testing populations indicated interest in more adventures.
- Assessments are needed on other chapters to fully ascertain the quality of material overall.
- Current materials, including comics, tutorials and Raspberry Pi Image are available at: https://suzannejmatthews.gitbooks.io/aosk/content/

Threats to Validity:

- The workshop with middle-school students presented unique challenges, as some students had to go home early without taking the post-quiz.
- Some students also skipped quiz questions, leaving answers blank (these were removed from our population).
- While the students loved the comics, not all of them enjoyed reading the tutorial component on their own for an extended period of time, and got easily distracted.
- This led to our decision to have a guided workshop for the later groups.

Future Work:

- We plan to collaborate with Comic-BEE [4] to extend the storyline and make it more interactive.
- Potential topics for future additions include:
  - Sharing personal information online.
  - Data-collection settings on apps.

POWERED BY Raspberry Pi

Comic-BEE
Comic-Based Education & Evaluation
https://Comic-BEE.com

References

[1] JR Byrne, L Fisher, and B Tangney. 2015. Computer science teacher reactions towards raspberry Pi Continuing Professional Development (CPD) workshops using the Bridge21 model. In Computer Science & Education (ICCSE), 2015 10thInternational Conference on. IEEE, 267–272.

[2] Peter Chapman, Jonathan Burket, and David Brumley. 2014. PicoCTF: A Game-Based Computer Security Competition for High School Students.. In 3GSE.

[3] Suzanne J Matthews, Joel C Adams, Richard A Brown, and Elizabeth Shoop. 2018. Portable Parallel Computing with the Raspberry Pi. In Proceedings of the 49th ACM Technical Symposium on Computer Science Education. ACM, 92–97.

[4] Secure Decisions. 2017. Comic-BEE: Comic-Based Education & Evaluation for Cyber Security. https://comic-bee.com/. Online; accessed 27 September 2018.