INteractive Animated VIsualization and PracTice basEd Cybersecurity Curriculum and Training (InviteCyber) Framework for Developing Next-gen Cyber-Aware Workforce

PIs: Xiaoli Yang[1], Quamar Niyaz[1], Ahmad Y Javaid[2], Charlene Czerniak[2]

Student Researchers: Gabriel K Aguayo[1], Abel Reyes[1], Ethan Ewoldt[1], Ramesh B Govindula[1], Sai S Sudha[2], Jyothirmai Kothakapu[2], Laxmi M Podila[2]

[1]Purdue University Northwest, Hammond, Indiana, USA, [2]The University of Toledo, Toledo, Ohio, USA

Poster
Video

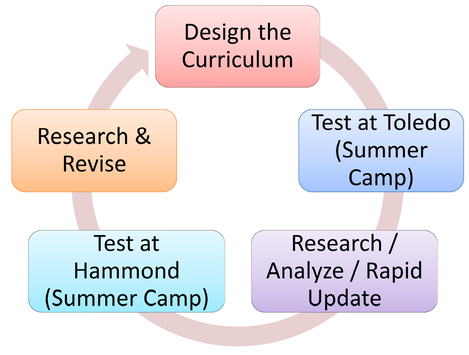
Objectives

- Spread awareness of threats associated with smartphone & tablet usage, and inculcate interest in cybersecurity careers among high school students
- Develop a cybersecurity mindset to identify and mitigate threats by understanding the adversary's objective
- Help students use their observatory skills and become proactive and vigilant
- Develop a high school cybersecurity curriculum

Research Questions

1. Parts of the curriculum most useful in teaching the material?
   a. Characteristics of each module that interests students?
   b. Possible to replicate these qualities (a) in other modules?
2. Interactive animated visualization modules work for learning physical, software, and mathematical aspects?
   a. Distinction based on gender and/or race?
3. Student problem-solving abilities improve with real-world hands-on activities in learning modules?

Methodology and Design

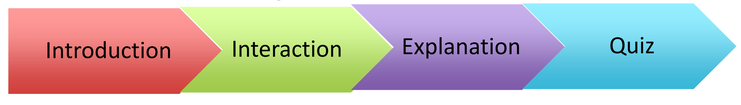


Rapid prototyping, testing, and revision (PTR) model

Utilize summer camps to test the developed material

Use in-house developed + open-source frameworks

Framework Design – Four Sections per Module



- Each learning module comprises these four sections
- This flow ensures use of interactive animated visualization to enhance interest and allow self-paced navigation

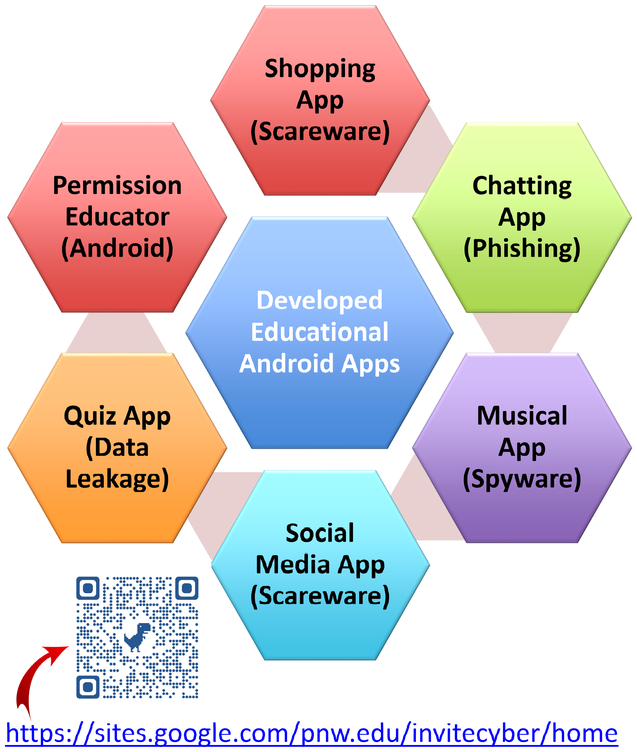
Challenges

- Select developmentally appropriate knowledge areas and offer students in a timely and age-appropriate manner
- Cybercriminals are motivated to target students, launch online assaults, cyberbully, hold ransom, and abuse
- Smartphones are widespread, without much understanding of the threats they bring to personal safety
- More time spent online may increase the likelihood of exposure to cyberattacks and related personal harm/threats

Scientific Impact

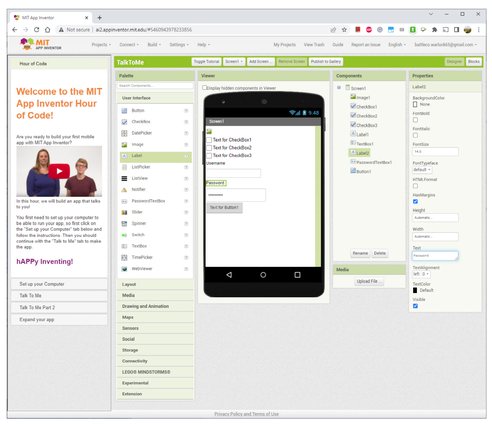
- Smartphone apps and interactive visualizations with animations work better for teenagers
- Improved student learning from hands-on experience via engaging visualization-based cybersecurity curriculum
- Permission-Educator App to help students understand Android permissions and their implications in device safety
- Development and testing of high school cybersecurity curriculum in summer camp setting

Developed Content



https://sites.google.com/pnw.edu/invitecyber/home

Use of Free MIT App Inventor



- Six android apps developed showcasing real attacks for hands-on experience
- Use of free MIT App Inventor for app development exercises
- Developed high school curriculum delivered and assessed in summer camp over 10 lecture sessions

Developed Curriculum

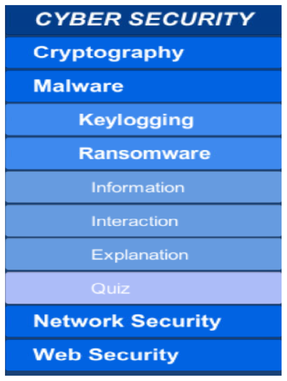
Fundamentals
- Intro to Internet
- Intro to Cybersecurity
- Cryptography
- Security Principles

Cybersecurity
- Internet Security
- Web Security
- Malicious Software
- Cyber-Safe Practices

Software Design
- Intro to Software Design
- Intro to Software Security Design
- Android Software Development

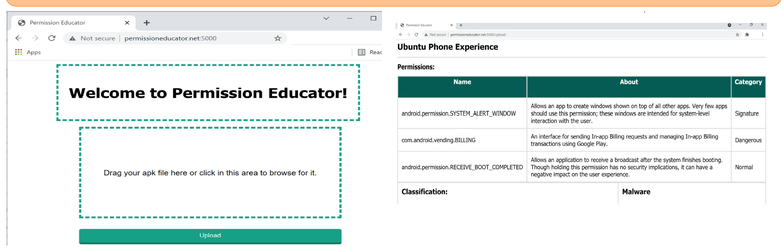
MIT App Inventor Tutorial

Learning Tool



- Framework design provides a menu categorizing and listing various topics based on difficulty level
- Tool allows self-paced learning of topics by involving user in active learning through interactive animation
- Potential tracking of user navigation may provide detailed insights on how different students learn differently
- Online + Offline usage available

Permission-Educator



The app aims to provide a simple and informative user interface to explain app permissions.

Impact on Society

- Spread awareness of the risks and threats associated with the use of smartphones/tablets among school students
- Enable teenagers understand smartphone/tablet ecosystem through basic app development and information visualization of data flow between apps
- Educate youngsters on various permissions associated with the installed apps and what role they play in personal safety
- Attract youngsters to cybersecurity as a career to fulfill the national skill gap in this area

Education and Outreach

- High schools in Hammond and Munster IN, Hoffman Estates, IL, and Toledo, OH engaged in summer camps
- Developed content made available on a public website
- Outreach through various international conference publications (total 3, another 2 in preparation)
- Enhanced cybersecurity learning by introducing visual and interactive presentation of topics
- A mix of modalities (ppt slides, Unity-based self-paced learning module, App Inventor) utilized for enhanced learning

Quantify Potential Impact

- By the end of the project, roughly 60 high school students are expected to be impacted directly
- Additional teacher participation and outreach expected to impact hundreds more
- High schools in Hammond and Munster IN, Hoffman Estates, IL, and Sylvania and Toledo, OH are potential early adopters of the curriculum
- Additional conference/journal publications expected to have a nationwide reach and usage of the developed content

Supported by the National Science Foundation SaTC EDU Grants # **1903419** and **1903423**