Covert Education Improves Student Engagement: Building Cyber Skills With An Alternate Reality Game

Problem Statement and Goals

Problem:

- STEM students learn more effectively with hands-on exercises
- Traditional lecture-based coursework does not meet this need
- Rigid deadlines and class structures can stifle self-directed learning

Goals:

- Build a campus-wide challenge to teach practical skills in an unconventional format
- Use intentional ambiguity to drive curiosity and motivate participation
- Introduce new cybersecurity concepts through puzzles and challenges

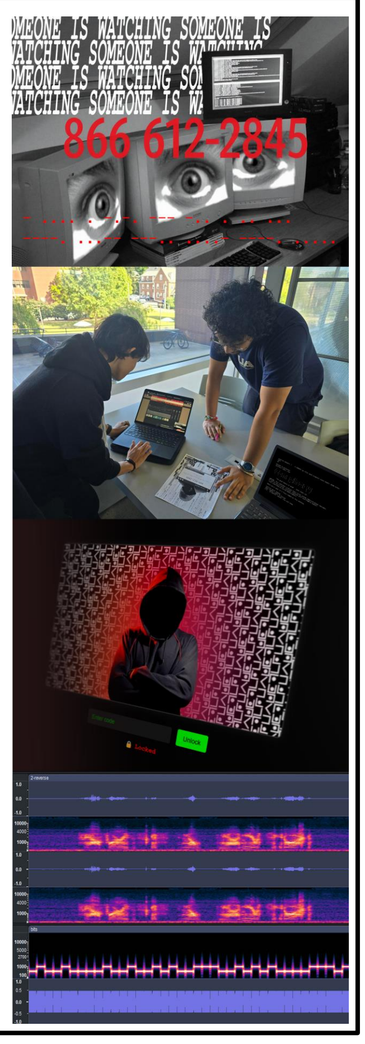
Approach

Methodology:

- Conducted an alternate reality game (ARG) for one month
- Multiple entry points: hidden QR codes, cryptic posters, social media posts
- Tracked student solve progress via a custom Python Discord bot and database

Challenge Categories:

- Cryptography
- Steganography
- Linux System Administration
- Open-Source Intelligence



From top: Poster with Morse code; Students working on challenges; Dark web cipher page; Phone tree audio files

Results

Participation

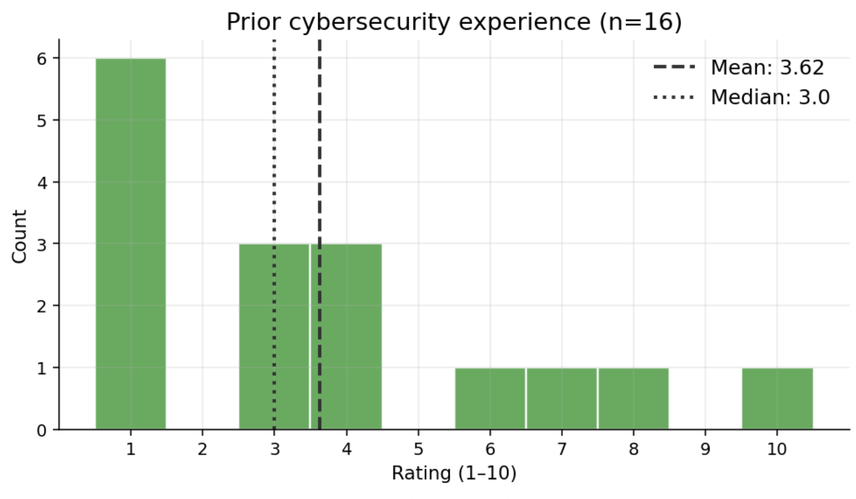
- 152 students completed the first stage
- 29 students completed at least half of the challenges
- Four students solved the 12-puzzle series

Educational Impact

- 16 competitors with completion >= 50% surveyed
- Low average prior cybersecurity experience: 3.63 / 10
- High average educational value rating: 8.06 / 10

Future Goals:

- Measure long-term educational outcomes
- Incorporate LLM jailbreaking, binex, network forensics
- Reach a larger student population through viral marketing



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Abstract

Students in technical fields learn more effectively when given hands-on learning opportunities [1].

Alternate reality games (ARGs) are a type of cybersecurity event that incorporate both real-world and digital challenges. When used in an educational context, these competitions improve security awareness and student engagement via real-time feedback [2]. Supplementing traditional lectures with ARGs presents an opportunity for cybersecurity skill development in undergraduate populations.

We conducted an ARG over the course of one month at Penn State University Park. The challenge consisted of a series of real-world and digital cybersecurity challenges. These challenges covered cybersecurity topics including cryptography, forensics, Linux system administration, and open-source intelligence collection. 152 students started the challenge, 29 completed at least half of the challenges, and four completed the 12-puzzle series. Of the 29 students with at least 50% completion, 16 responded to a request for feedback. These students reported a positive educational impact (8.06/10 preference points), and their testimonials confirmed exposure to new technologies and engagement of critical thinking skills.

For future work, we plan to expand the challenge to cover additional cybersecurity topics (including large language model jailbreaking, binary exploitation, and network forensics), reach a wider student audience, and create an ongoing yearly ARG. We also plan to expand evaluation to include self-reported educational outcomes and long-term follow-ups with participants.

References:

[1] S. Freeman et al., “Active learning increases student performance in science, engineering, and mathematics,” Proceedings of the National Academy of Sciences, vol. 111, no. 23, pp. 8410–8415, May 2014, doi: 10.1073/pnas.1319030111.

[2] T. R. Flushman, M. Gondree, and Z. N. J. Peterson, “This is not a game: early observations on using alternate reality games for teaching security concepts to first-year undergraduates,” in Proceedings of the 8th USENIX Conference Cyber Security Experimentation and Test (CSET ’15), Washington, DC, USA, 2015, doi: 10.5555/2831120.2831121.

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