Jail, Hero or Drug Lord?

Turning a Cyber Security Course Into an 11 Week Choose Your Own Adventure Story

Andreea-Ina Radu, Tom Chothia, Sam Holdcroft and Richard J. Thomas
School of Computer Science, University of Birmingham, UK
Motivation

Story/narrative is an important aspect of gamification.

In making cyber security education challenges this is often overlooked.

Types of Games
Examples of narrative within security training

Within competitions, the use of narrative is common

- PicoCTF used a story about helping a broken robot get home

- HackFu is set in a theatrical environment (with actors playing roles within the story!)

Intro to CS course as a campus treasure-hunt, with CTF-style challenges, puzzle-based learning, and alternate reality games (1st year undergrad)

Security and cryptography courses following Divergent storyline (school level)
Our Goal

Provide a framework to put exercises into the context of a story.

The story should tie the exercises together, for a 11 weeks cyber security course.

Students should have control over the story.

**End-goal:** Improve student engagement & attainment within the course.
Contribution

We have developed a choose-your-own-adventure *story engine* to add a narrative to educational CTF challenges.

We have written a story for this based on investigating a black market site (*The Cotton Highway*), in a corrupt company.

We have used this with a 2nd year cyber security class and collected data about its affect.
Tech deets
Framework

Virtual machine

Ex 1, flags
Ex 2, flags
Ex 3, flags
Ex 4, flags
Ex 5, flags

Player space

Flags submission webserver
Logging webserver
Mail server
Story engine
Web server

Introduction
Technical engine
Story development
Evaluation

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Framework

Virtual machine
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- Story emails

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From: NikAdler@sensiblefurniture.com
Subject: You know crypto, right?

427,
I'm your line manager, Nik Adler. Let's get things straight from the outset - as a cyber advisor, you're privy to a lot of information and data. I trust you will be responsible and carry out your duties with delicacy and precision.

We're having issues trying to decrypt some files - maybe you could take a look at them? We've put them in your home directory so you can get started on them.

Once you've managed to get in, each should have a cryptographic token in them. Please reply with as many of those tokens you can find. Under no circumstances, should you relay this onto anyone else.

N.

From: monkey.see482@imeverywhere.sensiblefurniture.com
Subject: Welcome to the doghouse. Want to see what actually goes on?

Hey!

I told those guys in IT they need to give you stronger encryption keys for email. Guess old moneybags decided it's too expensive to actually care. What do you care, anyway? You're the new cybergeek I see - what a generic term nowadays which has absolutely no context.

Who am I? You'll find out soon enough, but you need to prove yourself to me first. Why am I emailing you? Well, congratulations smarto - you bagged last place in the prize list. The guy who sat in your seat was involved in something big, but he went missing. So... what happens if one of your best goes 'away'? You replace them with someone better, or at least that's probably what HR said to you to sell the job.

This is where you come in. The email you just got from Adler? There's more context than just a simple decryption task to get you started. [...]
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Story Engine

Written in Java -- but simple to use/change

-> reads an XML config file which contains the story logic

-> same file keeps track of story progress

-> interaction via emails, the **flags (tokens)** being keywords

-> email templates and news stories stored on VM

Experimental: logging choices sent by students

### Exercise ex2

**Event first_boss_token**

**Required**

- Token emailed to NikAdler

&

**NOT Event first_chimp_token**

<table>
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<tr>
<td>Email Start_Boss_Path</td>
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<tr>
<td>Email ChimpStart_Boss_Path</td>
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**Event first_chimp_token**

[...]

**Story XML High-Level Definition**
Story time!
Three-act structure

Act I
- Reluctant hero who gets thrown in an unfamiliar situation

Act II
- Hero learns, acquires knowledge; then suffers a setback
  - Plot point - 1st choice
  - Plot point - 2nd choice

Act III
- Fight between hero and villain

Setup

Confrontation

Resolution

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Technical engine

Story development

Evaluation
Three-act structure in THE MATRIX

Act I
- Neo chooses the red pill
- Neo living in the matrix

Act II
- Neo finds out about the Matrix and the real world
- Morpheus’ team gets ambushed
- Neo chooses to save Morpheus

Act III
- Neo fights Smith

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Characters

Employee 427

Chimp (Charle Garcia)

The Bosses

Jak & Nik

Carol
IT admin

Thomson

Introduction  Technical engine  Story development  Evaluation
Results & Evaluation
Results - Student Choices

23 students began the story; 20 saw it through to the end
Evaluation

23 out of 144 students started the story

Self-selected sample - following the story was voluntary

Students following the story avg 11.08 points higher than no story

Student engagement - reading week reports contained 74% more words for students who followed the story
## Evaluation

### Comparison with prev academic year:

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### Accounting for individual capability:

\[ \Delta = \frac{15/16 \text{ mark} - ICS \text{ mark}}{100} \]

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Evaluation - Survey

Did the story increase your level of engagement with the module? **Avg 5.5/10**

How interactive did you find the story? **Avg 6.18/10**

Please rate how fun you found the story **Avg 7/10**

Time spent on the story vs time perceived to be needed to finish story

**Introduction**

**Technical engine**

**Story development**

**Evaluation**
Student comments

Comments on story or plot
- I did like the complicated underground manoeuvres of the Sensible Furniture crowd. The Charles Garcia reveal and discovering the message that led to his demise was also a big moment in the tale. Was genuinely upset when Chimp died. RIP.

Were you happy with the ending?
- No. Because I went to jail. Also I can see now that there was a way to win as the bad guy.
- I liked the opportunity to choose a path, but also be able to change at certain points. Felt involved with the characters and had a fitting ending.
- I didn't lose (end up in jail), the taste of victory is sweet.

Why do you think that concept of adding the story is a good idea?
- Engages students to pay attention to the exercises, gives them a little real-life context (which often aids understanding) and instils confidence in students that the course is being very well-managed.
- It's a lot more engaging and it puts you in a hackers position (something we've all wanted to do) without the real life consequences.

Would other courses benefit from a story mechanic?
- I could see something like this working for robot programming where you would have to program a virtual robot in some sort of story.
- Modules like Graphics can have story elements. So for example, a detective case: to get the final clue to solve the murder/treasure, one needs to create this graphical image which contains some clue.
Future work

Use the framework emails as formal flags submission.

-> require students to take part

Working with other Universities which are interested in adopting and expanding the framework

Adding story engine into SecGen framework (Cliffe Schreuders, Leeds Beckett University).
Conclusion

Developed a choose-your-own-adventure *story engine* which can be added to exercises, in order to tie them together in a real-life scenario.

Wrote a story for our ICS module, based on investigating a black market site.

Showed that adding a story increased student engagement with the course material.

Showed that students who followed the story did in fact score higher marks in ICS.
Questions time!

Andreea-Ina Radu
a.i.radu@cs.bham.ac.uk

Exercise sheets, VM & co:
http://www.cs.bham.ac.uk/internal/courses/comp-sec/story