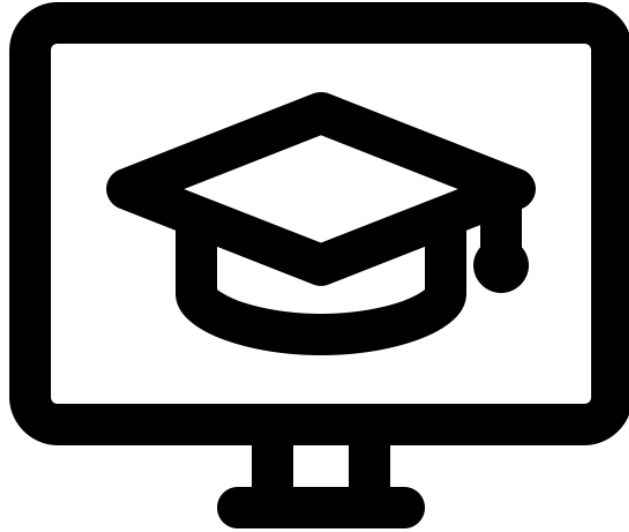


# Authenticity, Ethicality, and Motivation: A Formal Evaluation of a 10-week Computer Security Alternate Reality Game for CS Undergraduates

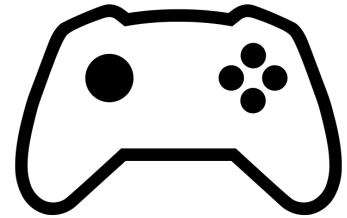
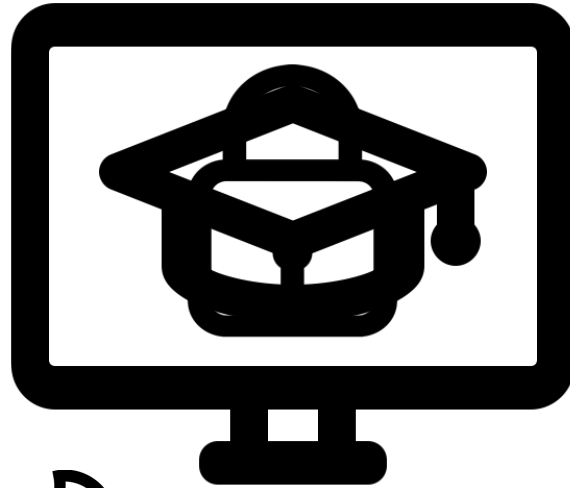
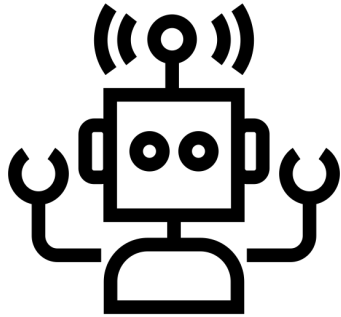
**John Morelock, Virginia Tech**

**Zachary Peterson, Cal Poly, San Luis Obispo**

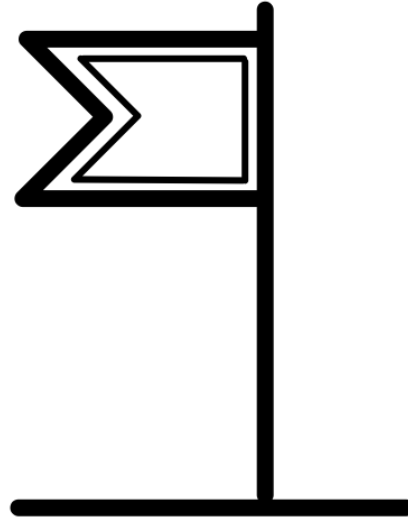
# Innovating CS and Security Education



# Cal Poly's CPE123



# CPE123: Security



# Alternate Reality Games

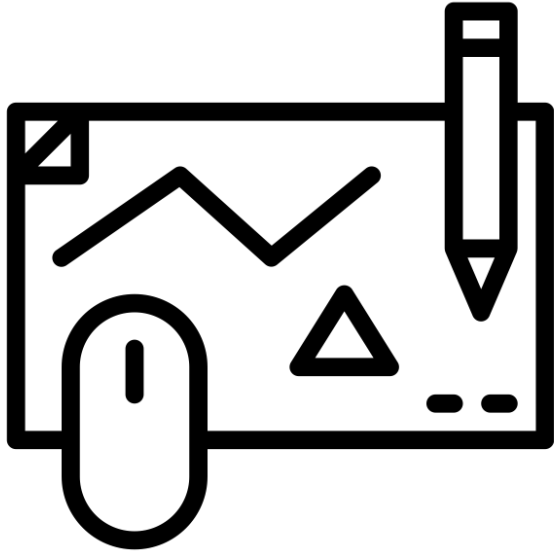


Inspire counterfactual thinking

Maintain engagement

Provide an authentic context for  
course material

# Game & Course Design



Iterative design process

Starting with KSAs, LOs, and an initial story

Weekly refined and aligned topics to story

Resulting in a design document

# The Story









Try again!

Passdigit:

HINT: Your favorite 1-digit number



Try again!

Passdigits:

HINT: Your favorite 3-digit number



SHA1-DEBUG: b3359f5d1d47b3c4aedfa16172d013f602627261 != SALT: B DIGEST: 6e979f426b676955f4896002085eb834b93326b1

Password:

HINT: You'll never break this randomly chosen 6-character uppercase/lowercase/digits password. Certainly not online.



What's this? NOObS playing with passwords?

Your realize your classwork is as public as a story on cable news.

Tell your professor to learn to protect you better than this.

```
SELECT * FROM db.users:
```

```
test,  
znjp,  
asd,
```



## 환영

Welcome to **Dark Park!** My name is Daniel Park. My mission is simple: to provide all of the Dark Web a safe port to communicate, lurk, exchange tips, hide or possibly share secrets as the case may be, receive news the rest of the Internet never sees, to be your one stop shop to everything you love about the Dark Web. And it is ALL FREE! So join me, set up a guaranteed secure account here, beyond the street lights in the shadows of Dark Park!

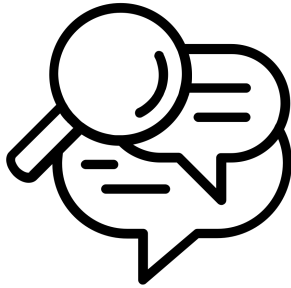
[Log in](#) to Post!

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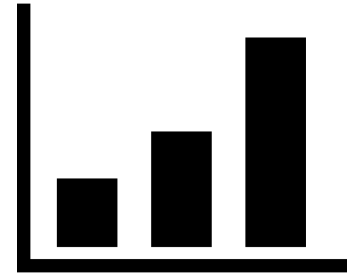
**Rumor Mill**



# Methods



**1. Qualitative analysis of student focus groups**



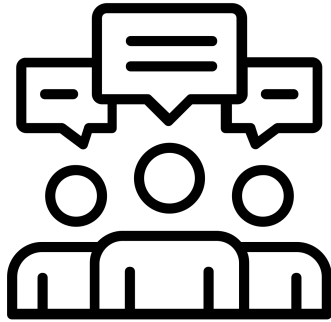
**2. Quantitative analysis of student survey**

# **Answering Research Question 1**

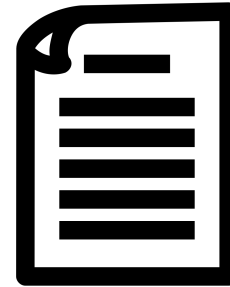
**What aspects of the ARG affected student experience in the course?**



# Qualitative Data Collection



**2 focus groups  
n = 20  
(4 female, 16 male)**

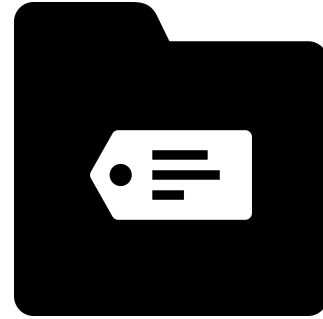


**Interview protocol on  
perceptions of course,  
game, and security**

# Qualitative Data Analysis



**Open coded for various  
aspects of student  
experience**



**Categorized codes to  
discern general patterns  
across responses**

# **Aspects of student experience analyzed**

**Positive and negative aspects of the course**

**Positive and negative aspects of the ARG**

**Suggested changes to the course and ARG**

**Changes in students' behaviors, perceptions, and understanding related to cybersecurity**

## **Results: The ARG provided an authentic context to motivate problem-solving**

**“ Even though we all knew exactly when [the ARG] started and exactly what was going on, it was way **more engaging than just getting assignments**...when you’re like, “Hey, we’re doing an attack,” you’re like, **“Oh, I know this is fake, but it’s exciting.”**”**

*-Male focus group participant*

## **Results: The ARG provided an authentic context to motivate problem-solving**

**“ The game, that **made it more fun**. And even though some things ended up taking multiple hours, **it didn't feel like it was a task**. It felt like it was just a fun thing to do.**

*-Male focus group participant*

## Results: Even inauthentic elements were enjoyable

“ I think because, at least for me, I knew from the beginning [the ARG] wasn't real, that even though throughout the quarter [with the introduction of videos], it became like more obvious, **I still really enjoyed the videos...**I showed my family members, and it was really cool.

*-Female focus group participant*

## Results: Authenticity often clashed with ethicality

“ I missed the first day of this class when you said that this was not a real thing we were doing. So **I actually thought we were doing a phishing attack** against a person...I was like, “This could so be real, and then we’re just going to go and do the worst possible thing?” So I had that whole thing, like, **“No, I’m not going to participate.”**”

*-Male focus group participant*

## Results: Authenticity often clashed with ethicality

“ I think on the other end though, making [the ARG] more fake and not as believable I think made the [ethical] line a lot clearer...**seeing this in a game and a set setting, you're not harming someone else**, this is completely within [Cal Poly's] system...It was nice to know that it wasn't real and we were doing it in practice, rather than I think it would have been a huge issue if like it wasn't like that.

*-Female focus group participant*



## Results: The course changed students' perceptions of the cybersecurity profession

“ You have to be right on defense 100% of the time. And on attack, you only have to be right once. And so, I was thinking about that, and **it makes [cybersecurity] a very important profession**, given how it must be a perfect system in that way. So it seems like it's actually way more necessary.

*-Male focus group participant*

## **Results: The course changed students' perceptions of the cybersecurity profession**

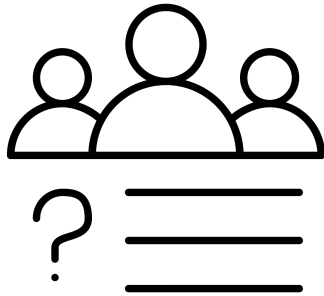
**“ I’m going to get into web security. I don’t know, it looks fun...I think that what this class did tell me is don’t get into cryptography. Okay, I’m not going to lie. I was falling asleep during the lecture because I was just, I couldn’t grasp it. But web security, I was into it.**

*-Female focus group participant*

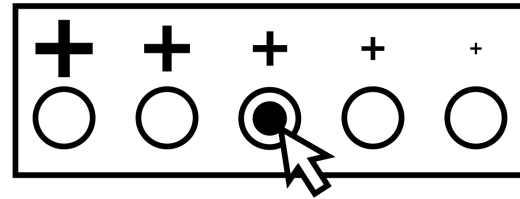
## **Answering Research Question 2**

**How did students' motivation-related experiences in the course differ based on gender?**

# Quantitative Data Collection



**Electronic survey**  
**n = 54**  
**(14 female, 40 male)**



**Likert-scale items on**  
**student achievement**  
**motivation**

# **Measuring Achievement Motivation: Eccles' Expectancy-Value Theory (EVT)**

**Expectancy for Success** - Confidence in one's ability to succeed

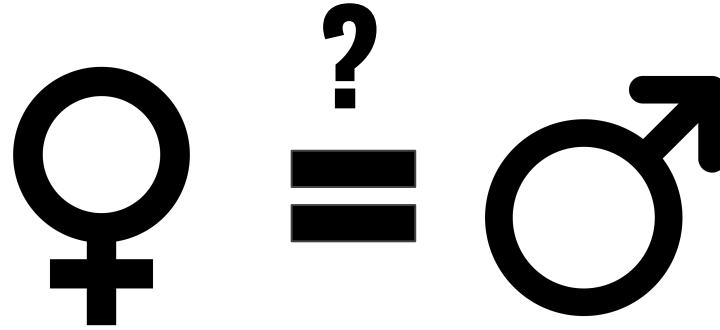
**Attainment Value** - Importance of doing well

**Utility Value** - Usefulness to future plans

**Intrinsic Interest Value** - Enjoyment of participation

**Cost** - Perceived difficulty and effort required to do well

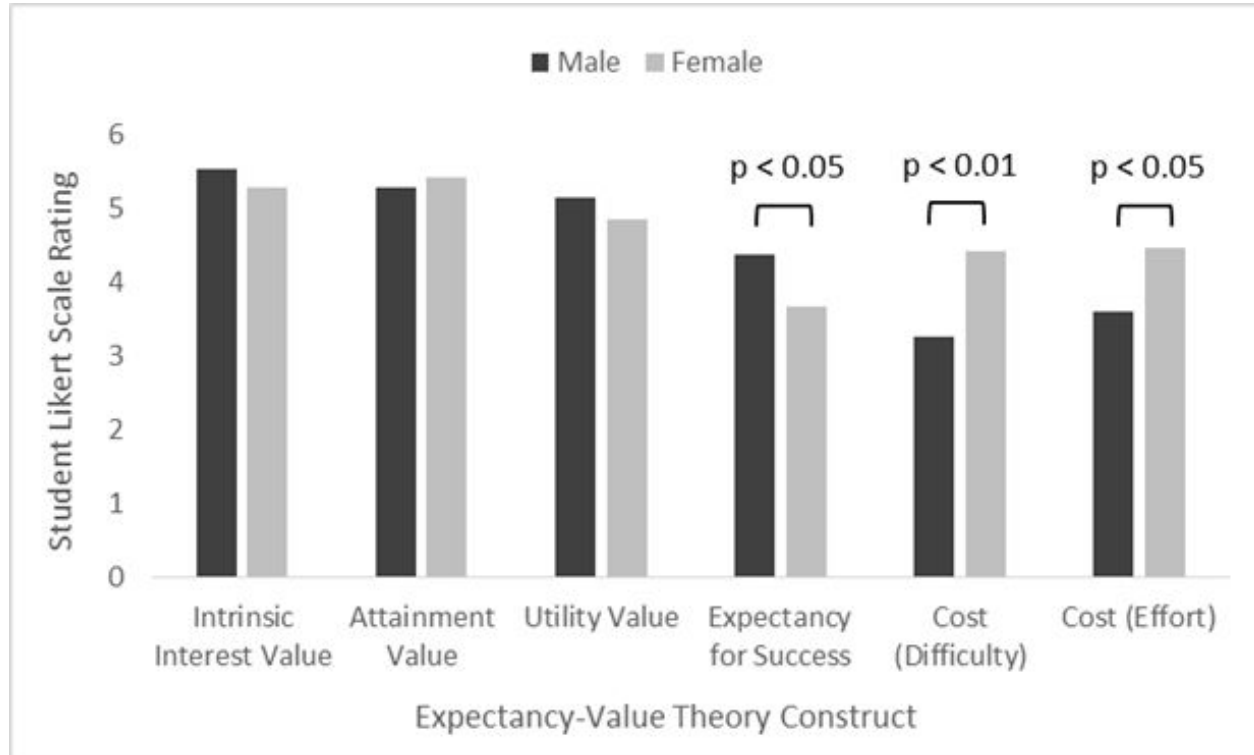
# Quantitative Data Analysis



Comparison of male and female  
responses on EVT Constructs

Two-sided t-test

# Results: Women had less confidence and found the course harder and requiring more effort than men



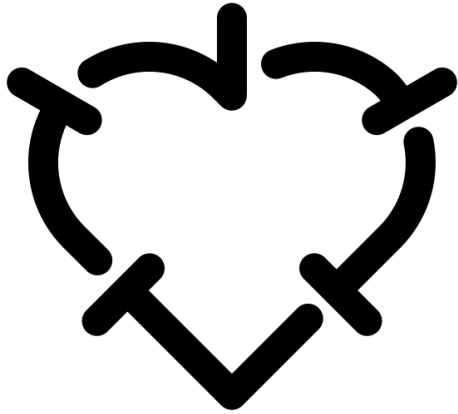
## Results: Women had less coding knowledge to start

“ I felt like with a lot of the labs, I knew conceptually what I had to do, but **I did not have the skills in writing code** to actually do it, because all the lectures were conceptual, and I seemed to understand them. But then I had no tools to go in and do that in the lab.

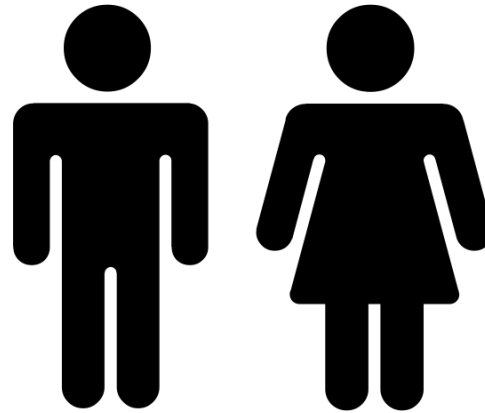
*-Female focus group participant*



# Discussion



Ethics

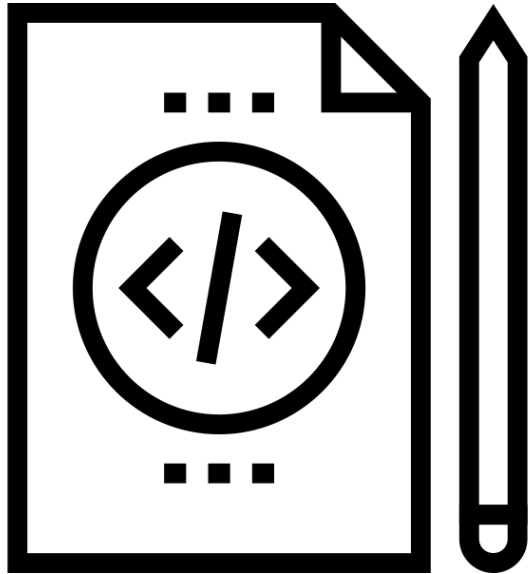


Gender Gap



Hard Work

# Conclusion



Plans to revisit and refine coursework

Increase reality

Ultimately release as a package