27th annual INCOSE international symposium

Adelaide, Australia

July 15 - 20, 2017

Klew Williams // Worcester Polytechnic Institute // Massachusetts, USA

Alternate Reality Games in the Systems Engineering Classroom

with Dr. Alexandrina Agloro and Dr. Shamsnaz S. Bhada (previously Virani)

ARGs in the Classroom

What can novice systems engineers learn from playing an Alternate Reality Game?

How to accommodate and discuss "human factors" such as gender in systems.

ARGs in the Classroom

The in-class ARG was an immersive, experiential learning event which is otherwise very difficult to recreate.

Alternate Reality Games (ARGs) for systems engineering

Research Goals and Approach

Mission Statement

Teach students how to think and rethink through systems involving humanistic concerns.

WHY?

Fight “human blindness” – account for the *human in the loop!*

Literature

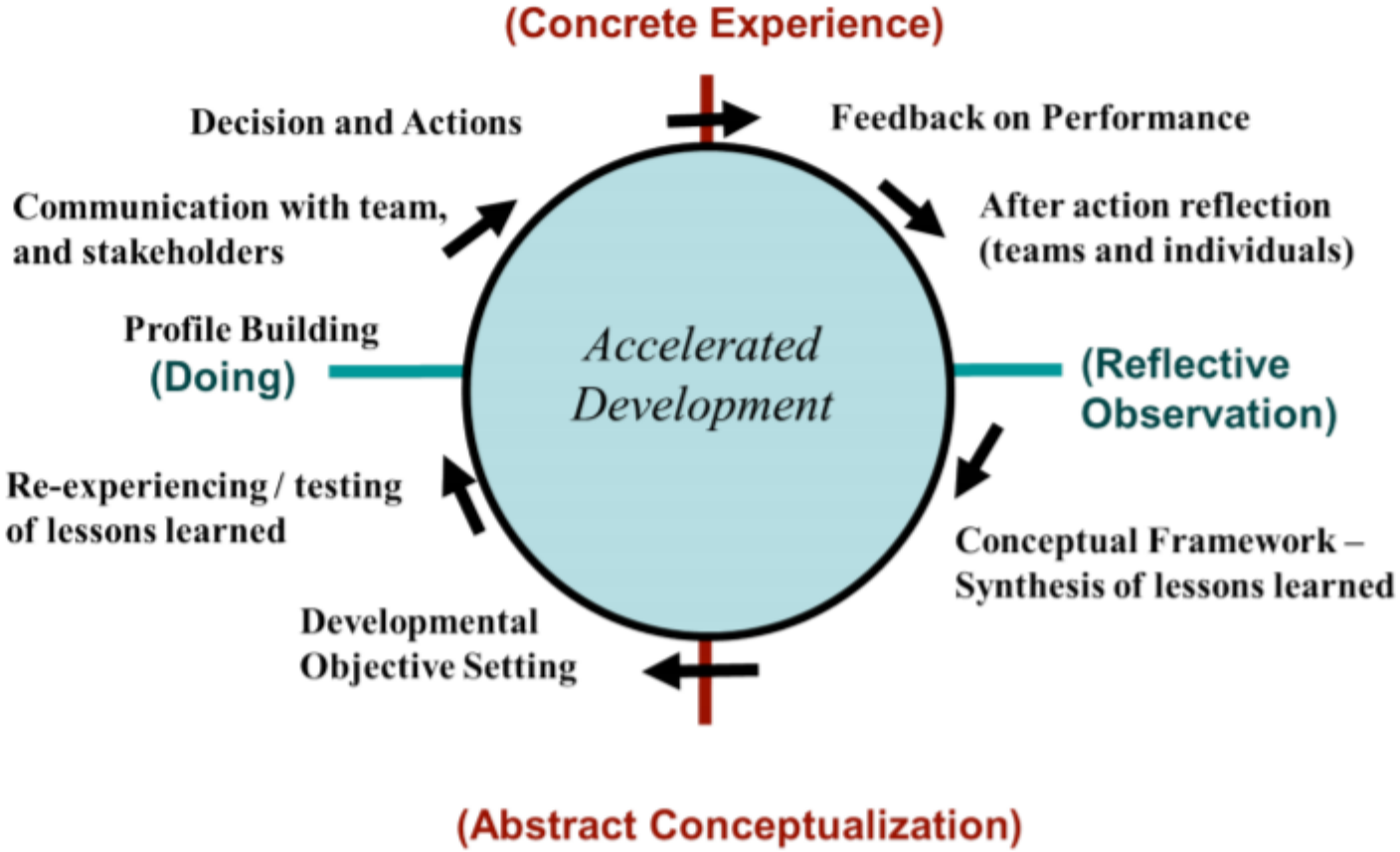


Figure 2. All Phases of Experiential Learning to be Engaged

Investigating an Innovative Approach for Developing Systems Engineering Curriculum: The Systems Engineering Experience Accelerator (2011)

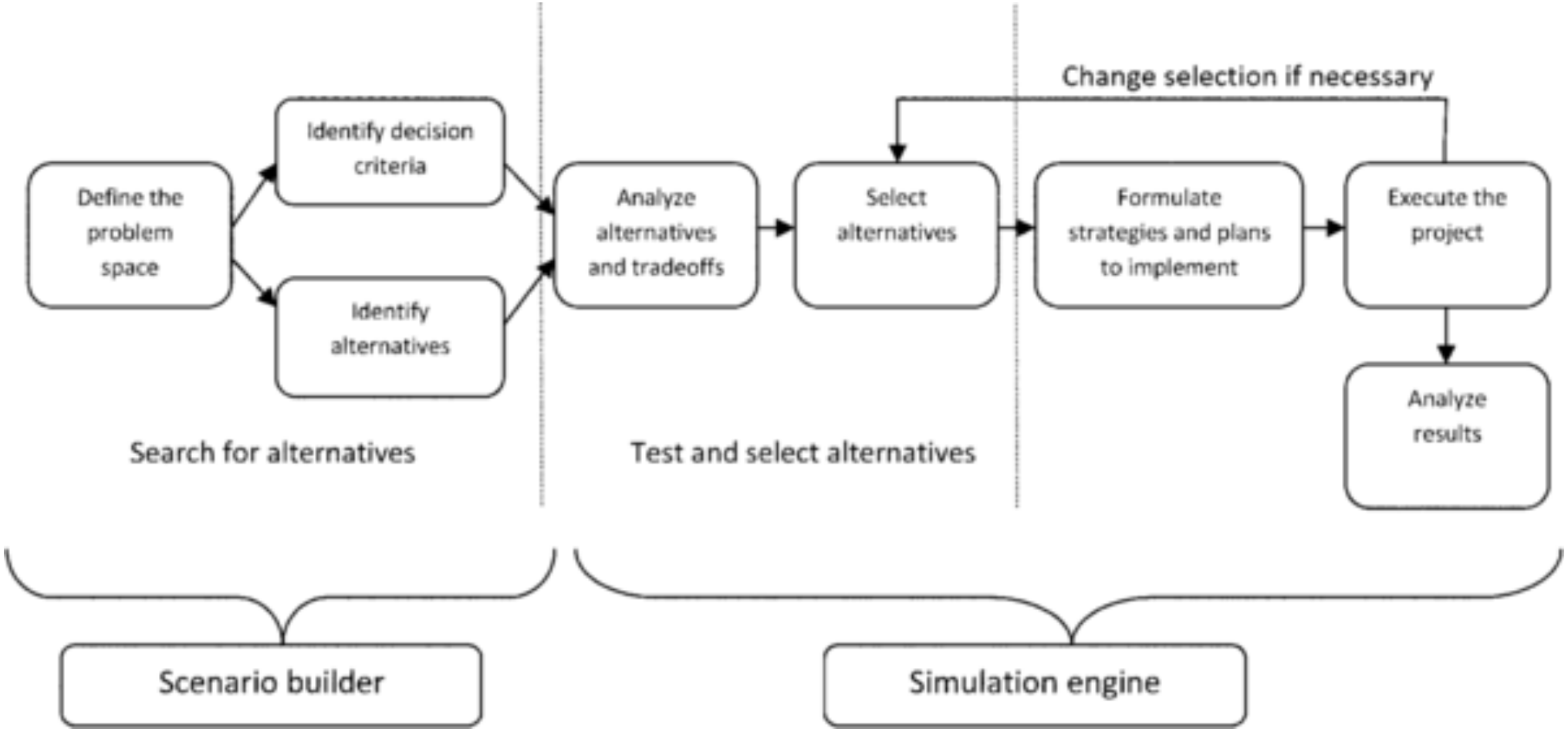
Literature

…and by Flushman, Gondree, and Peterson:

Alternate reality scenarios can "**help bridge concepts into the real world**, drawing students into fictional scenarios presenting authentic problems."

This is Not a Game: Early Observations on Using Alternate Reality Games for Teaching Security Concepts to First-Year Undergraduates (2015)

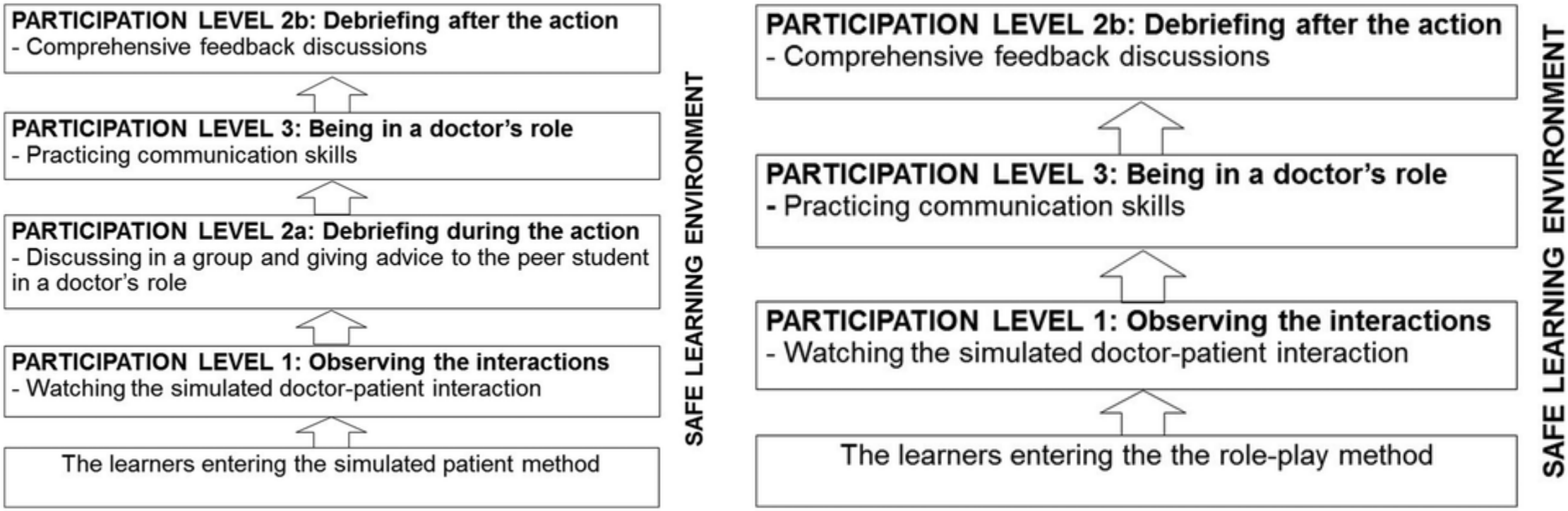
Literature



A Simulation-Based Approach in Support of Project Management Training for Systems Engineers. Systems Engineering 17 (2012)

Literature

…and by Koponen, Pyörälä, and Isotalus:



Communication Skills for Medical Students. Simulation & Gaming: Results From Three Experiential Methods (2014)

Experience Goals (Learning Goals)

1. Systems analysis in a realistic scenario
2. Revising requirements mid-process
3. Considering human uncertainties
4. Investigating the problem domain through narrative

Designing an ARG to teach humanistic concerns to novice Systems Engineers

Game Design

Design Goals

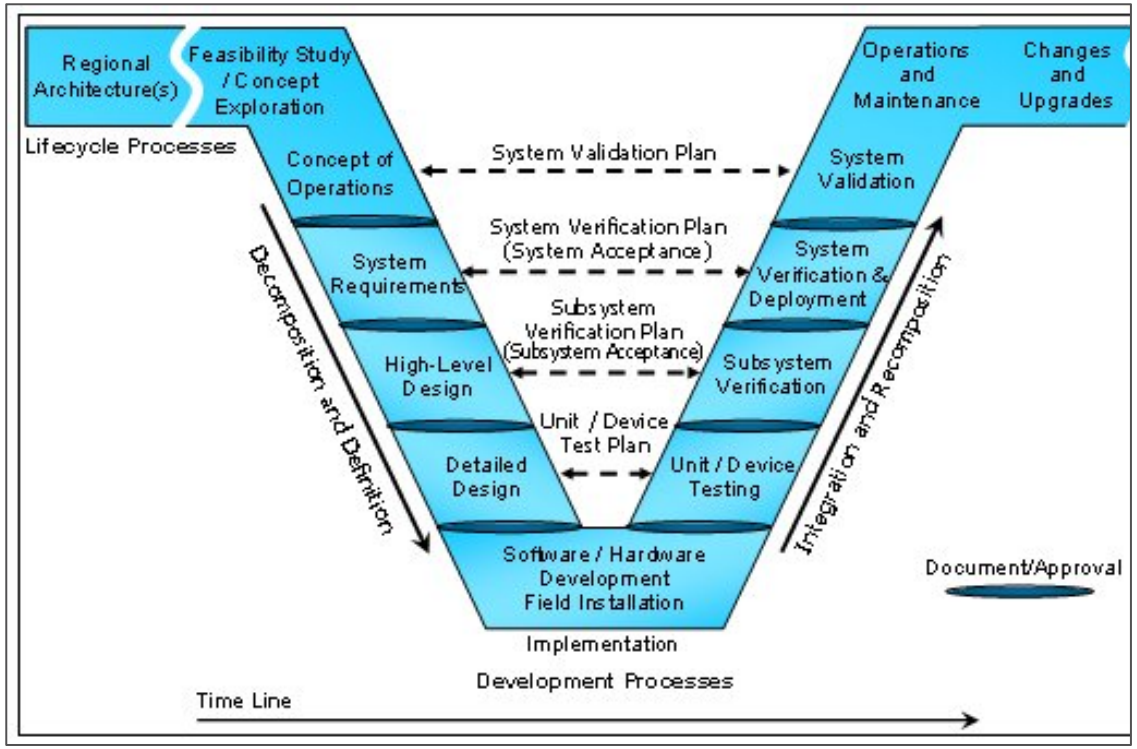
1. Modularity
2. Ease of implementation and reproduction
3. Ease of data collection
4. Realism

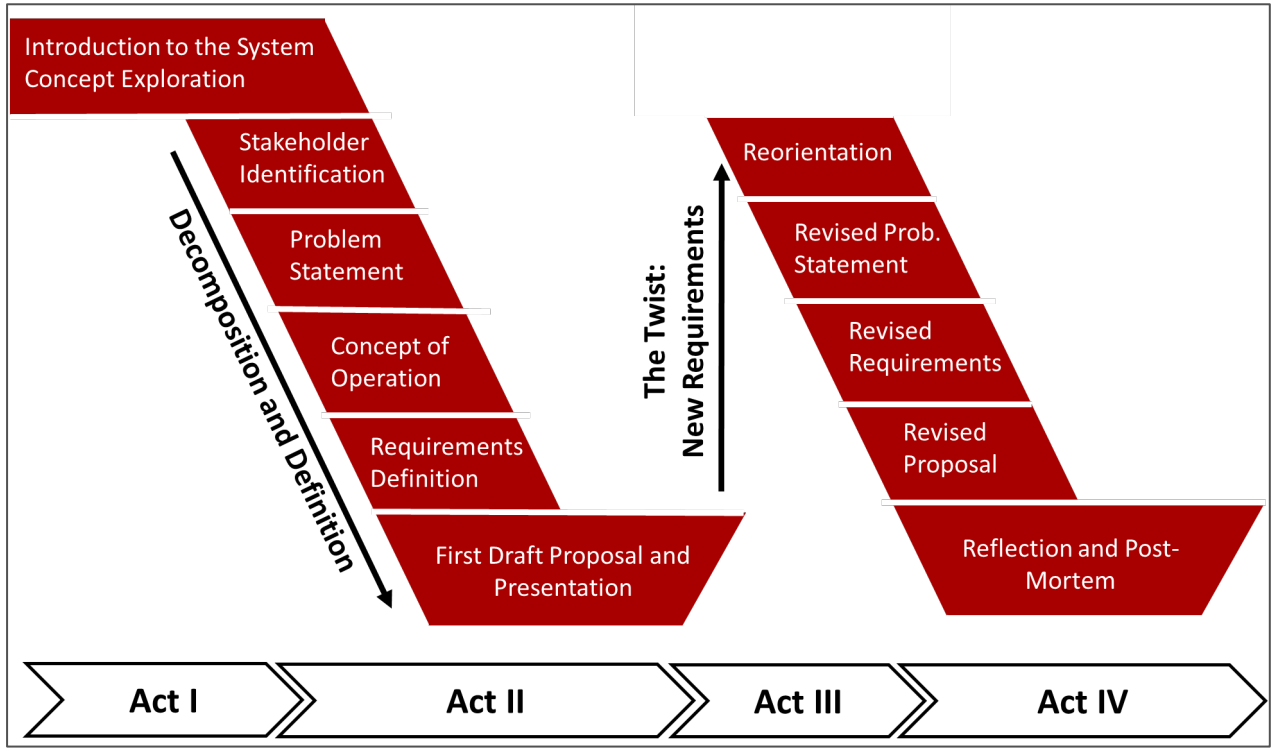
Design Challenges

1. How to generate buy-in in a classroom setting?
2. How to establish a complete fiction with limited resources?
3. How to make this experience reproducible in *any* classroom?

Design Goals

We patterned our plot on the V model.





[Federal Highway Administration, 2013]

Finalized Scope Summary

Deliverables: 4 key milestones (aligning with the ARG acts)

Executing story beats and actor communications in SYS 501

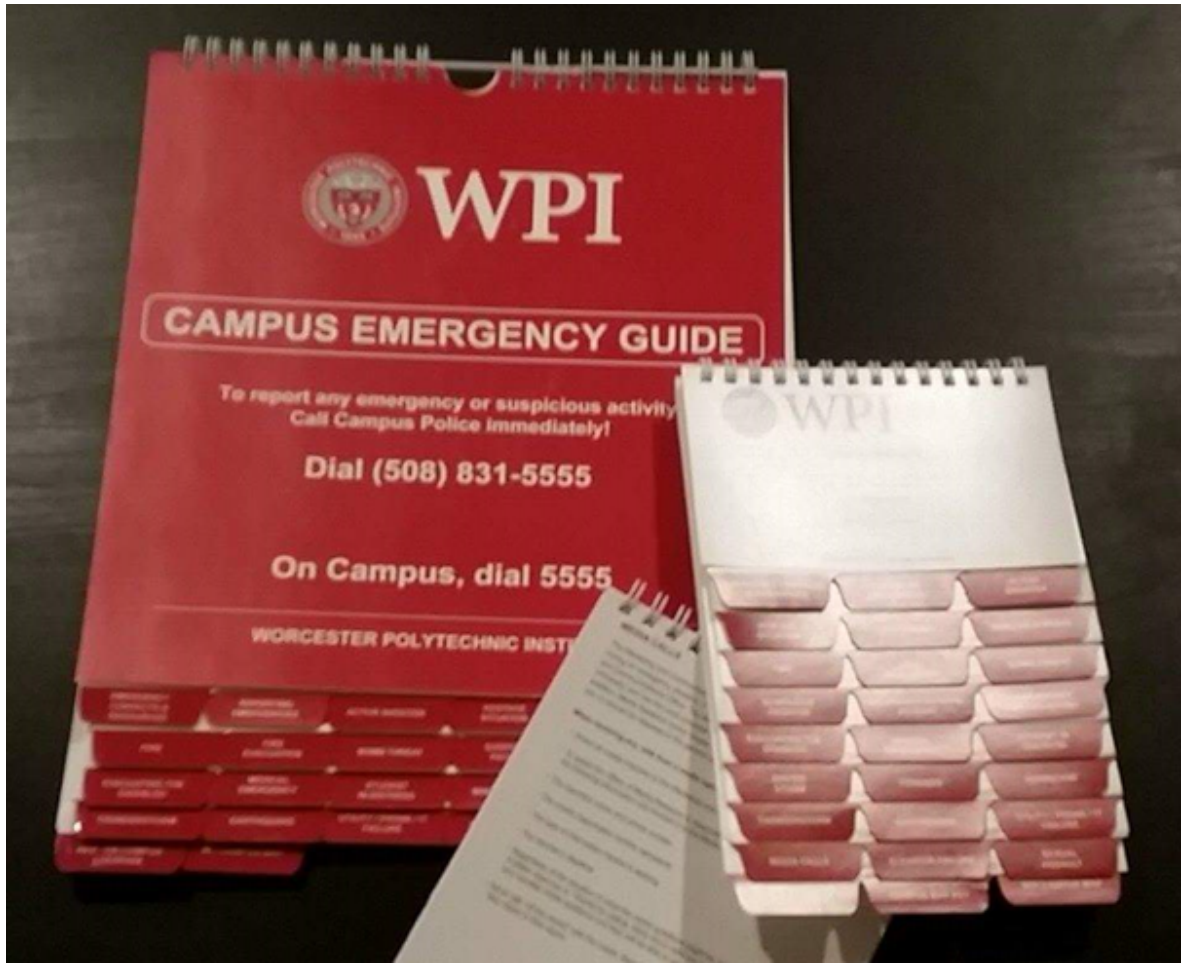
Implementation in the Classroom

ARG Materials

Students were given information mocked up and distributed as realistically as possible.

Real World Materials

Students also received tactile materials for realism and research assistance.

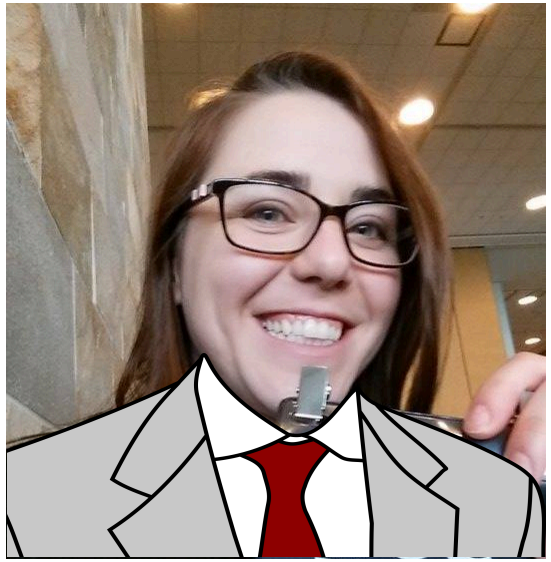


Actors Portraying Stakeholders

ARG used three in-class actors; the game master (me!) answered emails.

Prof. Dean O'Donnell

Klew Williams



Keenan Gray

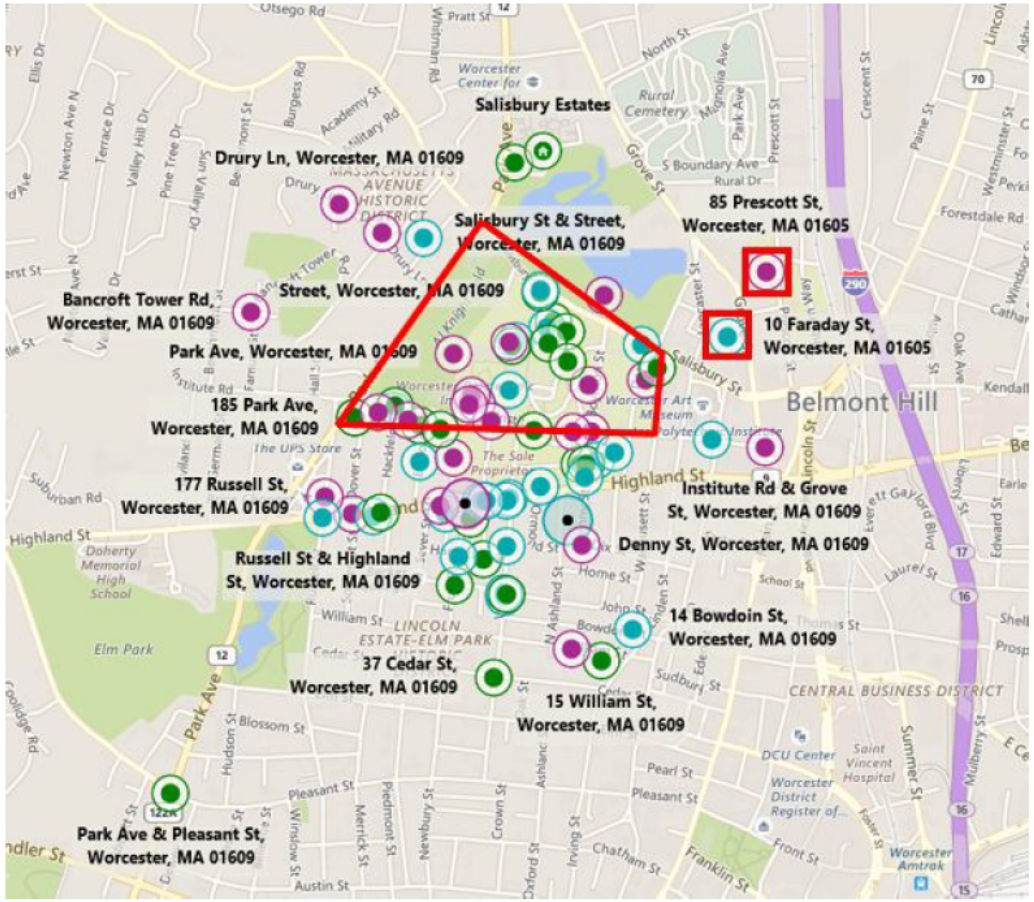
Data Collection Points

- Assignments (Group)
- Surveys (Individual)
- Post-Mortem Essays (Group)
- Post-Mortem Discussion (Class)

Student Work Examples

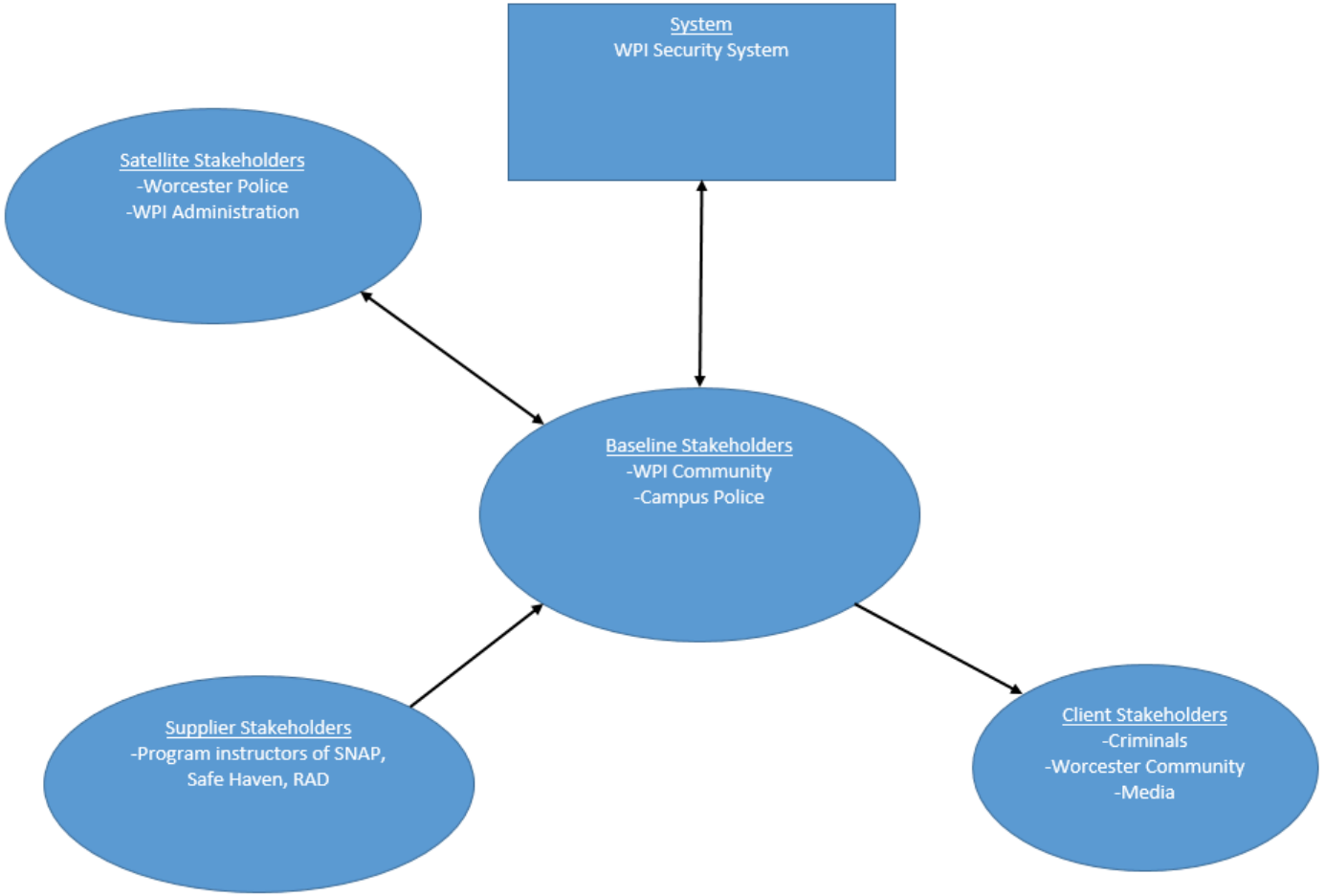
WPI Criminal Activity

- 1.33 crimes/month [1]
- Off-campus: 48 of 80 (60%)
- Not considering 5 vacation months
- Only considers crimes that meet Clery Act
- Many on-campus crimes were from WPI students



Criminal activity of the WPI area [1] (red denotes on-campus area)

Student Work Examples



Student Work Examples

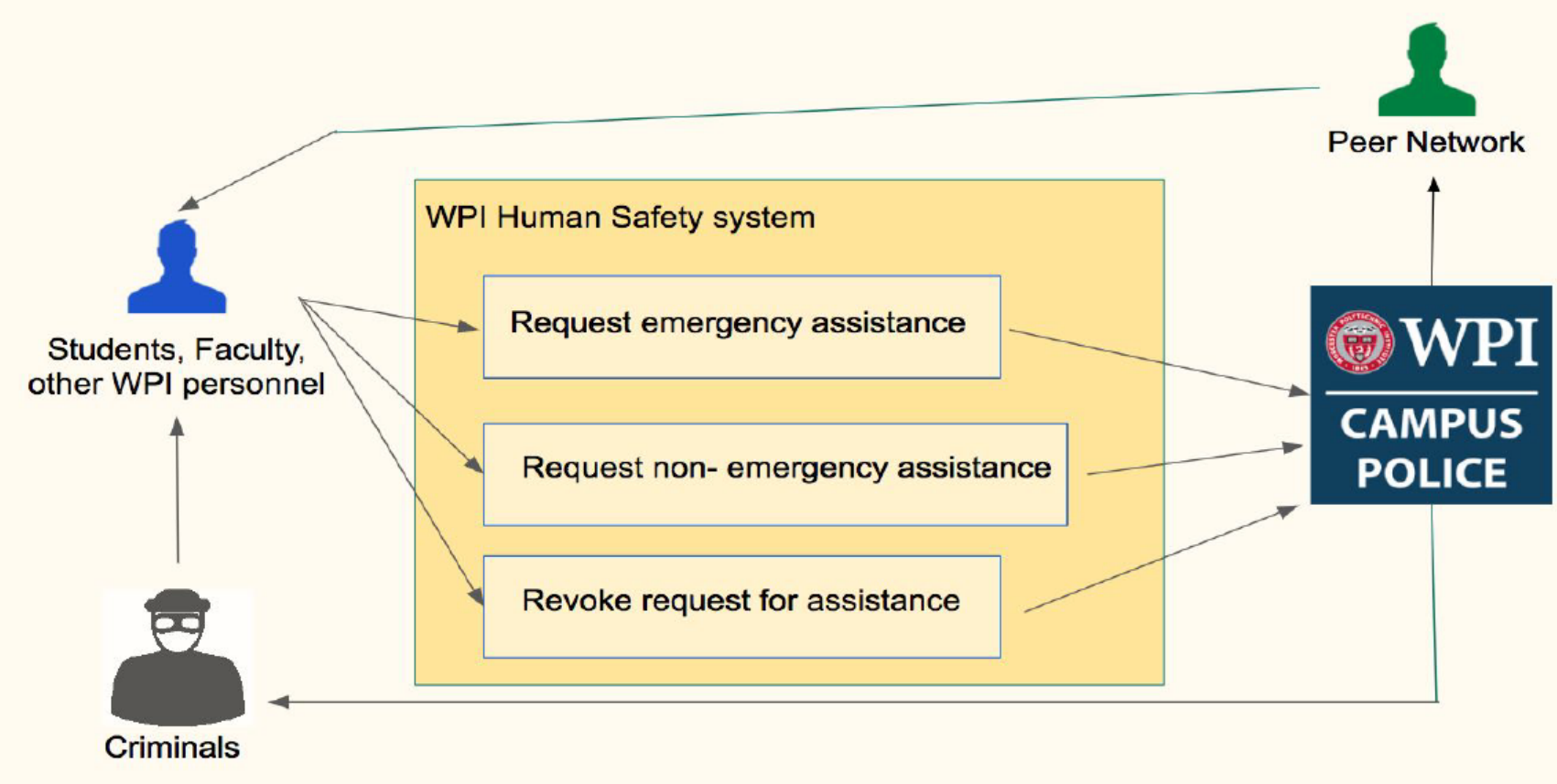
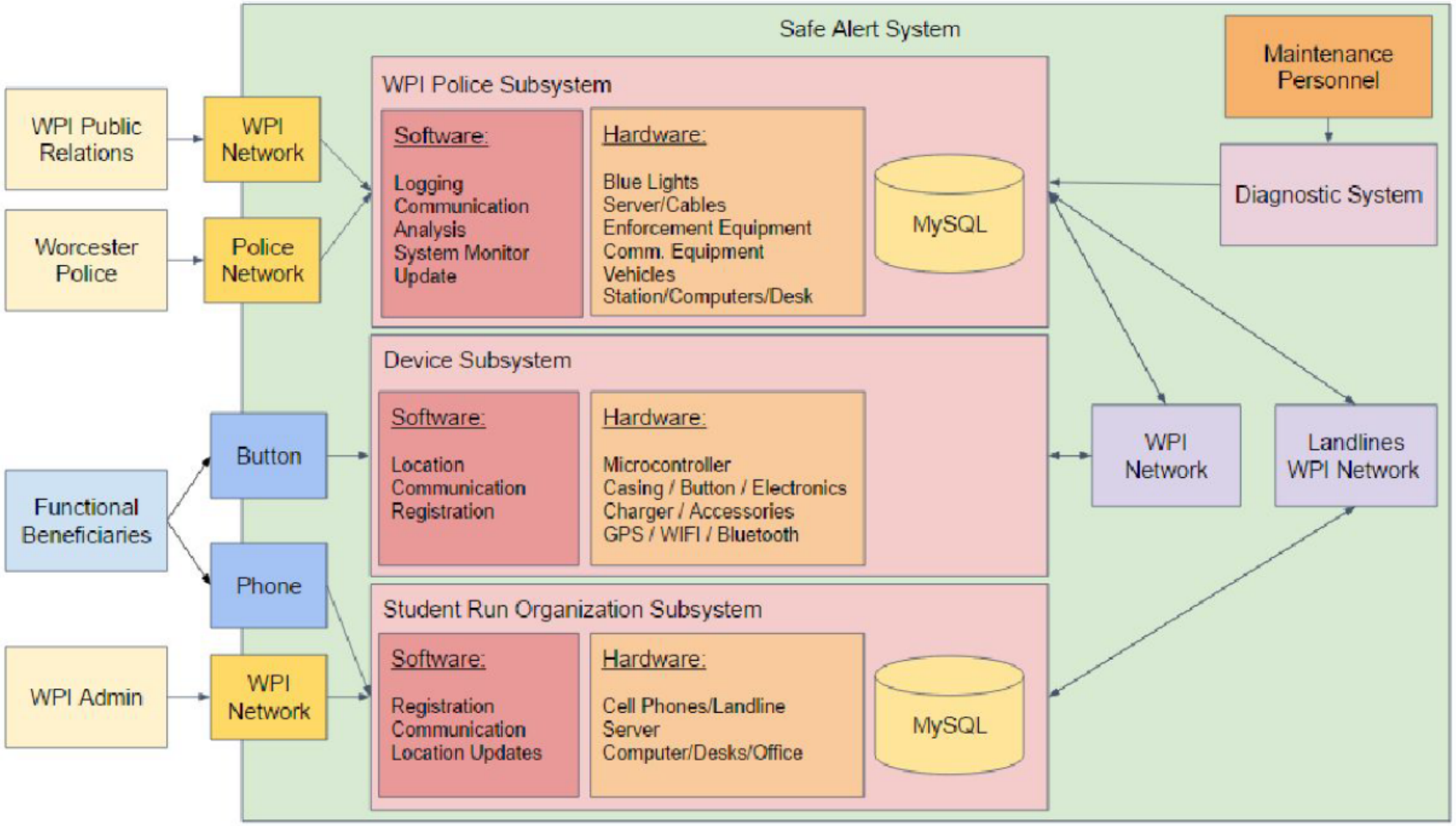


Figure 3.3. Use Case for the WPI community.

Student Work Examples

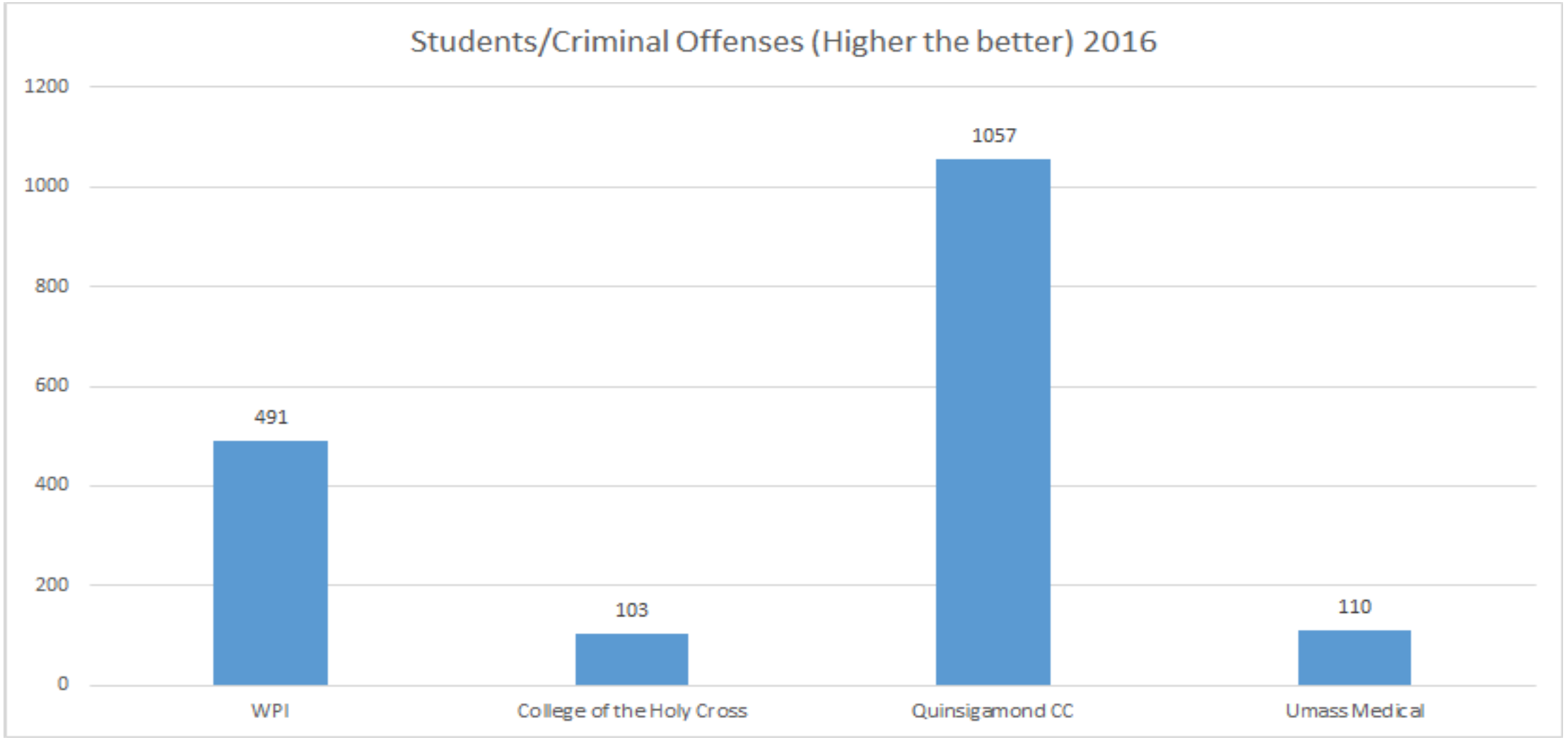


Feedback, analysis, and recommendations for the future

Results and Lessons Learned

Results by Learning Goal

US Department of Education



Results by Learning Goal

"Yeah, it was kind of like the new information was like, 'We have this new really important thing for you to do that's a **subset of what we already told you to do…**'"

Results by Learning Goal

Criticality				
	High	Student volunteer could get killed	Attacker infiltrates student group	
	Medium	Student volunteer could get hurt Malfunctioning device burns	Prank emergency calls	Phone number taken / Privacy
	Low	Location and ID information stolen		Increase of tuition
		Low	**Medium**	**High**
		Likelihood		

Figure 3.5. Risk analysis resulting matrix

Results by Learning Goal

"So I felt like it was, it probably very instructive to have this be such a human-focused system rather than a mechanical system. But it made it hard to apply things we learned in class….And **bridging that gap was hard**."

"It was sometimes h**ard to tell when something wasn't a requirement** because none of the stakeholders felt strongly about it and when it wasn't a requirement because it hadn't been developed as part of the game"

Highlighted Feedback

- “I don’t really feel that it had much of an impact on group dynamics.”
- “So, you know, security systems aren’t like a glorious fun thing but it’s something you could actually solve, and we could see, we can use some of the things we learned from Systems Engineering to apply to something more real.”
- “No effect, I did not look too deeply or question the validity of the scenario or data that we were given, I wanted to focus more on developing a system that met the needs of the scenario” – example of pushback

An Unexpected Lesson

Key Takeaways

1. Actors: early and often
2. Scenario rooted in reality
3. Invest in acclimating students to the conversation