Augmented Reality for Learning:

A DBR journey through making and playing AR games

The Radix Endeavor

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THE EDUCATION ARCADE

the education arcade

MIT OFFICE OF DIGITAL LEARNING

How do we craft powerful experiences in real places?
How do these experiences foster deep learning?
How do you author these types of games?

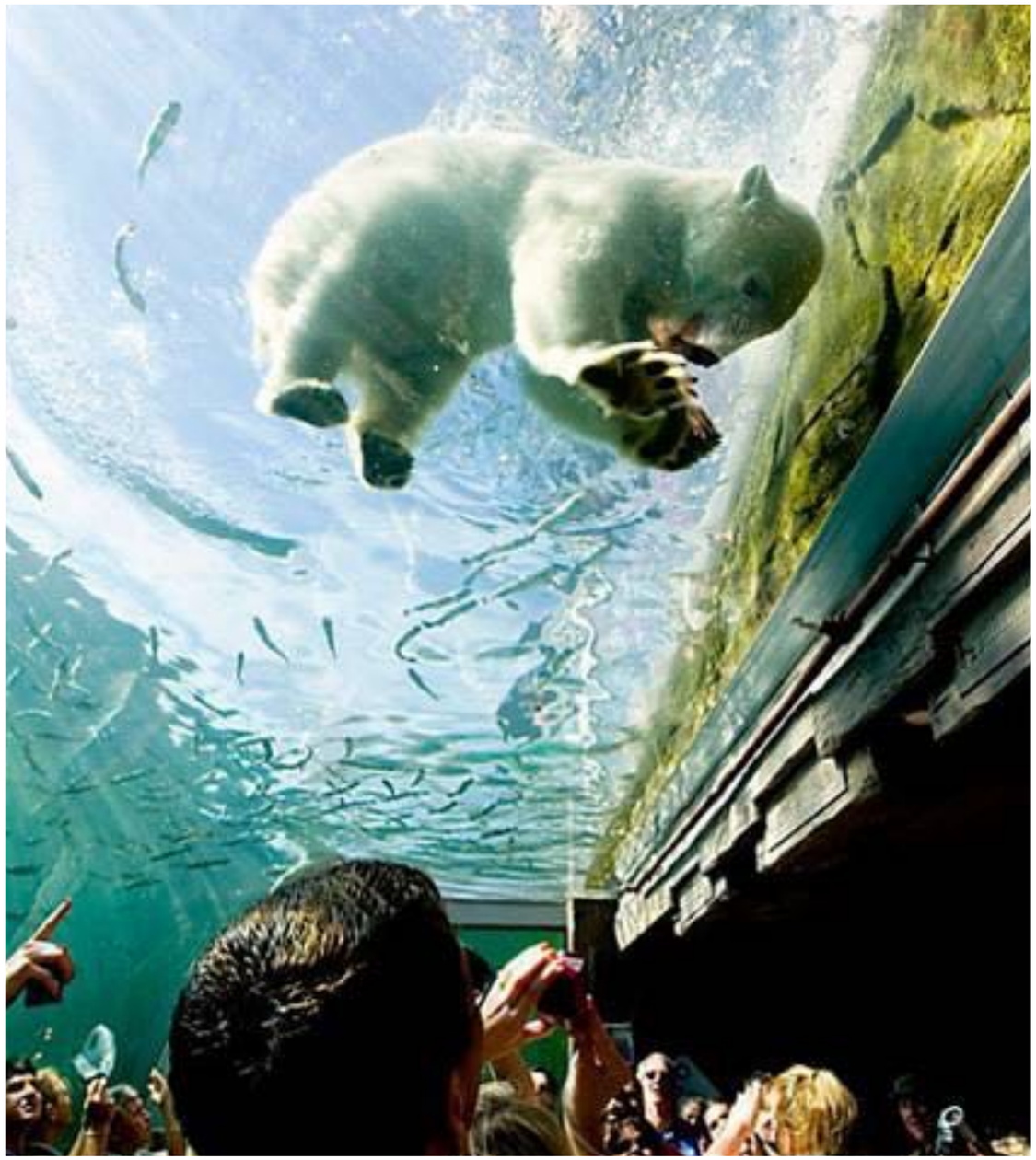


Photo: PolarBearsInternational.org

Photo: Red Butte Botanical Garden

Two Goals

PLAY GAMES

Games played by visitors/users/students

Goals to learn content, explore a physical space, foster collaboration

– E.g., Field trip to Zoo, visitors to living history museum

MAKE GAMES

Users design and implement AR games

Learn design process, coding, content

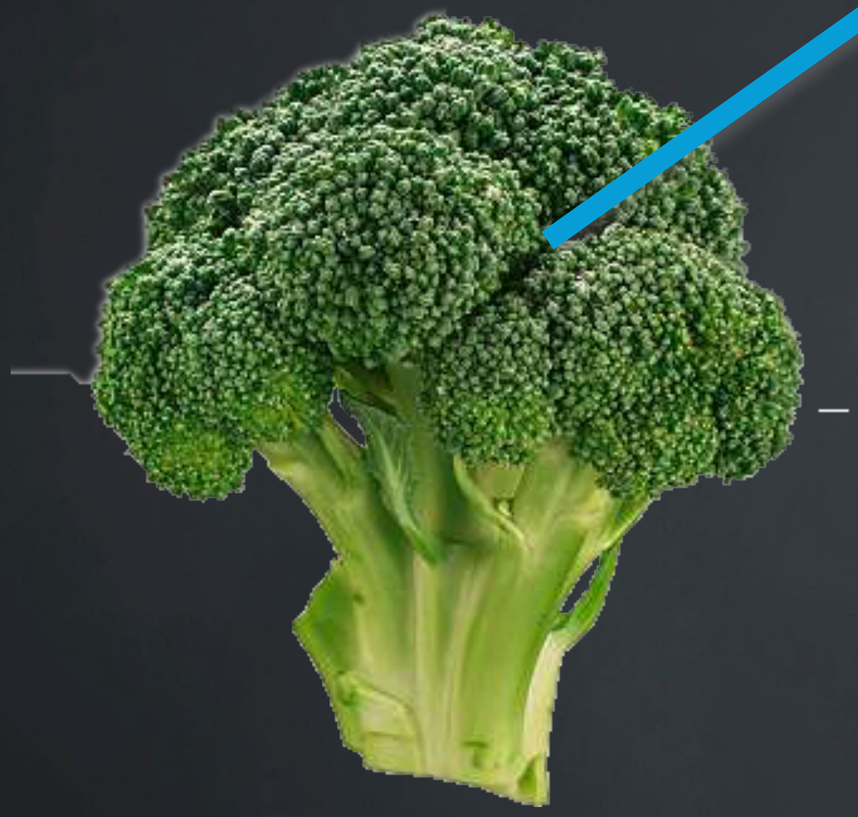
– E.g. schools, after-school/summer programs

Learning? Games?

The Legacy of Math Blaster

Edutainment

–Where play is the **reward** for learning



The Legacy of Math Blaster

Edutainment

- –Gets kids to eat broccoli
- –But doesn’t promote healthy eating
- –What happens when the chocolate goes away?

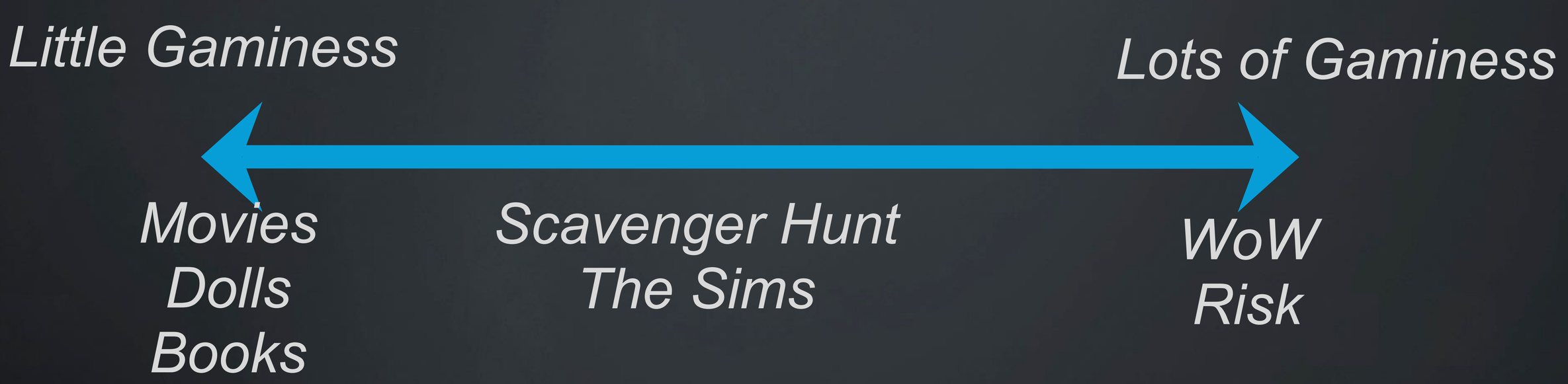
The Joy of Gaming = Hard Fun

Gaminess

Why games?

What features are important to ***structure*** games?

- Interesting **decisions** (*Sid Meier*)
- **Consequences** to decisions (*+/- value*)
- Clearly defined **goals** (*rules/constraints*)
- Visible measurable **feedback** (*quantifiable outcome*)
- Underlying **model**/system (*coherent system of rules*)



The Fun of Structure

Structured, goal-oriented, feedback-driven can be fun

In games we willingly submit to arbitrary rules and structures in pursuit of mastery, but only if we can continue to be playful.

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Resonant Games

- Design for the whole learner
  - Resonant design must begin with seeing the whole learner.
- Design for communities
  - Resonant design factors the sociality of learning and the sociality of play into our projects. Design for knowledge, skills and practices
- Design for Knowledge, Skills and Practices
  - Resonant design takes the connection between learners and knowledge, skills, and practices very seriously.
- Design for society
  - Resonant design honors the fact that knowledge and skills and the players we are trying to enchant and educate are all part of society, as are the relationships between players.

The principle of cultivating player identity
The principle of scaling across time, space, and users
The principle of preparing for future learning
The principle of deepening complexity
The principle of guiding reflection
The principle of providing multiple pathways
The principle of constructing knowledge socially
The principle of creating a strong narrative
The principle of providing authentic contexts
The principle of making space for imagination
The principle of designing systems for exploration
The principle of working within an educational system
The principle of providing professional development
The principle of making curricular connections
The principle of creating a culture of inquiry
The principle of integrating with your life
The principle of connecting data to practice
The principle of designing adaptive experiences
The principle of codesigning with educators
The principle of working with the right partners
The principle of facilitating lifelong learning
The principle of fostering communities of practice
The principle of applying skills to daily life

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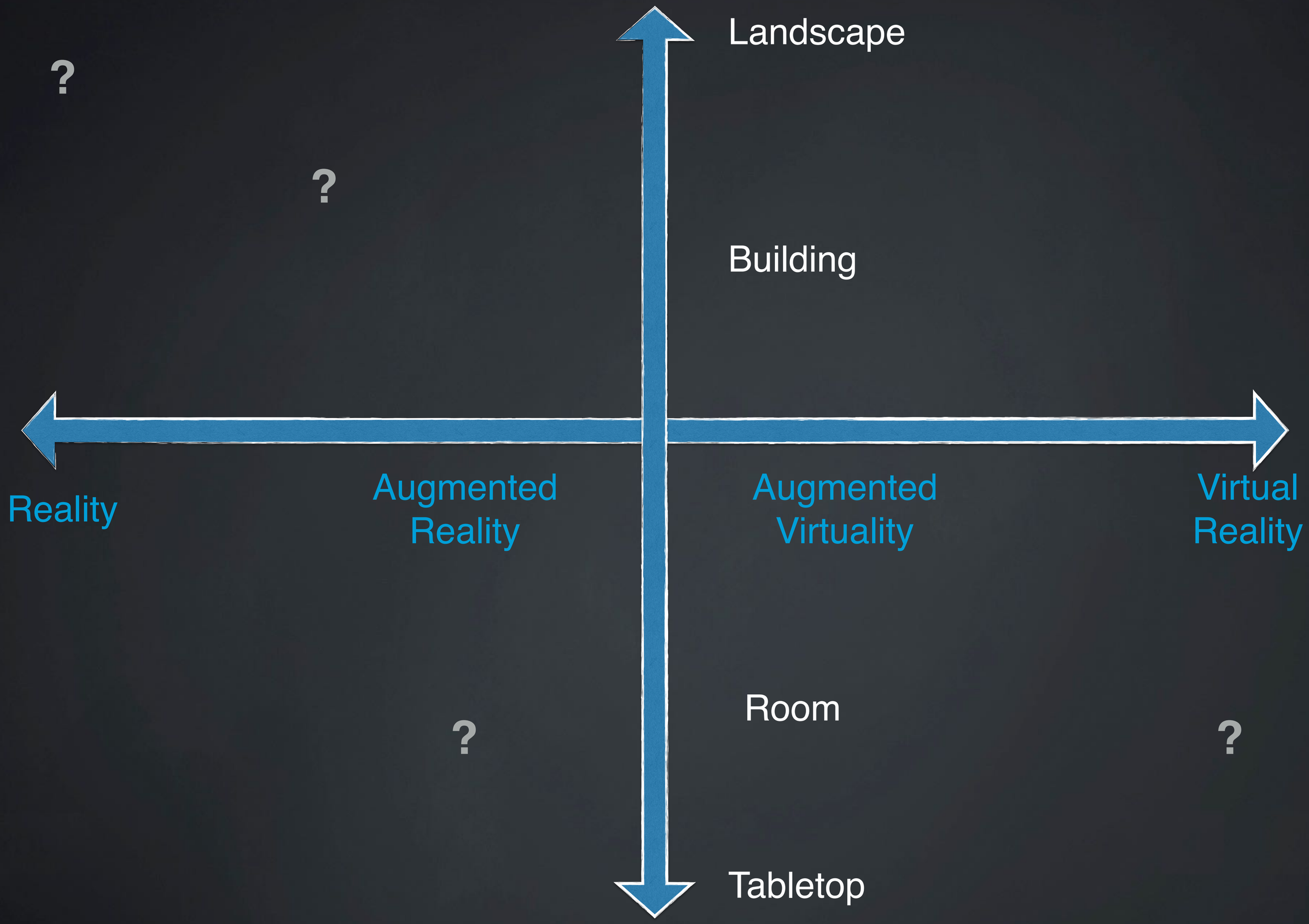
Mixed Reality



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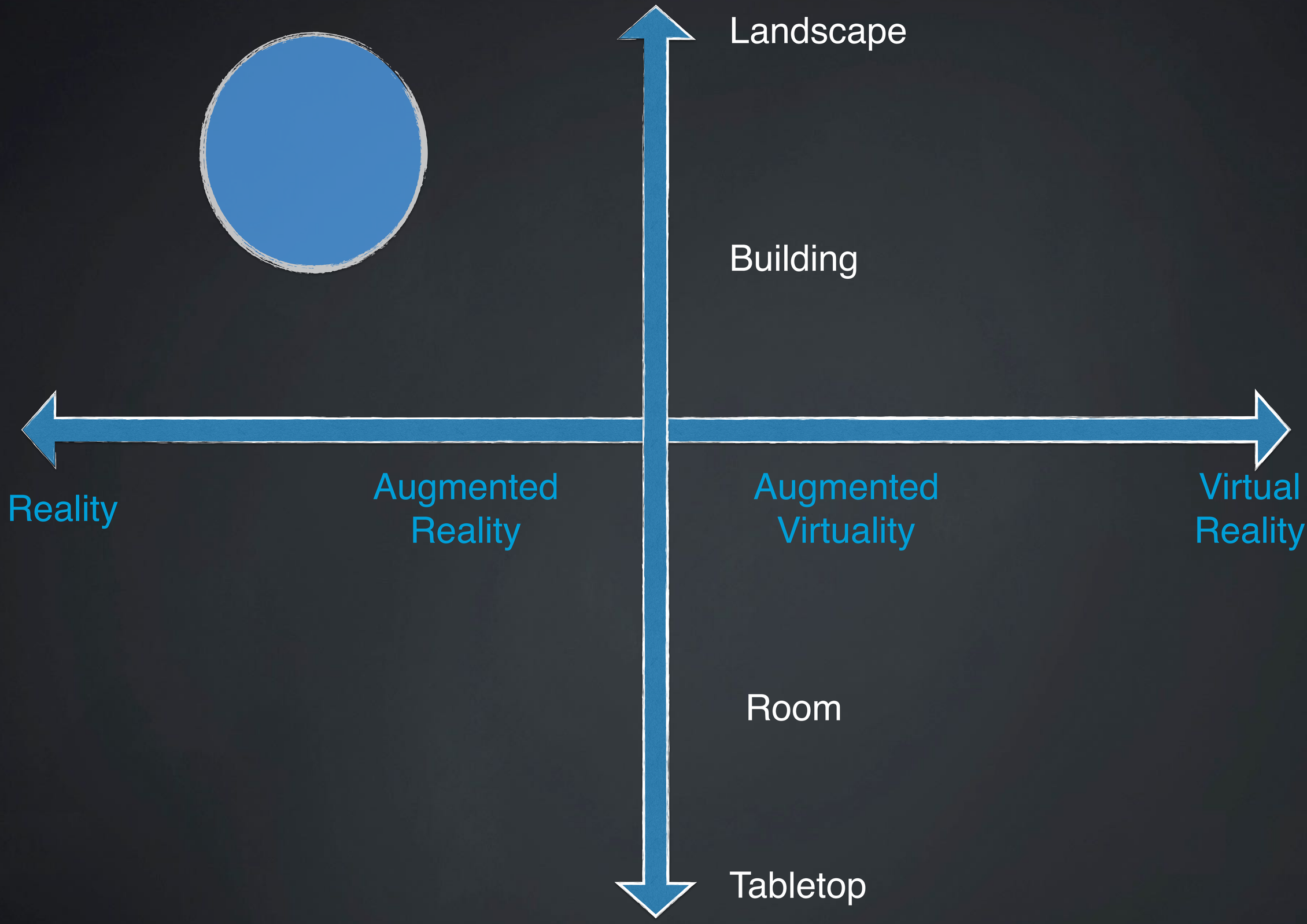
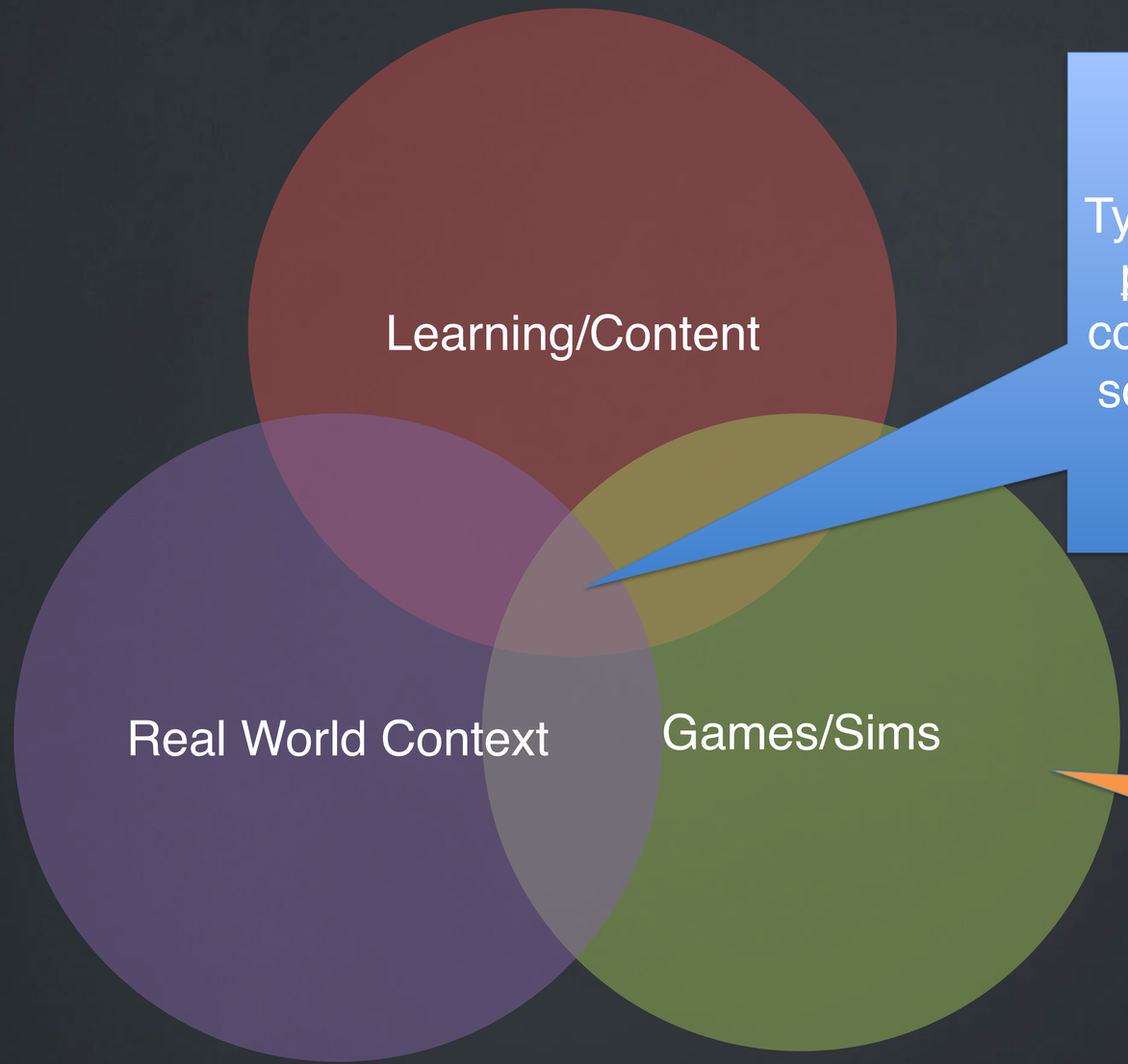


Augmented Reality

Computer simulation on mobile device triggered by real world context



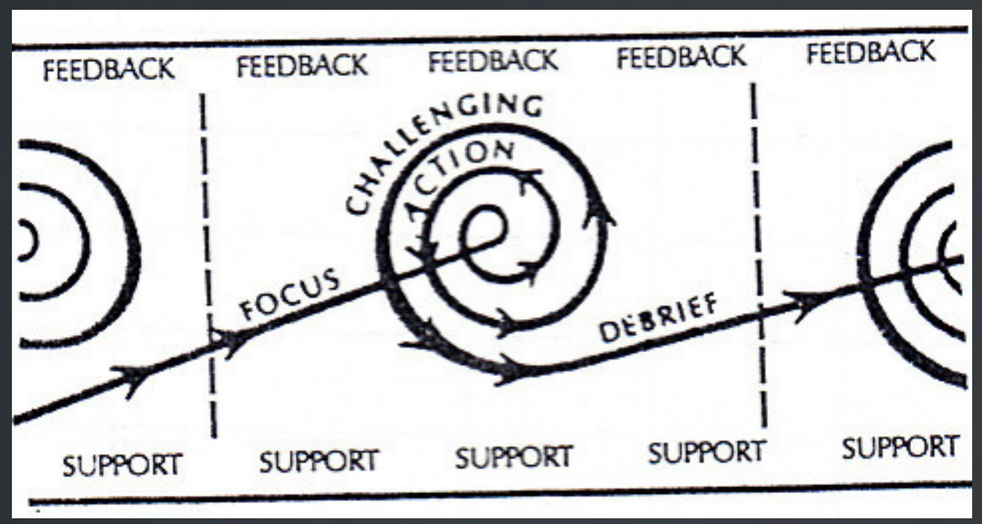
Typically played on smart phone or other mobile computer (GPS) in large-scale real world location

Why games?

Learning

Action Reflection Cycle

Experience



Resources ⟷ **Reflection**

AR: Environmental Detectives (circa 2001)

Scenario - Determine source and course of action for chemical spill.

Result - Many solutions were “socioscientific” in nature combining digital/real and social/scientific considerations.

BUT when students are disconnected from context it was about “collecting dots”.

Collecting Dots

Driving Questions

How do we connect the real and the virtual successfully?

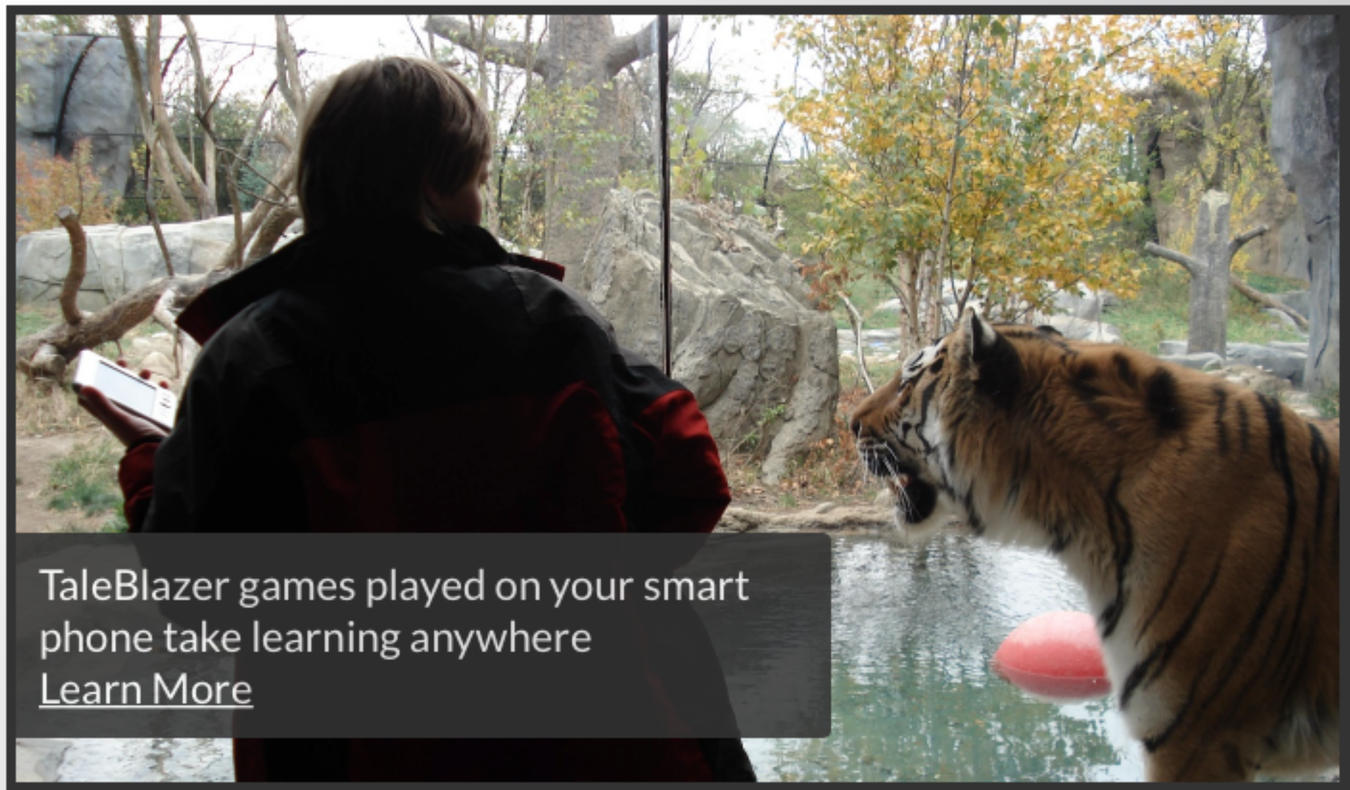
How do we connect people to the real context (and not detract from it)?

How do we make both of these scalable and accessible?

Taleblazer Mobile *Games*

TALE BLAZER

Home About Support Login | Register



Play games

Make games

Featured Partner: Explore history

iCSI Project

Play — or make your own — location-based augmented reality (AR) games with TaleBlazer for Android and iOS

Playing Games	Making Games	Using Games
How to Play	Getting Started	For Organizations
Featured Games	Demo Games/Tutorials	For Education
Supported Devices	TaleBlazer Editor	Research

TaleBlazer Client

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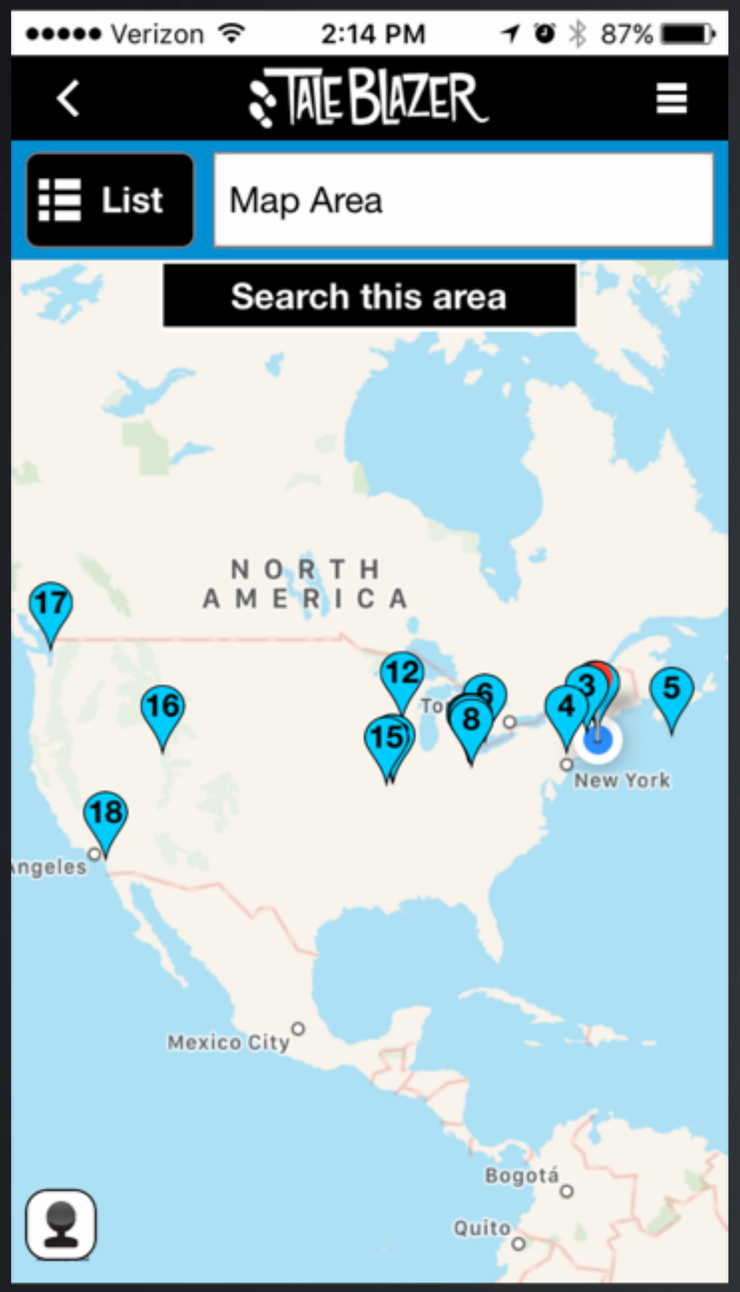
TaleBlazer “Places” – Public Games



What does this look like at Old Sturbridge Village?

And is it better than a stagecoach?

Why a living history museum?

- Rich, diverse content
  - Artifacts/architecture, interpreters & signage
- Untapped opportunity
  - Activity with right amount of “structure”
  - A “thing to think with”
  - On visitor’s schedule

Driving Questions

How do we connect the real and the virtual successfully?

How do we connect people to the real context (and not detract from it)?

How do we make both of these scalable and accessible?

“Dollars & Sense” - Economics

You: New En
making deci
prosperity

Goal: increa
debtors’ p

playful experience

roleplay, decision-making…

struggle with ideas

related across a theme

TALE BLAZER

“Dollars & Sense” Pilot Study

High school students (n=10) played “Dollars & Sense” @ OSV

– Most had visited before (some as young kids)

Played in pairs, sharing one smart phone

Field notes, Pre/Post written surveys (Likert, free response)

Post-Game Group Debrief

Idea #1: Interesting Decisions

D&S establishes a narrative context

Role-playing, Choices that matter (“sim” genre)

Multiple pathways, outcomes

Player co-create their experiences

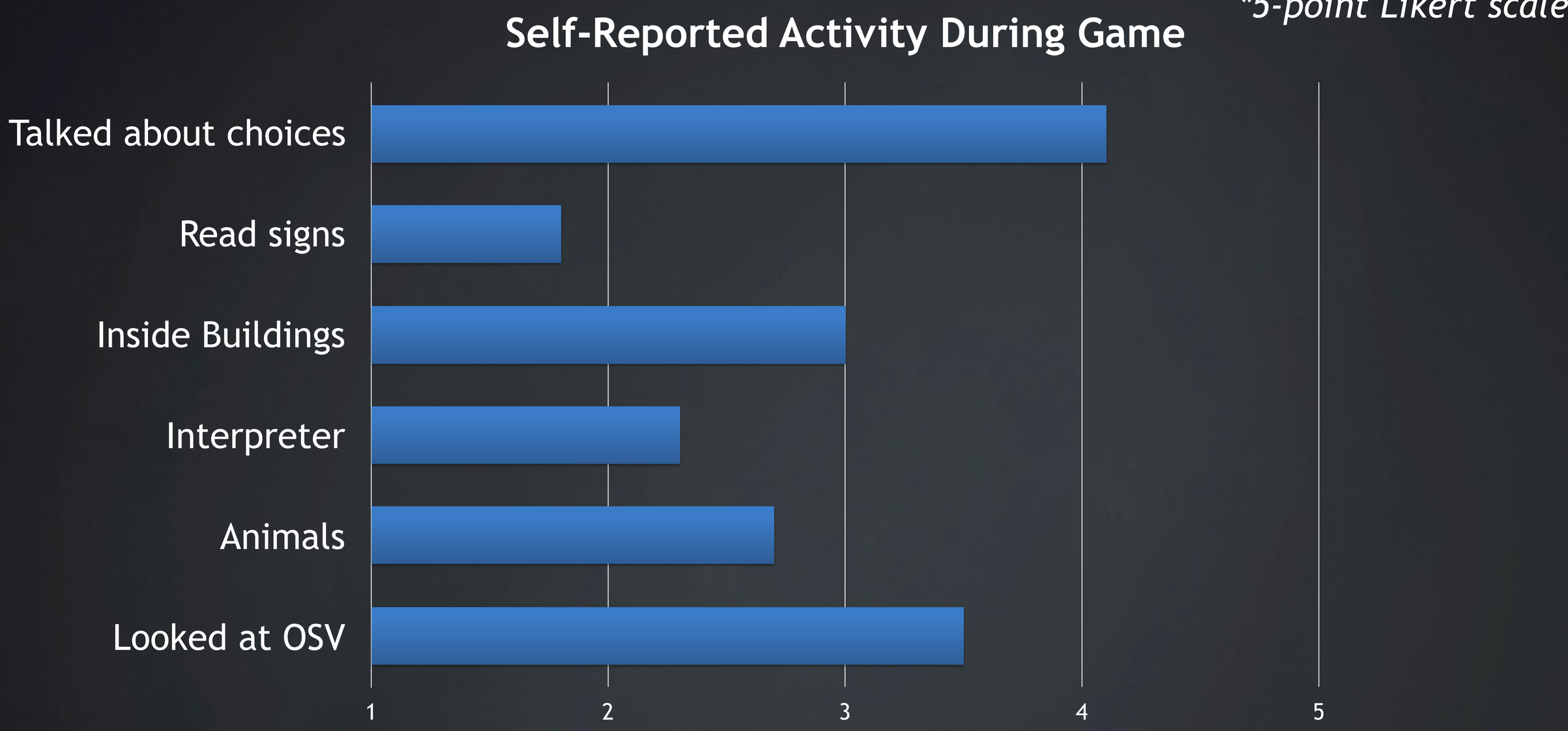
Engages players’ imaginations

Idea #2: Leverage Surroundings

- Intro prompted players to use surroundings
- Give players “permission” to go into buildings, read signs, speak with staff
- Some spoke with interpreters to get information to help gameplay
  - –But it goes both ways, environment can pull you out of “flow” of game
- Permission to wander, explore *(Osterweil’s Four Freedom’s)*

Idea #2: Leverage Surroundings

*5-point Likert scale



Idea #3: Provide Individual Agency

Give player control of his/her pace

–Emphasize it’s not a race

–Let them slow down, be present

Freedom to explore

–validating their interests,

–autonomy, ultimately empowering

Idea #4: Foster Social Interaction

Sharing, 2 players = 1 device

Cross-team comparison of outcomes

Dialogue between player and interpreters during gameplay

Future: multiplayer (one world) game dynamics

Some take aways…

foster social interaction

interesting choices

provide individual agency

leverage surroundings

Indoors - The Final Frontier

Additional Challenges: Indoor locations

Can be confusing to navigate

- *What room am I in? Where should I go next?*
- *What's in this space?*

Often densely populated

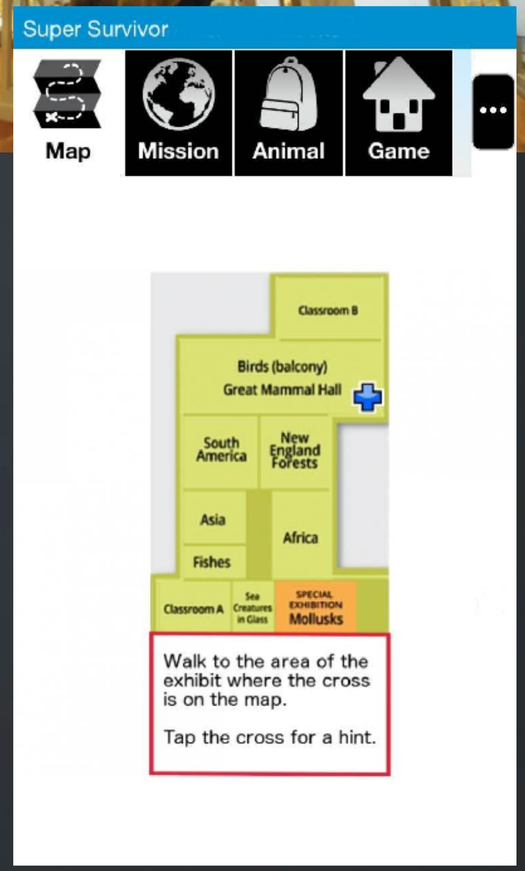
- *With both artifacts and visitors*

Hard to find specific artifacts

- *Where is the mouse deer?*

It's easy to miss details

- *A koala has two thumbs!*



Other Goals for Visitor Experience

(True for both Indoor & Outdoors…)

- Encourage synthetic thinking
  - Themes, across exhibits
- Give visitors something to “do”
  - Right amount of structure
  - (e.g., more than a scavenger hunt)
- Have fun, find value in spending family time here
  - What were their expectations? Educational? Fun?

Integration of TaleBlazer + Beacons

Provide location awareness via beacons.

iBeacons use Bluetooth

Minimal visual clutter (proximity based, can be hidden)

Relatively portable (battery powered)

Relatively affordable ($30/ea and getting cheaper)

Integrated beacons into TaleBlazer, including Technical Proof of Concept.

Pilot Game: “Super Survivor”

Created TaleBlazer game (including internal pilot)

Three galleries (+ start area)

Tutorial + 4 “nodes” + conclusion

Assigned 1 (of 3) biomes

Tasked with modifying fictional creature’s features to best survive threats and challenges of that biome

Pilot Game: “Super Survivor”

Example: Find ‘landmark creature’ (lion cub)

Look at three nearby creatures paying attention to their teeth.

Which teeth do you want for your creature?

– *(Added ability to change mind, based on feedback)*

Methods

One Saturday, 9 families (across 3 sessions)

Kids ages 6-12 and accompanying adults

  –Shared 1 loaned device among small family groups

Data:

–Observation protocol (room, level of engagement, field notes)

–Written post-survey (completed by families)

–Focus groups, semi-structured (notes)

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TaleBlazer's Second Goal

MAKE GAMES (cont'd)

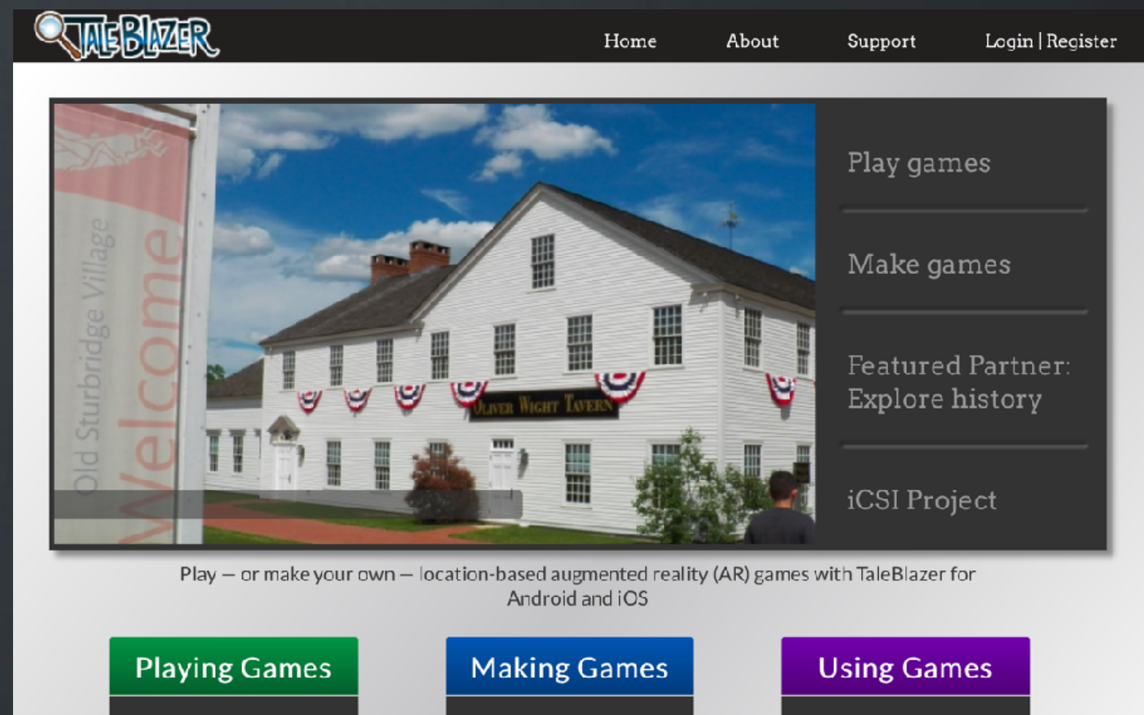
-Student voice, collaborative design

-Creative / STEAM

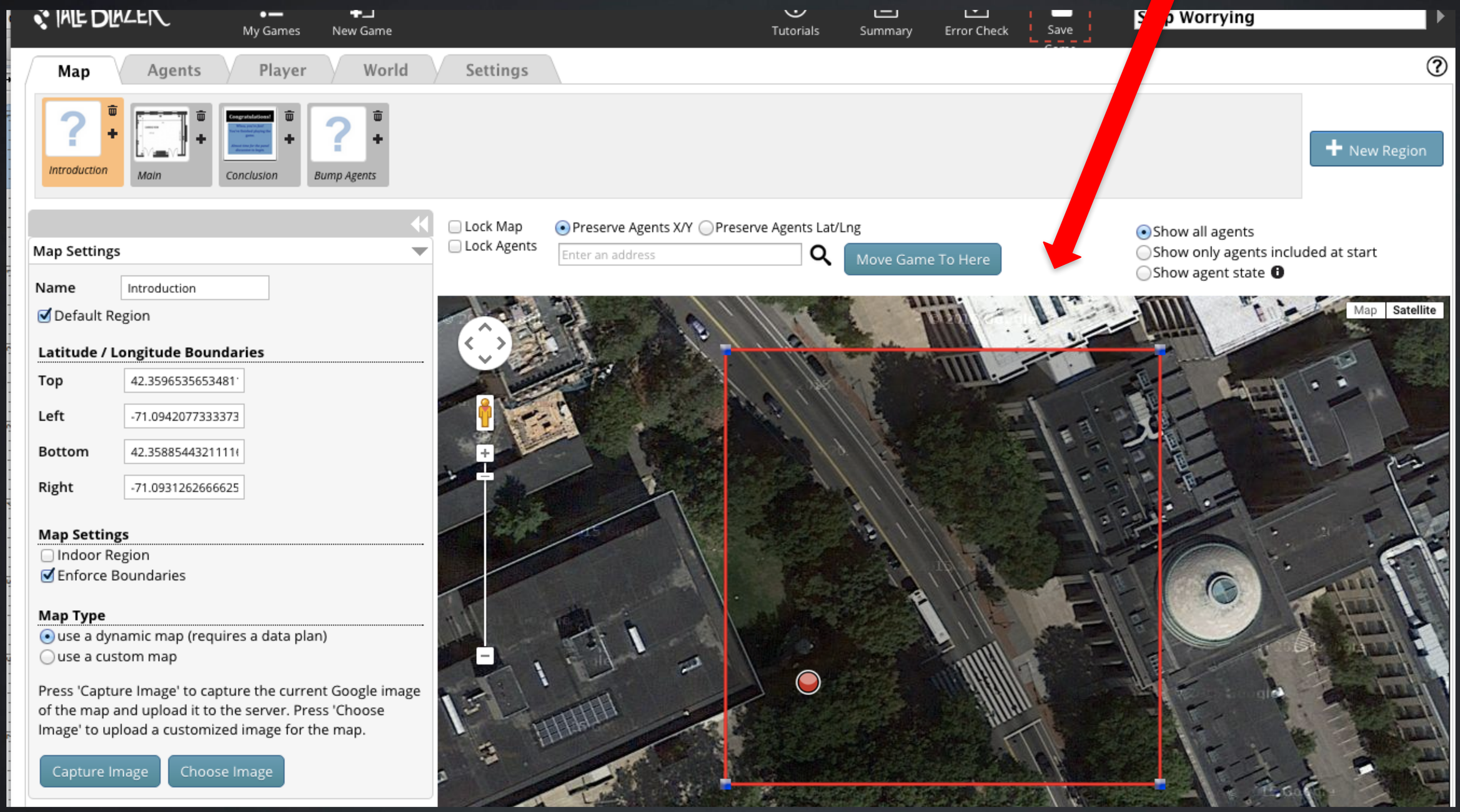
-On-ramp for programming

-Related to Scratch, StarLogo, AppInventor

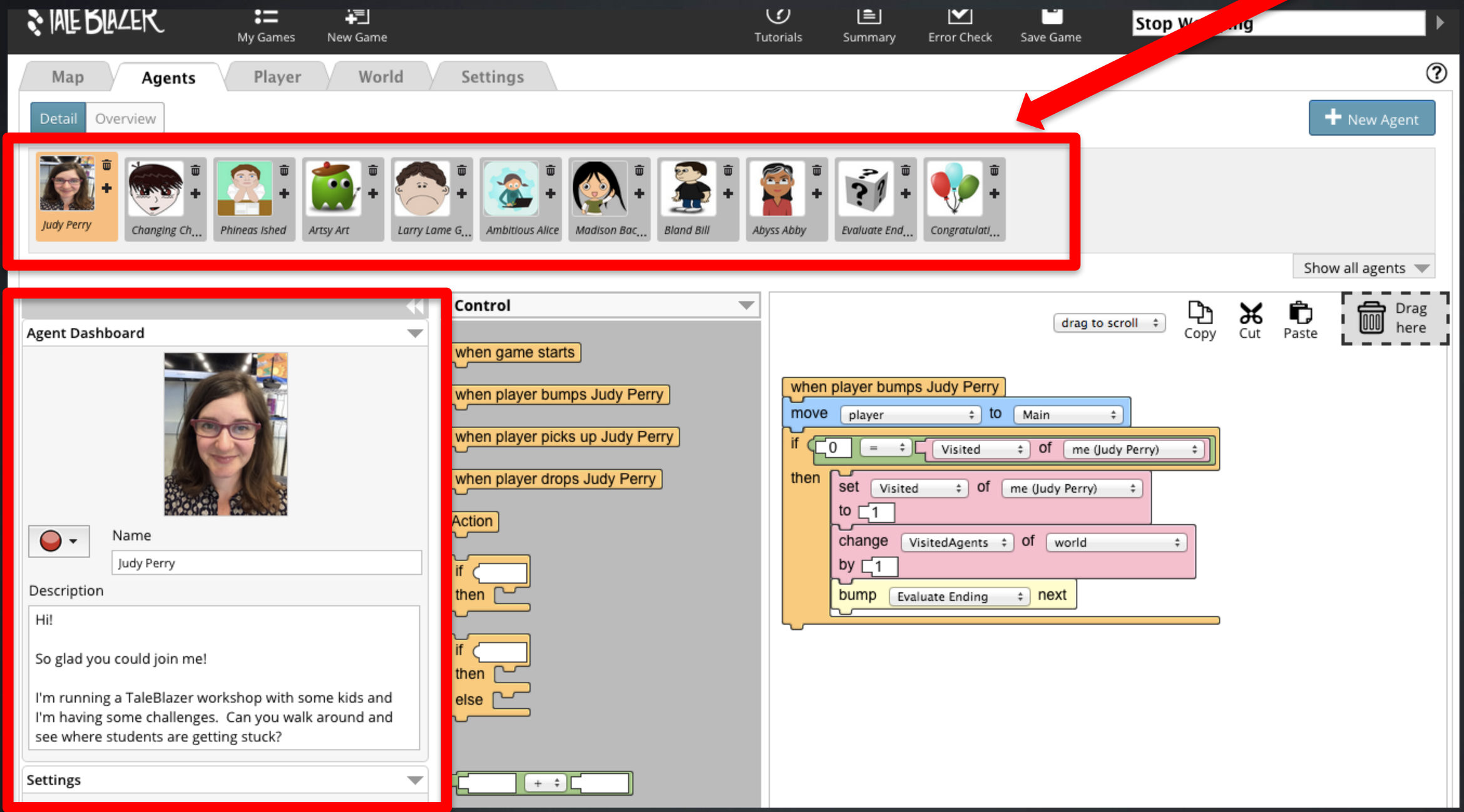
- –Block-based programming environments
- –Less intimidating
- –"Low threshold / high ceiling"



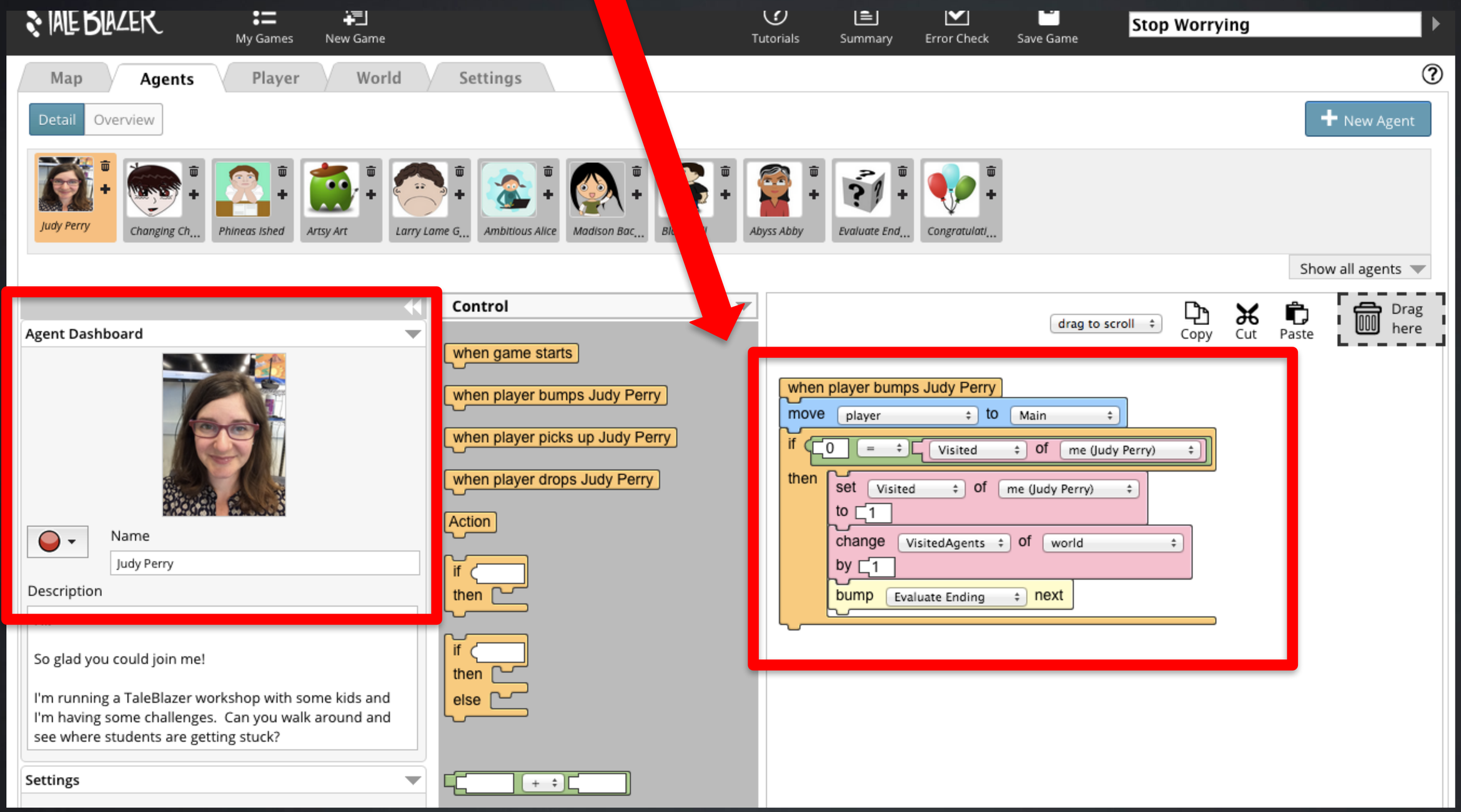
Game Editor:
Locate Your Game on a Map (Google Maps API)



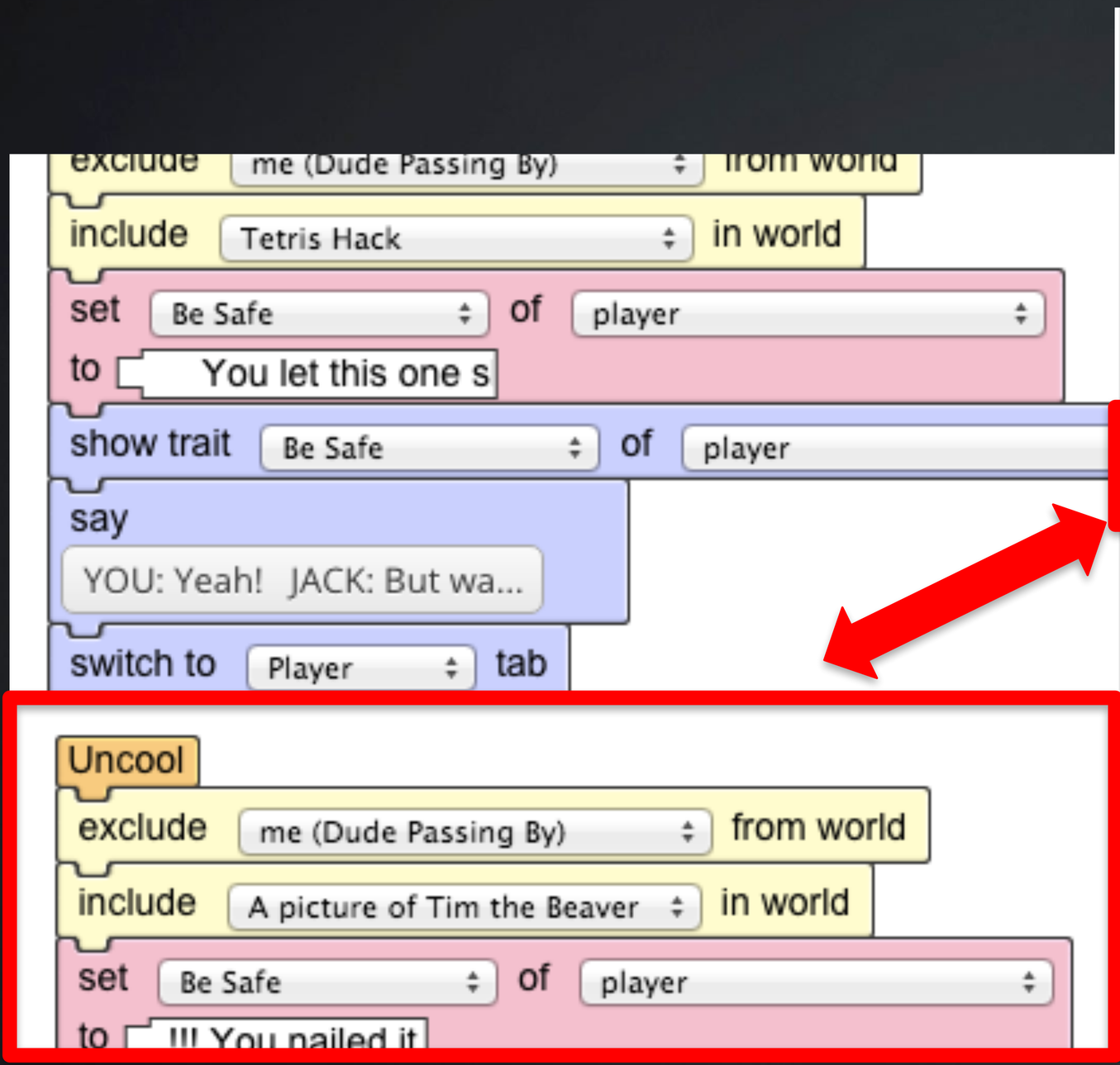
Game Editor:
Create Agents (Virtual Characters/Objects)

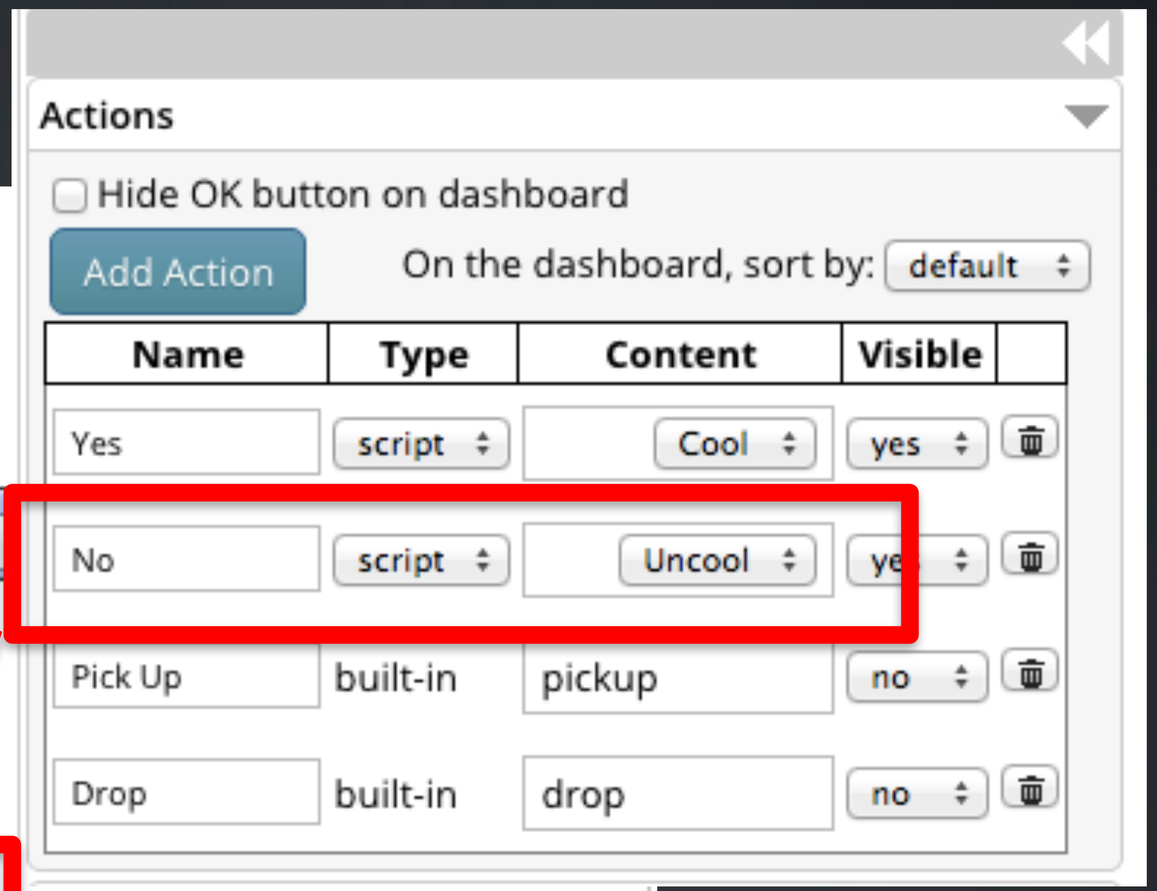


Game Editor:
Blocks-Based Scripting Creates Game Dynamics



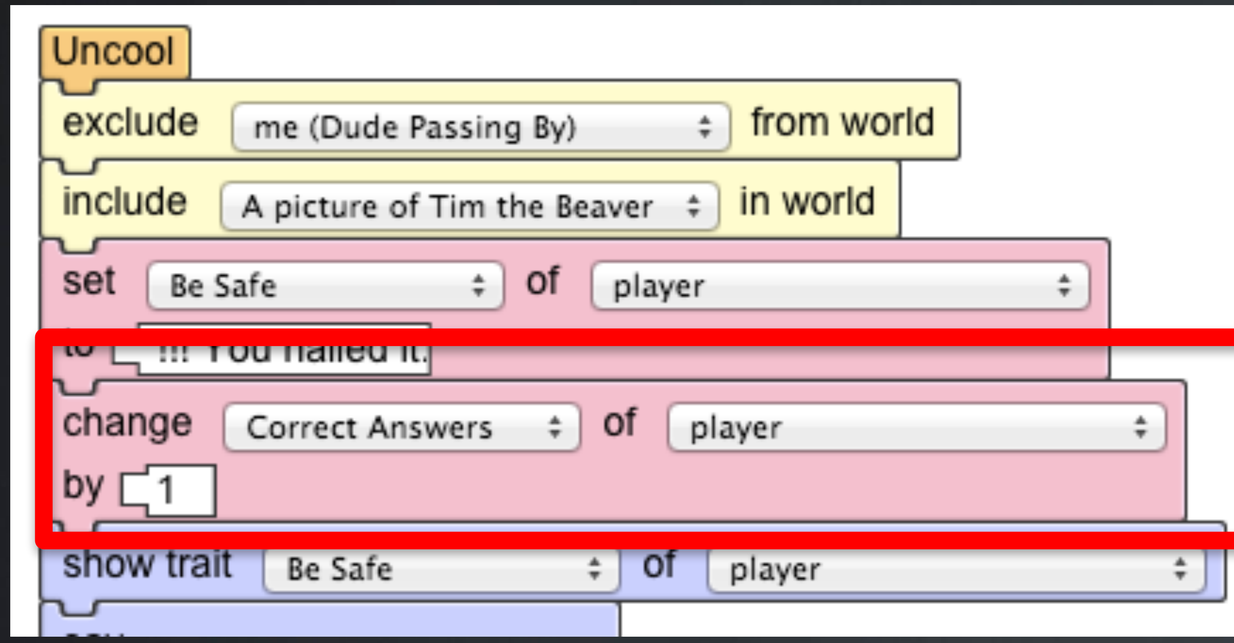
Game Editor:
“Actions” Create Interactivity & Player Choices

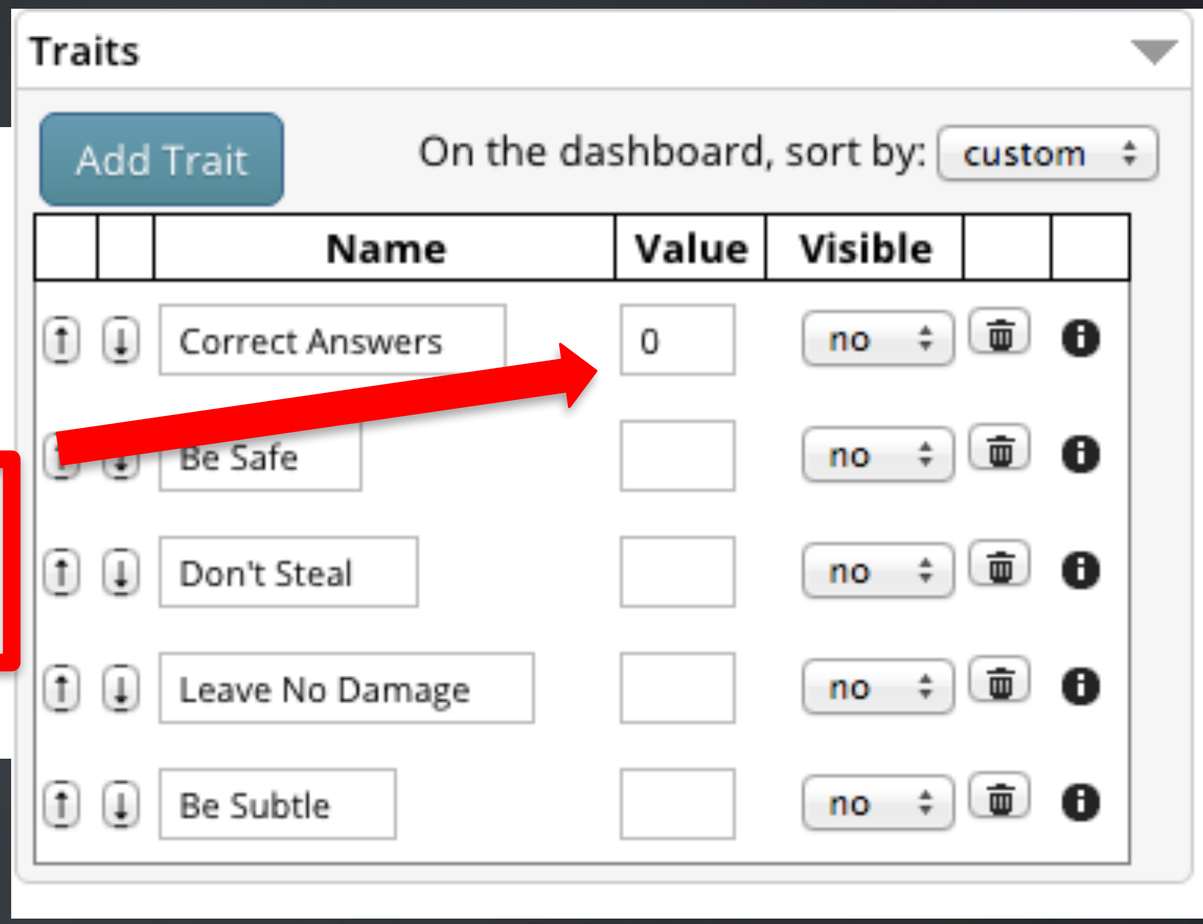




Game Editor:
Traits act as variables

Traits = Player health, score, etc.





Two examples: Youth Making Games

iCSI – STEM themed

- **Haunts** – local history

iCSI

Informal Community Science Investigators

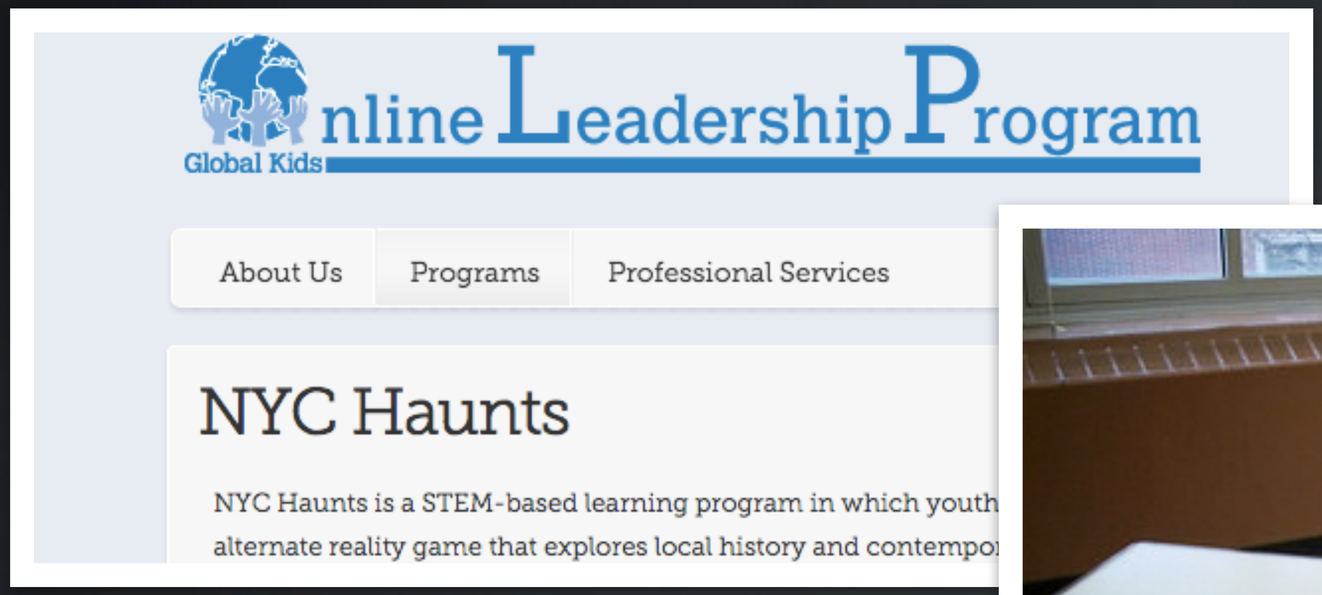
3-year NSF funded partnership between: Missouri Botanical Garden; MIT; Columbus Zoo (OH), San Diego Zoo, Red Butte Botanical Gardens (UT)

1. Engage informal visitors playing AR games
2. Tweens/teens making AR games (summer camps)
   – Leverage AR games to promote STEM knowledge/ engagement (including technology design/authoring), showcase research, foster community engagement (citizen science), develop 21st cent. skills.

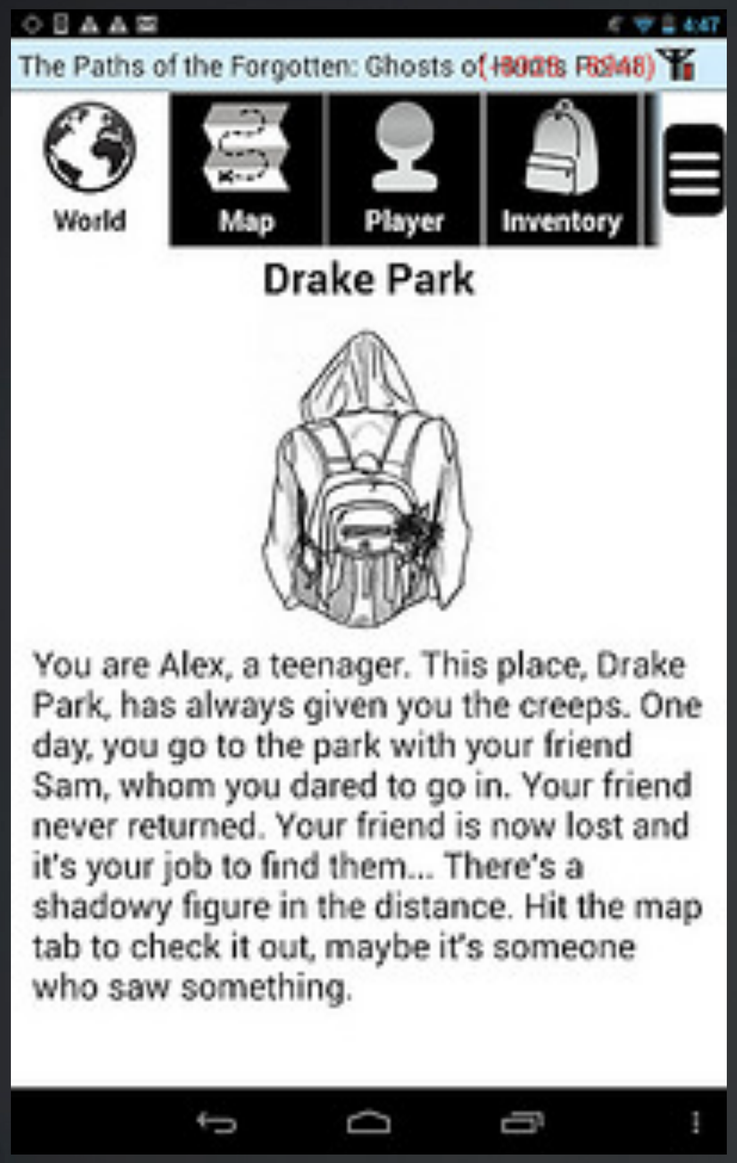
>> Successful camps, looking to extend model.<<

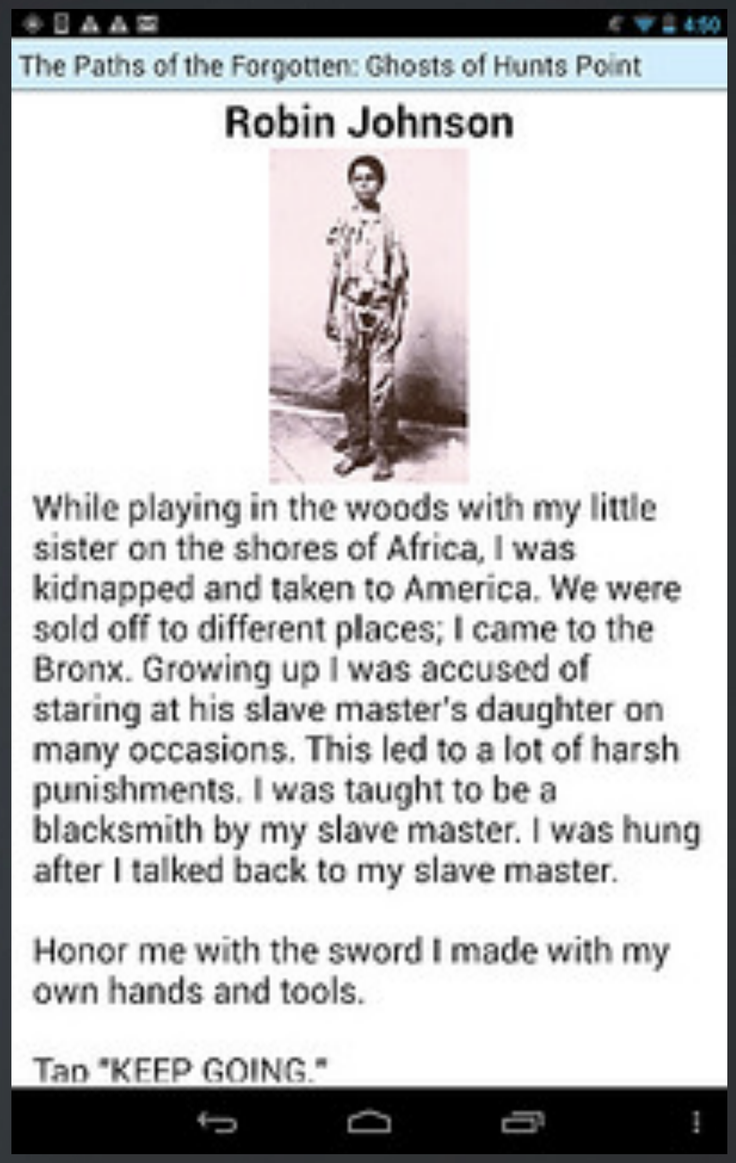
Funded by NSF ISE Grant # 1223407

Haunts: Urban Youth Making Local Games



The Paths of the Forgotten: Ghosts of Drake Park



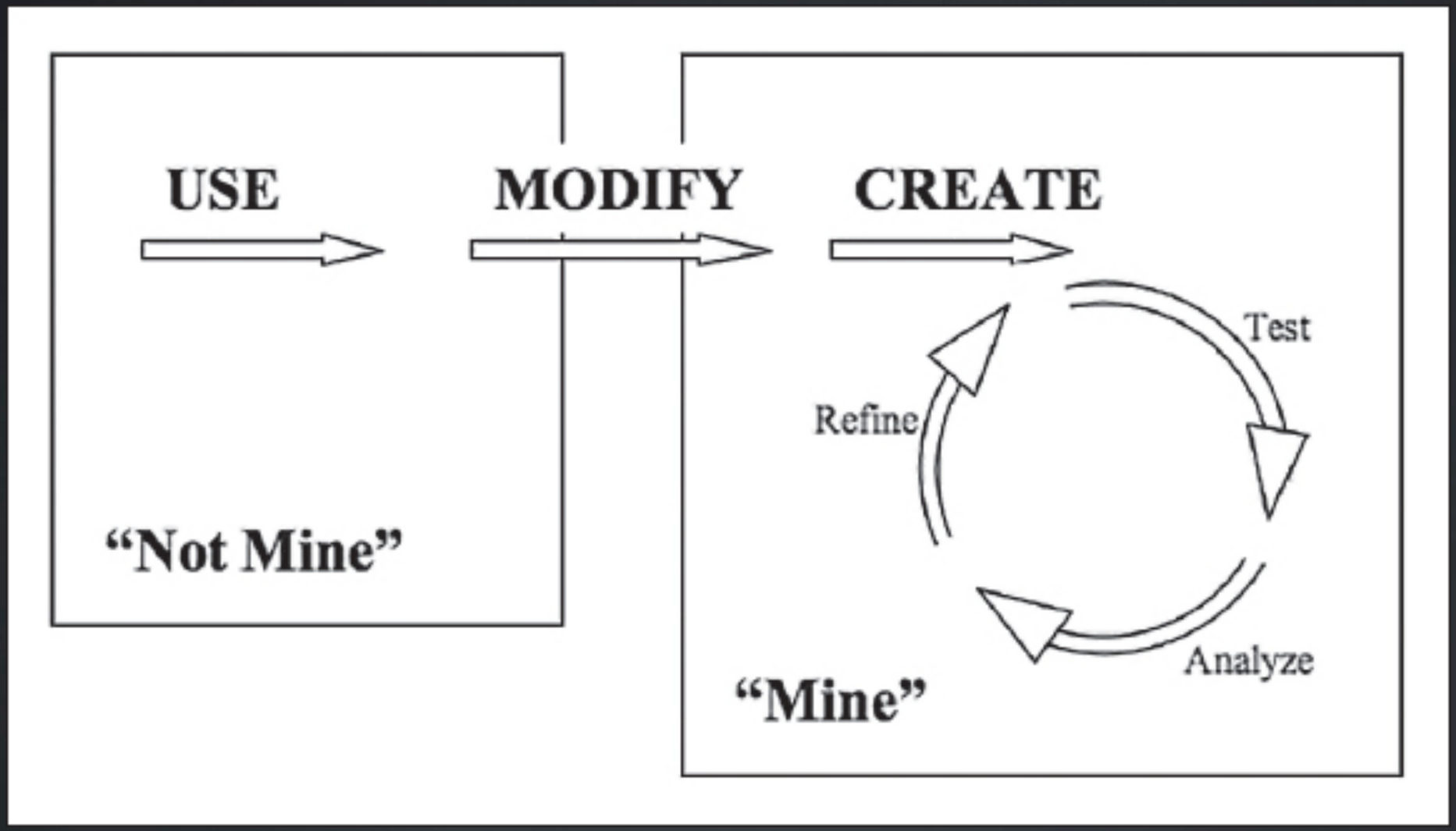


TALE BLAZER

TALE BLAZER

Missing Modify

Template games



Game X – Making “Big Issues” Local

Iteratively developed “template” game

- –Ver. 1.0 situated in suburban Boston-area town
- –Customizable to alternate urban & suburban locations

Goal: Engage youth, make “big issues” feel relevant & local

- –Youth agency > learn more, make a difference

Funded by Bryan Johnson Foundation

Game X – Making “Big Issues” Local

Proof-of-concept = Game X: Climate Change

Roleplay youth in local town, negatively affected by global climate change.

Challenged by Mayor to bring “big ideas”

Explore town, finding visible and hidden real-world and fictional objects and characters.

- E.g., EV charging stations, bike paths

Players decide what actions to take, feedback about outcomes.

(Left) Template showing Score Game structure with content; (Right) Blank version to be filled in my students to reuse/adapt game architecture to new content.

Introduction

You are an alien explorer sent by your people to explore the planets around Alpha Centauri.

Game Goal

Find enough of the right fuel to get to Alpha Centauri and back home.

Agent 1 — Greeter

(1) Description: Welcome! I don't know what you need for fuel, but feel free to explore and try some different things. Be careful, though. Too much bad stuff will hurt your ship! Your device will tell you whether the objects you choose will work as fuel or not.

Agent 2 — Bench

(2) Description: There is a leftover plastic wrapper on the ground next to a small pile of leaves that got stuck beneath the bench. Do you want to use the plastic wrapper or the leaves for fuel?
Choice: Leaves (+10) OR Plastic Wrapper (+0)

Agent 3 — Gravel

(3) Description: There's a good amount of rocks and gravel here along the side of the path, with weeds growing up around it. Do you want to test the rocks or the weeds?

Choice: Rocks (+0) OR Weeds (+10)

Agent 4 — Rotting Log

(4) Description: A rotting log on the ground, with a small bunch of wildflowers growing nearby. Do you want to test the log or the flowers?

Choice: Log (+25) OR Flowers (+10)

Agent 5 — Recycling Bin

(5) Description: The recycling bin doesn't have much in it, but there is a newspaper and a soda can. Do you want to test the soda can or the newspaper?

Choice: Soda can (+0) OR Newspaper (+10)

Agent 6 — Spaceship

(6) Description: Back at your ship! It's time to see if you gathered enough fuel to get you going again.

Scores to go to Agent 7: 31 to 31+; Agent 8: 11 to 30; Agent 9: 0 to 10

Agent 7 — Congratulations

(7) Score Range: 31 to 31+
Description: Congratulations! You collected enough fuel to get you to Alpha Centauri and all the way back home!

Agent 8 — Good Job!

(8) Score Range: 11 to 30
Description: Good job! You gathered enough fuel to get to Alpha Centauri. Hopefully, you'll be able to find more fuel once you are there so you can get home again.

Agent 9 — Oh no!

(9) Score Range: 0 to 10
Description: Oh no! You'd better get used to Earth, because you are going to be stuck here for a while! You didn't gather enough fuel to lift off.

Introduction

Game Goal

Agent 1

Agent 2

Agent 3

Agent 4

Agent 5

Agent 6

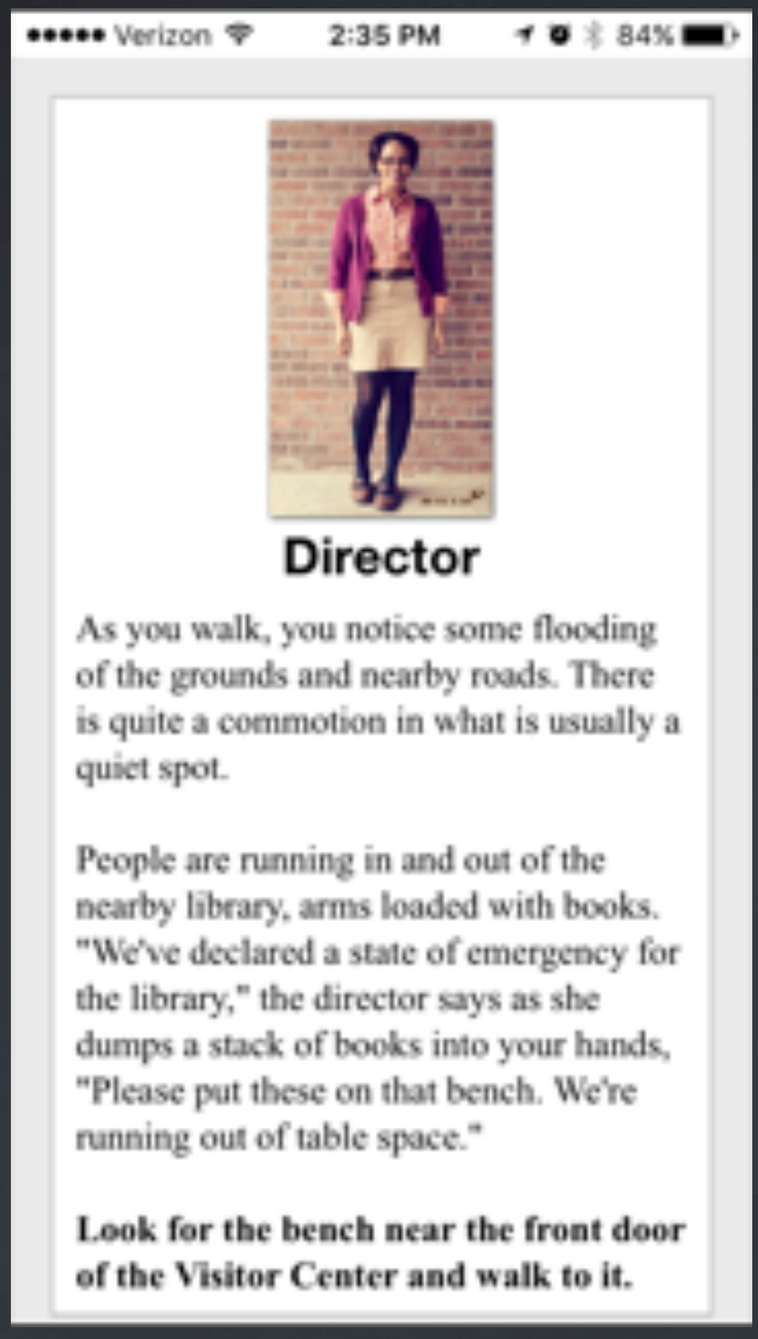
Agent 7

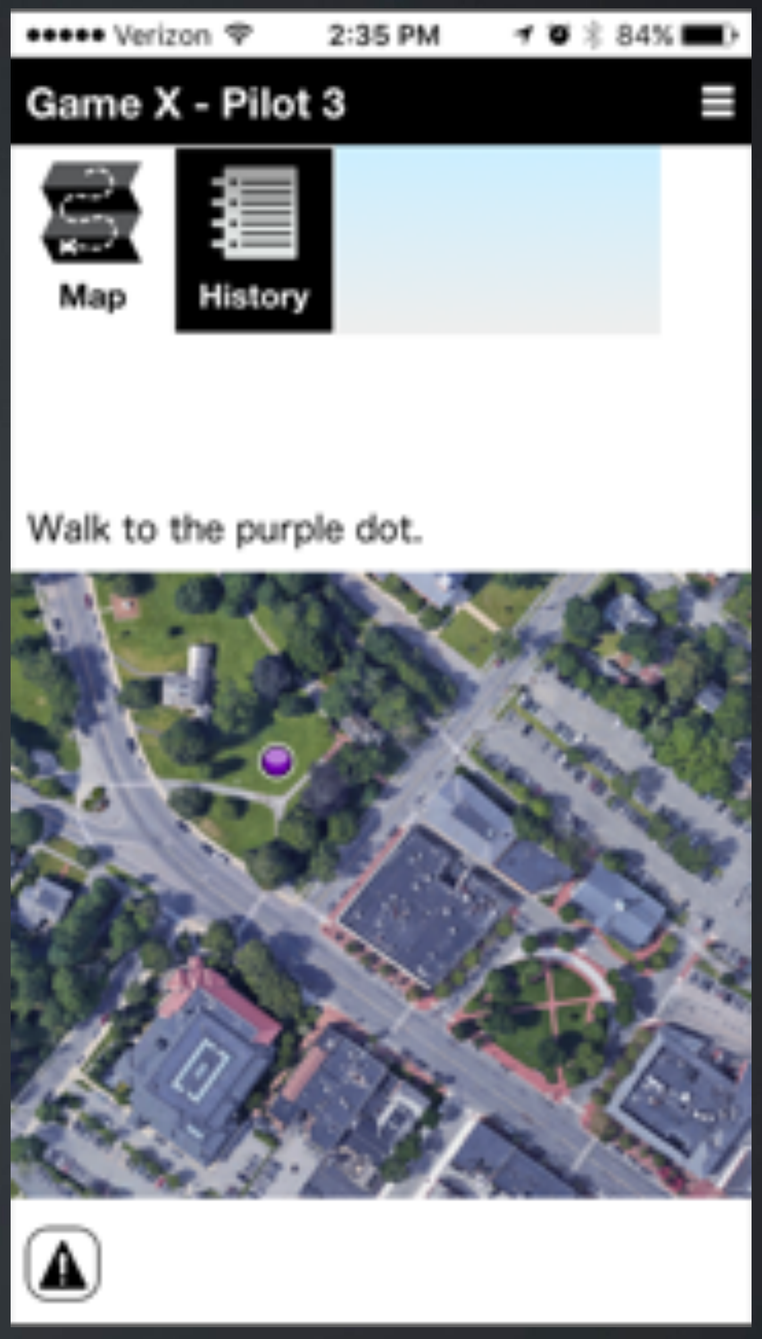
Agent 8

Agent 9

Game X


Verizon
2:34 PM
84%
TALE BLAZER
Lexington Center Games
Map
32.9 MB
1 of 2
Game X - Pilot 3
Come play this augmented reality game in Lexington Center to learn more about Global Climate Change and what YOU can do about it!
Start Over
Resume


Verizon
2:35 PM
84%
Director
As you walk, you notice some flooding of the grounds and nearby roads. There is quite a commotion in what is usually a quiet spot.
People are running in and out of the nearby library, arms loaded with books. "We've declared a state of emergency for the library," the director says as she dumps a stack of books into your hands, "Please put these on that bench. We're running out of table space."
Look for the bench near the front door of the Visitor Center and walk to it.


Verizon
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84%
Game X - Pilot 3
Map
History
Walk to the purple dot.

THANKS

STEP

TEA

NSF, NIH, MIT ODL

GATES FOUNDATION

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http://education.mit.edu

VR?

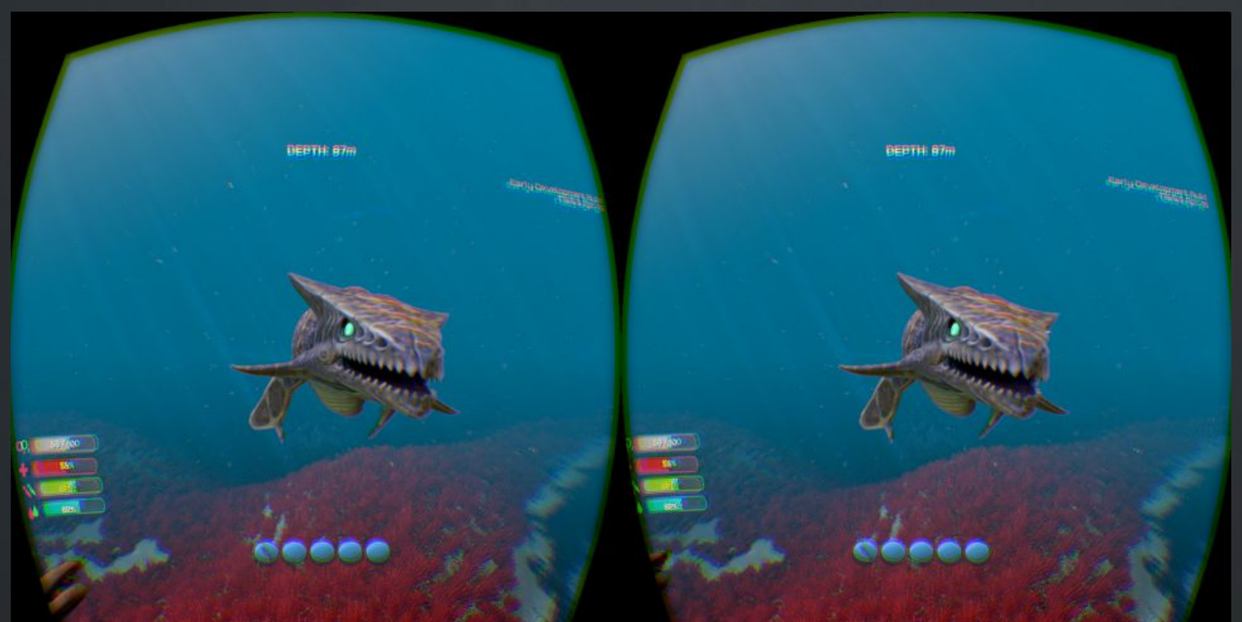
…instead of playing video games, students will enter a fully immersive and **scientifically accurate virtual reality chemistry lab**

Does adding salt affect the boiling point of water? The student would reach out with hand controllers, take a graduated cylinder, fill it with water, measure out the salt, light a Bunsen burner, add a thermometer, track the boiling point — and then repeat the experiment without adding salt.

VR

…instead of **playing video games**, students will enter a fully immersive and scientifically accurate virtual reality chemistry lab

Does adding salt affect the boiling point of water? The student would reach out with hand controllers, take a graduated cylinder, fill it with water, measure out the salt, light a Bunsen burner, add a thermometer, track the boiling point — and then repeat the experiment without adding salt.

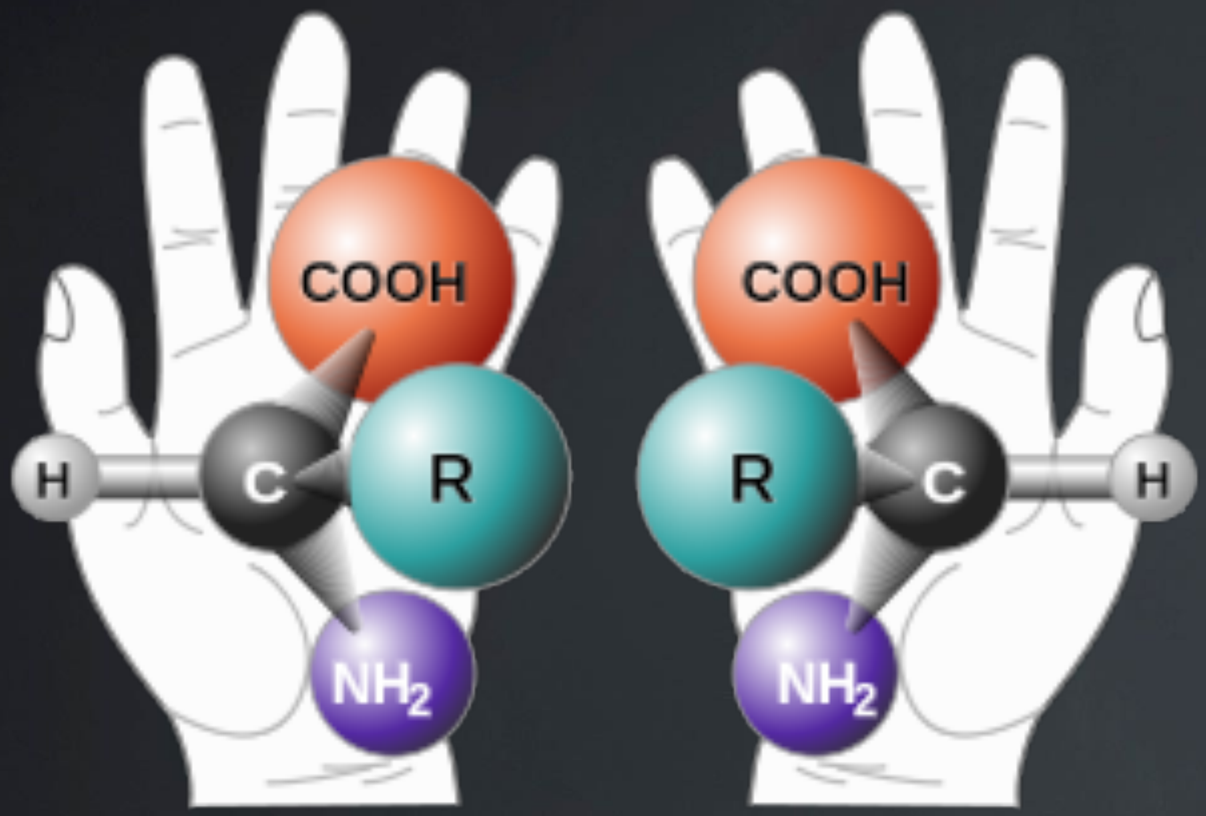


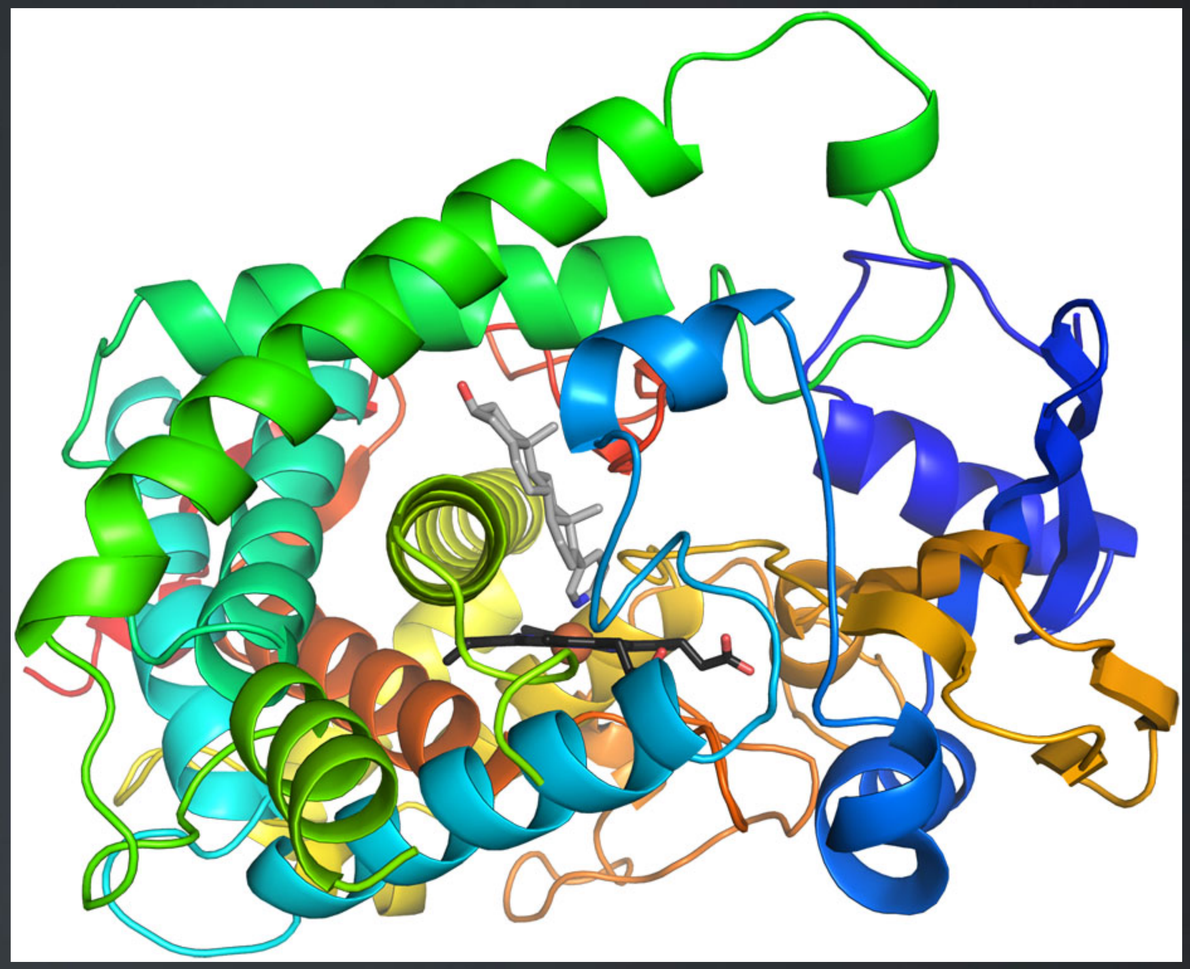
VR Frontiers for Education

Scale

VR Frontiers for Education

3D Structure



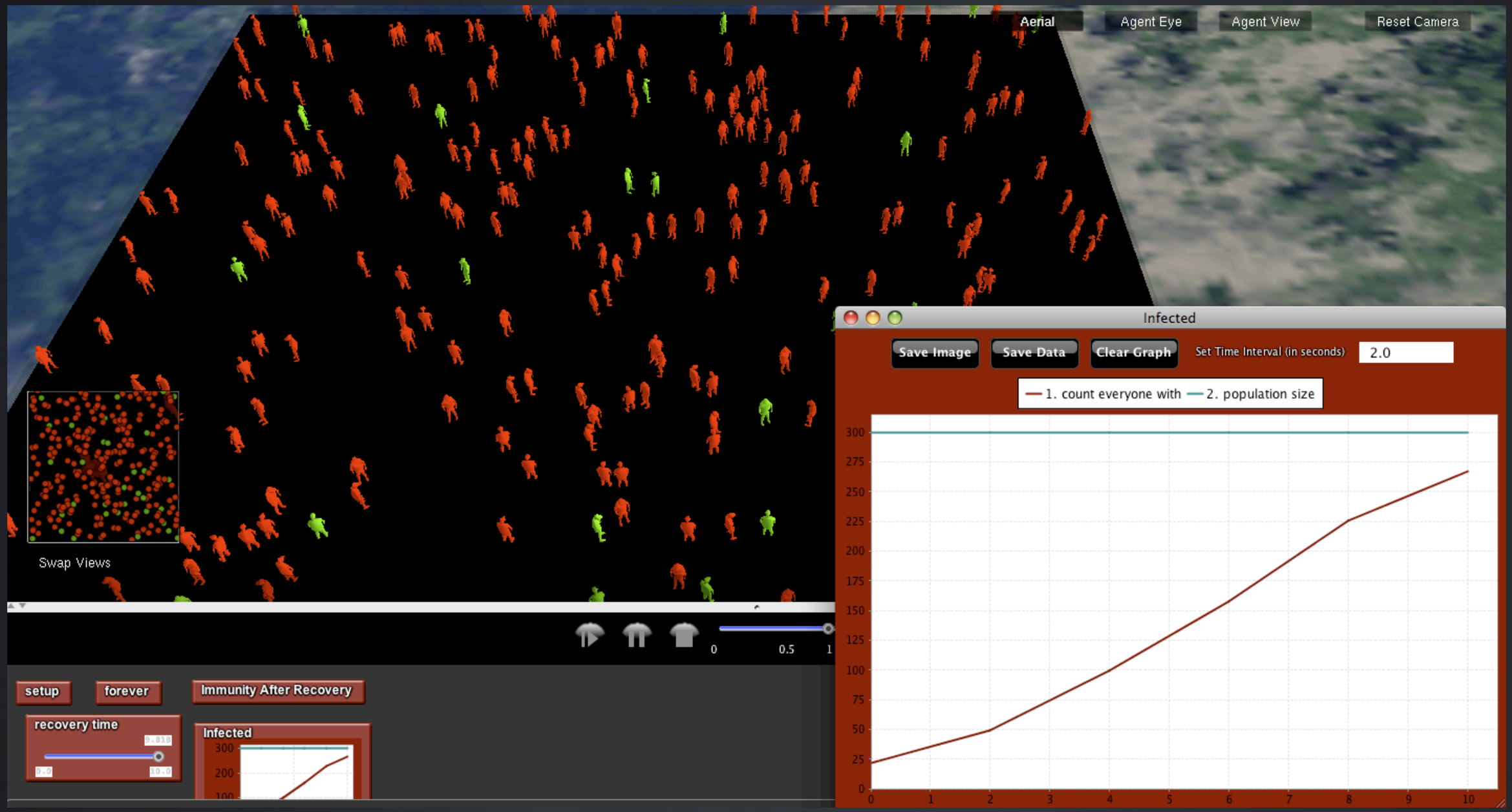


VR Frontiers for Education

Collaboration/Communication

VR Frontiers for Education

Individual/System Perspective Duality



Innovations on the Horizon

1) Interfaces — VR specific interfaces

2) Controls — Controls to facilitate complex tasks

3) Settings/Context — Real and fictional worlds

4) Pacing —How to break into smaller chunks or combine with other activities

5) Collaboration — New forms of collaboration and communication.

Design for (of) Schools

1) Pervasive activities - extending beyond the VR game

2) Persistent activities - leverage an investment in the experience

3) Changing schools - what are the metrics