

beyond the block:
sustained engagement and accessibility
with coding games in afterschool programs



PLAY ♦ MAKE ♦ LEARN

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Jesse Flot

Dr. Erik Harpstead

Carnegie Mellon University

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About Us

Carnegie Mellon
Robotics Academy

- Studies how educators can use robots to teach Computer Science, Science, Technology, Engineering, and Mathematics (CS-STEM). Their mission is to use the educational affordances of robotics to create CS-STEM opportunities for all learners.

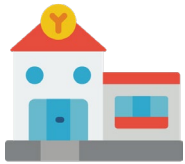
OH LAB

- Works at the intersection of culture, learning, play, and design in order to create brand new interactions and experiences. Through games, educational technologies, and new frameworks of interaction, the lab pushes on the edges of learning, empathy, and social empowerment.

So, what's the problem?



- Computer science and computational thinking are a core part of STEM disciplines



- Afterschool organizations that serve low-resource learners lack access to funding, curriculum, equipment, and trained facilitators



- Free coding games exist, but compete with an enormous catalog of other possible activities for student attention

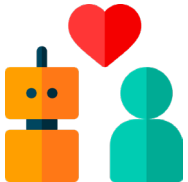


- Results in students with low rates of familiarity with technology, and lower confidence in their ability to learn CS

How we're working to help...



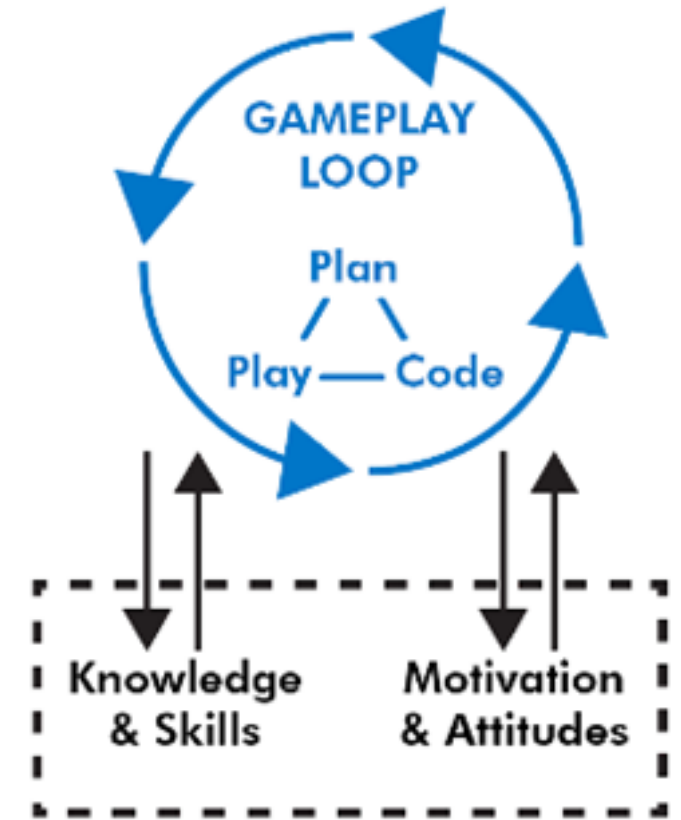
- In the Player-Programmed-Partner Games (P3G) Project, we codesign games with students at low-resource afterschool programs.



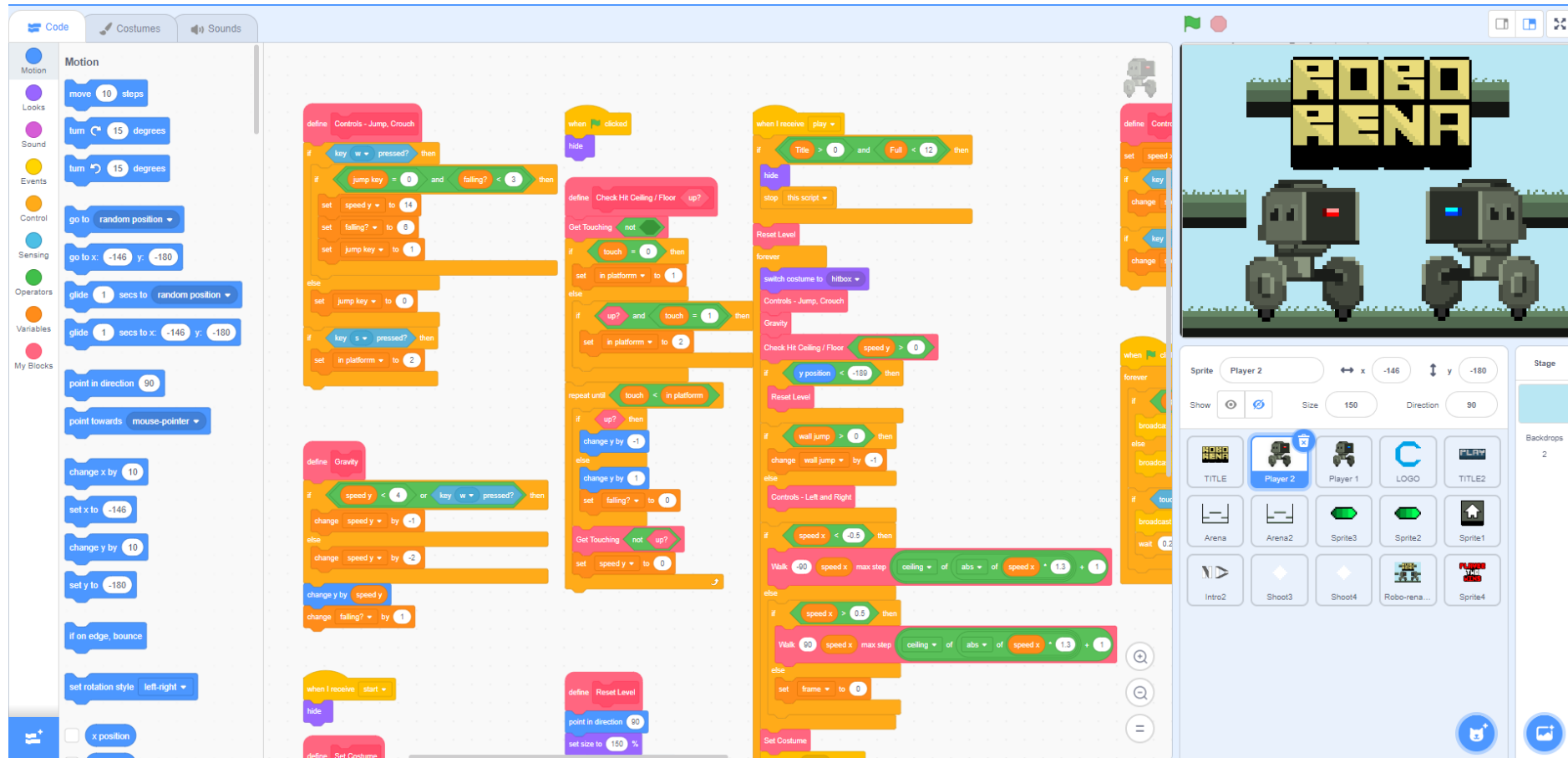
- P3G games embed a programmable, collaborative robot (aka “CoBot”) agent within existing gameplay, who then helps the player.

Theory of Action

- **Gameplay + Learning Loop.** Learners play the games, constituted by core gameplay and learning loops. Learners plan solution strategies, write or modify code for the CoBot, play alongside the CoBot, and then iterate.
- **Re-engagement.** Learners' increased beliefs in their competency in computer and robotics programming induce re-engagement with the game over a longer period of time.

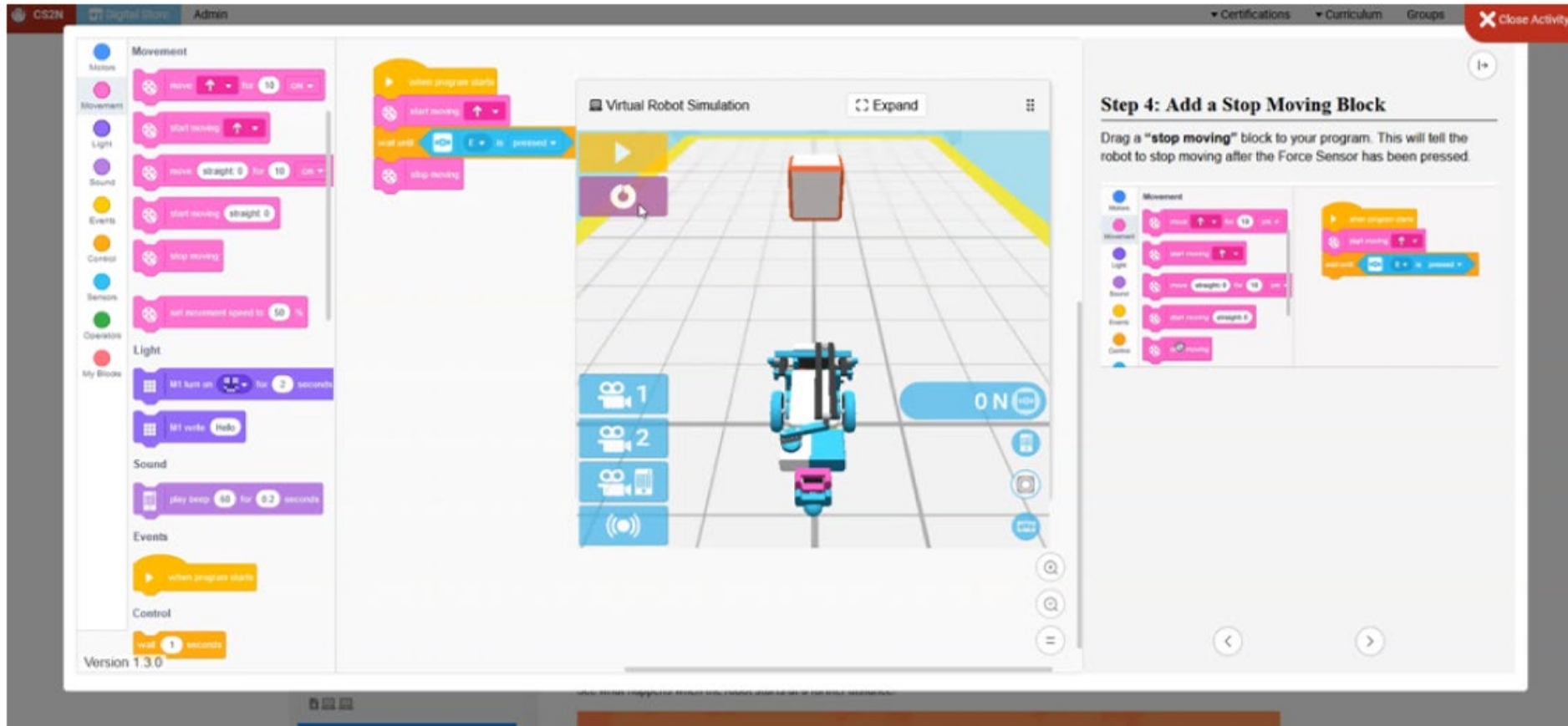


CoBot games are not this:



- **NOT** games with robots that students must program before playing.

Or this:



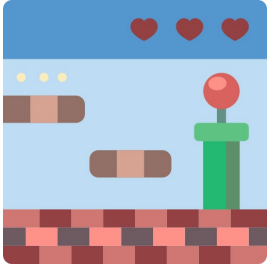
- **NOT** games where learning to program the robot is the entire game.

They're more like this:



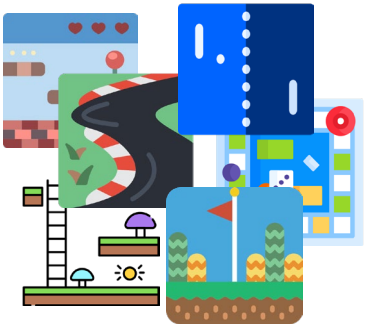
- Human and programmable CoBot working together in the game.

Our CoDesigned, CoBot Games



- An early assumption was that input from our Student CoDesigners across locations and cohorts would converge into one game.

- ***It did not.*** 😊



- In the spirit of Broader Impact, to help encourage engagement and re-engagement with programming, we have explored the role of the CoBot and the centrality of programming across several game designs, mediums, and genres.

- ***We ended up making 6.***

CoDesigned Game #1: *Super Slime Battle*

Game Snapshot

- **Genre:** Tower(less) Defense
- **Theme:** Halloween Town
- **Mechanics:** Shooting, Power-Ups, Wave Survival, Coding (Use-Modify-Crete)
- **Player-CoBot Relationship:** CoBot is a Teammate of Player
- **Player Verbs:** Move, Shoot, Collect, Repair, Set Destination
- **CoBot Verbs:** Move to, Follow, Fetch, Attack, Sense
- **CoDesigner Population:** Urban, Mixed STEM Affinity, High Literacy



Accessibility and Engagement

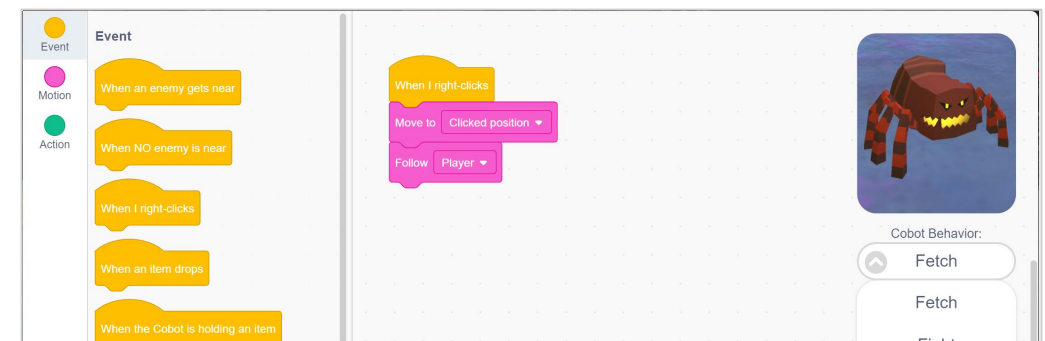
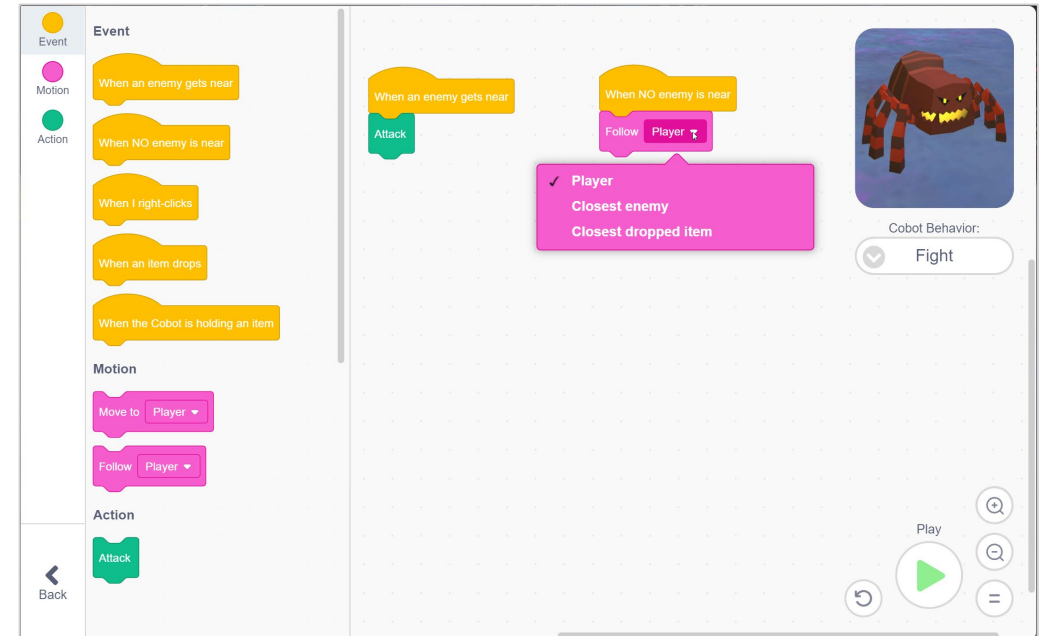
Design Considerations

- **Code Presentation:**

- Text embedded in Blocks
- Event-driven, nouns and verbs directly tie into gameplay
- Two pre-written starter programs: Fight, Fetch
- Interface available at match start and from Pause menu

- **(Re)Engagement Elements:**

- 4 Player characters with unique attack styles
- 5 visually distinct, programmable CoBot pets
- Endless Game Mode
- Desire to survive longer than previous attempt
- Desire to survive longer than other players



CoDesigned Game #2: *Acceleration City*

Game Snapshot

- **Genre:** Open World, Driving
- **Theme:** Rural + Suburban
- **Mechanics:** Multiplayer, Driving, Flying, Set Collection, Role Play, Coding (Use-Modify-Create)
- **Player-CoBot Relationship:** CoBot and Player share a Body
- **Player + CoBot Verbs:** Steer, Set Engine, Fly, Boost, Honk, Signal, Change Vehicle
- **CoDesigner Population:** Rural, Mixed STEM Affinity, Varied Literacy



Accessibility and Engagement

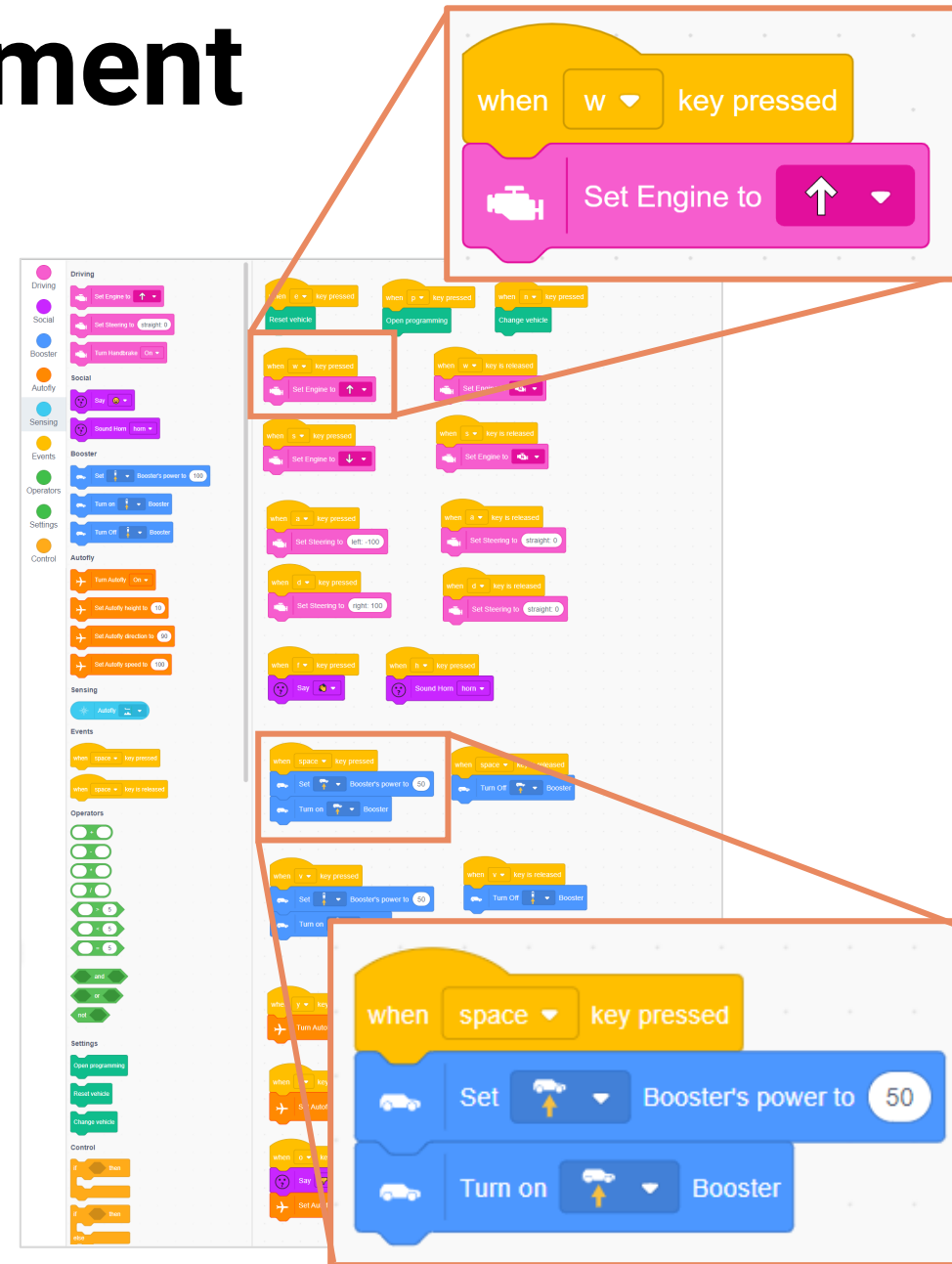
Design Considerations

• Code Presentation:

- Text AND Icons embedded in Blocks
- Programming presented as a customizable control mapping, logic and sensing available
- Functionally complete starter program provided, adaptable to Player preference
- Interface available at all times

• (Re)Engagement Elements:

- 8 unique vehicle choices
- World exploration and role play
- “Minanimal” set collection (*gotta collect 'em all*)
- Community-driven, informal multiplayer modes (*catch the robber*)
- In-game communication (Emoji signaling, horns)
- Playful transgression



CoDesigned Game #3: *Zillah City*

Game Snapshot

- **Genre:** Third-person Shooter
- **Theme:** Futuristic, Hope Punk
- **Mechanics:** Shooting, Avatar Customization, Unlockable Upgrades, Coding (Use-Modify-Create)
- **Player-CoBot Relationship:** CoBot is an Agent of Player
- **Player Verbs:** Move, Shoot, Customize, Set Destination
- **CoBot Verbs:** Move to, Follow, Capture, Flee, Sense
- **CoDesigner Population:** Urban, Low STEM Affinity, Varied Literacy



Accessibility and Engagement

Design Considerations

- **Code Presentation:**

- Text embedded in Blocks
- Event-driven, nouns and verbs directly tie into gameplay, logic and sensing available
- Two pre-written starter programs: Follow Ball, Follow Player
- Interface available from Clubhouse area

- **(Re)Engagement Elements:**

- Async Player/CoBot roles
- Player-Avatar representation
- Earning \$\$ to unlock all player upgrades
- Defeating Level 2, flying enemies
- Playful transgression

The image displays a block-based programming environment. On the left, a sidebar lists block categories: Event (yellow), Action (green), Sensing (blue), Control (orange), and Operators (purple). The main workspace shows three scripts:

- Script 1:** Triggered by "When Tracking Ball Lands (G)", it contains "Move to Tracking Ball" and "Start Capturing" blocks.
- Script 2:** Triggered by "When player leaves the Clubhouse", it contains a "Follow Player" block.
- Script 3:** Triggered by "When no Toxibots near Beastie", it contains an "if" block with the condition "# of Captured Toxibots > 0" and a "Move to Zed's Clubhouse" block.

A small video inset in the top right shows a character in a virtual world. A "Beastie's Programs" menu on the right lists "Follow Ball", "Follow Ball", and "Follow Player". A "Play" button is at the bottom right.

CoDesigned Game #3.5: *Zillah Beats*

Game Snapshot

- **Genre:** Rhythm Shooter
- **Theme:** Futuristic, Hope Punk
- **Mechanics:** Shooting/Timing, Avatar Customization, Coding (Scaffolded)
- **Player-CoBot Relationship:** CoBot and Player share a Body
- **Player + CoBot Verbs:** Move Left/Right, Move Up/Down, Shoot, Switch Weapon, Sense, Customize
- **CoDesigner Population:** Urban, Low STEM Affinity, Varied Literacy



Accessibility and Engagement

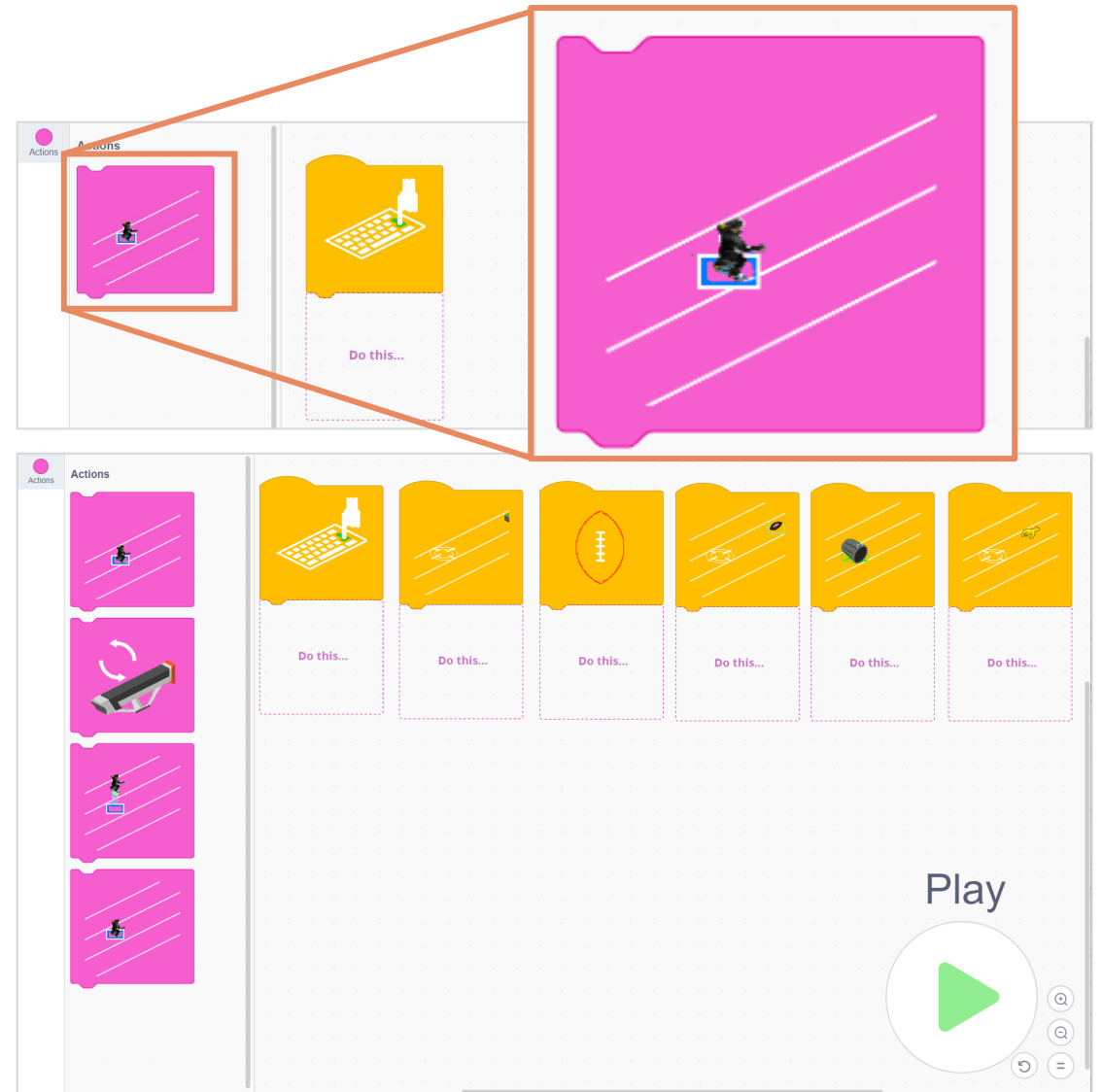
Design Considerations

- **Code Presentation:**

- Animations embedded in Blocks
- Event-driven, block visuals match game artifacts
- Scaffolded progression from 1 Event + 1 Action to 6 Events + 4 Actions
- Interface available at level start

- **(Re)Engagement Elements:**

- Player-Avatar representation
- Unlocking levels / new music
- Desire to beat previous high score
- Desire to beat another player's high score



Some Lessons Learned

- Pictures and animations embedded in the programming blocks aren't just good for removing literacy barriers.
 - Complimentary and matching visuals for in-game nouns and verbs greatly improve explain-ability.
- Avoid gatekeeping the fun by giving broken or incomplete code that students must fix before engaging with the game.
 - Give students agency regarding when and how interact with programming.
- Design meaningful reasons to students to re-engage with programming.
 - Re-engagement should lead to an observable and significant in-game impact (higher score, longer duration, lower difficulty curve, etc.).
- Leverage early prototypes and even asset packs to codesign the roles of the CoBot and Player, and the centrality of programming.
 - Just make sure that students understand they're prototypes and what a prototype is.



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Q & A

Thank you!

Jesse Flot: jbflot@cmu.edu

Dr. Erik Harpstead: harpstead@cmu.edu

<https://www.cmu.edu/roboticsacademy/Research/p3g.html>

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CoDesigned Game #4: *Friends Forever*

Game Snapshot

- **Genre:** Escape Room
- **Theme:** Horror
- **Mechanics:** Puzzle Solving, Exploration, Coding (Scaffolded)
- **Player-CoBot Relationship:** CoBot is a Guide to Player, CoBot is an Agent of Player
- **Player Verbs:** Move, Shine Flashlight, Interact, Collect
- **CoBot Verbs:** Move, Follow, Talk
- **CoDesigner Population:** Urban, Low STEM Affinity, All Female



Accessibility and Engagement

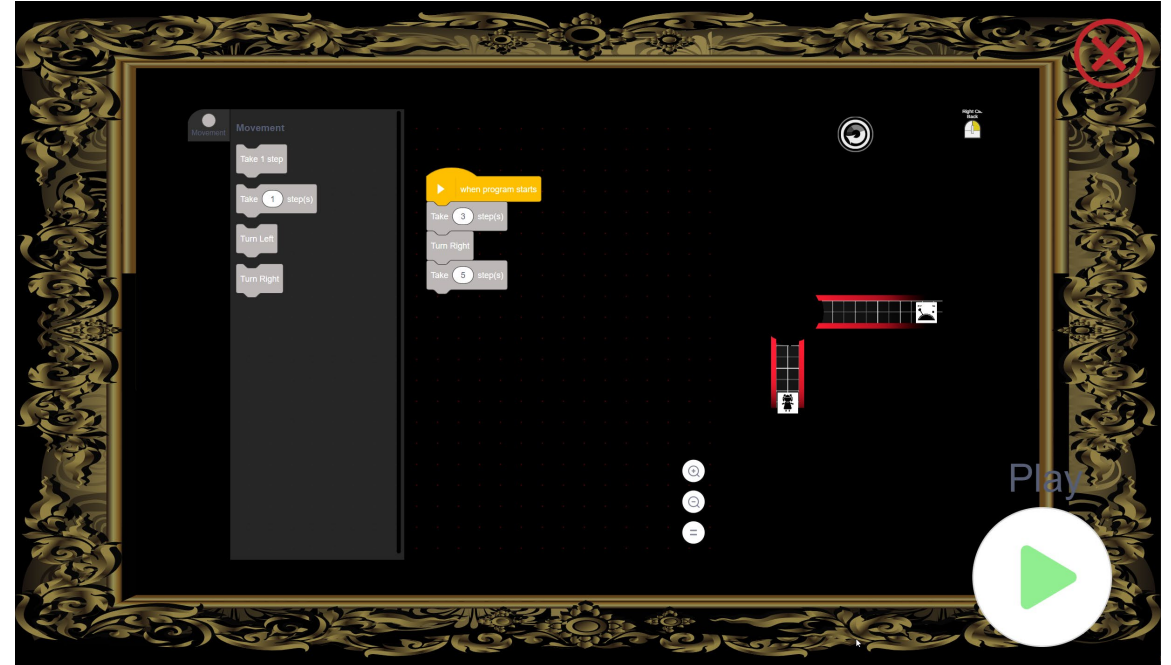
Design Considerations

- **Code Presentation:**

- Text embedded in blocks
- Programming challenges embedded as one of many puzzle types
- Sequential programming, verbs move CoBot doll
- Scaffolded progression of level difficulty / code solution length
- Interface available in programming puzzles

- **(Re)Engagement Elements:**

- Exploration
- Escape
- Revealing the narrative



CoDesigned Game #5: *Battle for the Hill*

Game Snapshot

- **Genre:** Board Game
- **Theme:** Sports
- **Mechanics:** Multiplayer, Set Collection, Take That!, Race to the Top, Victory Points, Coding (Lite, Implicit)
- **Player-CoBot Relationship:** CoBot actions may affect game board and multiple Players
- **Player Verbs:** Play Card (Move, Draw, No Effect), Move
- **CoBot Verbs:** Move Players, Reduce Breakpoints
- **CoDesigner Population:** Urban, Low STEM Affinity, Low Literacy, All Male



Accessibility and Engagement

Design Considerations

- **Code Presentation:**
 - Game Deck includes Sports suit cards and CoBot suit cards
 - CoBot suit cards contain Blocks
 - Multiple CoBot suit cards may be played in sequence
 - CoBot suit cards affect multiple players / areas / game flow
- **(Re)Engagement Elements:**
 - Community Competition
 - House Rules

