Introduction

The Pack is a program-to-play open world game intended to develop algorithmic thinking in middle school age subjects as applied to solving problems in environmental models. It is being developed through a partnership among the New York Hall of Science, Columbia University Center for International Earth Science Information Network and Design I/O LLC. It is the result of a design-based research project funded by NSF. This poster represents a high level description of the work in progress.

Empathy and Perspective-Taking

Evoking empathy in games can be a powerful approach for children to explore complex ideas that are unfamiliar to them. *The Pack* has been exploring how the personification of computational functions can impact the ways children engage with and relate to computational thinking skills. The Pack members have undergone multiple iterations, each iteration having different effects on children's engagement with the core computational ideas and the environmental systems that are part of the game.

Iteration 1: *Pack Members as Functions You Collect:* Each creature you feed and add to your Pack possesses different functions and attributes. You earn physical additions to your avatar each time you succeed in collecting the functions successfully.

Take-away: The Pack elicits emotional empathy, including turmoil over the idea of sacrificing characters for the sake of the environment. But presenting the Pack characters as a team you own and that you earn rewards for deploying took away from the computational thinking that we were hoping learners would engage in—thinking critically about what their functions were and how to combine the functions together to impact the surrounding environment.

Iteration 2: *Pack Members as Elements of Nature:* Your Pack members represent key elements of nature (fire, ice, water, wind) with environmental functions. As you combine them into different sequences, there are significant effects on the surrounding environment.

Take-away: The use of elemental characters supported more "god-like" play, contradicting the goal of evoking empathy and encouraging players to discern what functions the pack members represented. Computational thinking aspects of the game were obscured and environmental effects became confusing and difficult for subjects to tease out.

Iteration 3: *Pack Members That You Care for to Solve Problems:* You are a part of the environment and need to take care of your pack by providing sustenance. The Pack can be combined to navigate challenges in the environment (the need for water, the need to get to a place that they all can survive, etc.)

Take-away: The creation of personified creature-functions that need caretaking and follow the player seems to invoke both emotional and cognitive empathy responses, encouraging players to further investigate the creatures' functions and capacities to work together to achieve goals.

As we move forward with the final iteration of the game, we focus more closely on how children relate to the characters and how empathy contributes to the causal reasoning about environmental changes and computational thinking with which subjects are willing to engage.

Shaping *THE PACK*: Using Design-Based Research to instill empathy in a computational problem-solving game

Stephen Miles Uzzo, Wren Thompson, Dorothy Bennett, The New York Hall of Science

The New York Hall of Science (NYSCI) is developing a digital, open-world game inspired by NYSCI's award-winning 2,300-square-foot *Connected Worlds* exhibition. *The Pack* integrates the complex topics of computational thinking and environmental science while exploring players' empathetic responses to the world's creatures.

Transitioning to Computational Game Mechanics with an Environmental Narrative

In previous iterations of The Pack, the game mechanics attempted to balance both computational thinking skills and environmental concepts within the functions of the creatures. Formative testing and review of the game showed that this balancing act left players confused regarding the purpose of the creatures, and did not communicate either set of concepts and skills clearly. As a result, the project team redirected the game's trajectory to emphasize game mechanics around computational thinking skills, surrounded by a narrative exploring the environmental consequences of the player's actions.

Iterative design for The Pack

In the iteration of *The Pack* that involved the deployment of creatures with environmental functions, the design-based research team indicated several potential problems with game play:

- The players focused on eliciting extensive environmental change by using only a single creature type at a time
- As a result of players' actions, the game did not incentivize players to examine the sequencing of creature actions (algorithms), or parsing the creatures' functions.

In response to this, the project team redesigned the creatures' functions. In this recent iteration, the overarching question for design-based researchers has been "What kind of computational thinking are players doing in this game?"

- When testing their algorithms, the players engage in algorithmic design, reordering and sequencing their solutions based on the desired function of the algorithm when released into the environment.
- Players often recognize patterns in algorithm functions in relation to challenges, reusing algorithm portions created for previous challenges to address new situations that share similar demands.

SAVED ALGORITHMS

Current mechanics of The Pack

- The avatar must be close to water to survive, requiring players to manipulate the landscape and its water to navigate the world.
- Creatures in the "Pack" are the tools players can use to manipulate the landscape. Each creature has a discrete function that—when combined with other creatures into an algorithm—can result in actions that alter the environment.
- Pack creatures must be fed in order to function, requiring the player to either manually gather food for their algorithms or create algorithms to keep the creatures supplied with food.
- Players can test algorithms, refining the sequence and function of an algorithm prior to placing it in the "real world" and affecting the environment.

Images

Top: Player is using an algorithm to dig a trench and extend the reach of the existing body of water.

Center: Shows the pack creatures gathered around the player next to a body of water. Note the food inventory along the left edge of the screen, and an active algorithm, center left.

**Bottom:** The sandbox in which the player builds and tests algorithms for use in the world.

Future Work

Developing and Testing Environmental Narratives

The project team is currently developing the environmental models to be integrated into *The Pack*. The actions of the player will affect the environment, resulting in changes—both intended and unintended—to the world around them. As players explore the world around them and manipulate it toward a particular goal, they will encounter environmental challenges to overcome through the use of algorithms.

As the environmental narrative and challenges are developed, the design-based research team will invite subjects to engage in the narrative and discuss how they would address challenges posed in the game. In testing these narratives and challenges for the game, learning researchers will be able to provide the design team with insight on how the target audience thinks through the environmental concepts in the challenges. Learning researchers will also identify both misconceptions in environmental science that might emerge, as well as how well game play helps address existing misconceptions.

Engaging Teacher Perspectives
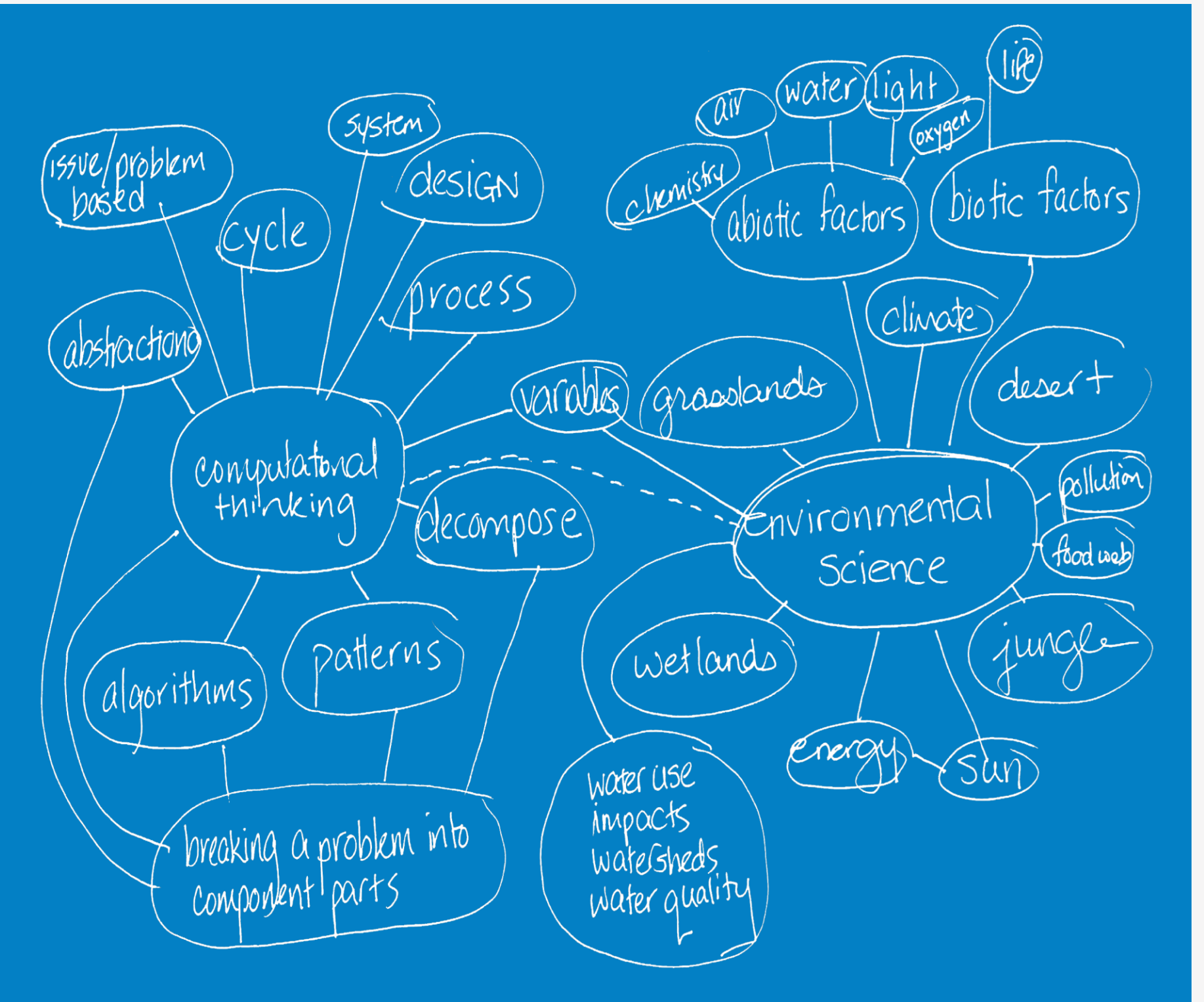
Design-based research for The Pack involves a panel of secondary science teachers from New York City schools. These "Design Teachers" test each iteration of the game prototypes to provide insight into the game design regarding usability in formal learning environments and as an adjunct to teaching complex environmental modeling concepts. Above is a chart drawn by the Design Teachers, illustrating their thoughts on how computational thinking and environmental science are linked.

As the project moves forward into the production phase (funded by the JPB Foundation) the project team will continue to consult with the Design Teachers to best support the use of *The Pack* in classrooms and informal spaces through external resources and tools.

Acknowledgements

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