Designing for Children
- With focus on 'Play + Learn'

Hungry World
A Multi-Modal Science Education System

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Abstract: Hungry World is an educational suite of products that teaches children about the environment. This suite includes a modular playground that depicts an abstracted food chain, as well as classroom materials, a website, and a variety of entertainment products that support the playground's ecological lessons. Altogether, this integrated product system takes a holistic approach to teaching lessons both inside and outside of the classroom. Weaving together physical and virtual play, classroom instruction, and entertainment, Hungry World engages different types of learning and extends lessons over time and across different media. The design of Hungry World integrates knowledge from civic playground designers, science curriculum experts, educators, and school children.

Key words: Design, playground, structures, play, science, ecology, food chain, cycles, environment, schools, education, alignment, system, online, website, entertainment, comics, toys.

Figure.1 Scale model of the Hungry World playground

1. Introduction

1.1 A Need for Educational Materials

With only 40% of California's 5th graders ranking as proficient in science[1], California's elementary schools have a clear need for educational tools and resources that support scientific education. Teachers must communicate abstract ecological concepts to children, with few tangible teaching aids.

1.2 Hungry World System Overview

Hungry World envisions an integrated way to teach science that incorporates play and entertainment into the curricula using already existing school resources. Focusing on the lesson of the food chain, the system consists of five components that can be taught individually, or together as a system. They are: playground, printed educational materials, website, entertainment, and stories & toys.

Figure.2 Hungry World is an integrated, multi-modal science education system.

2. The Hungry World Educational System

2.1 The Hungry World Playground

The Hungry World Playground is the first component of an educational system of products that communicate scientific lessons. Hungry World Curricula contain exercises, worksheets and assessment keys that use the Hungry World characters to teach ecology.

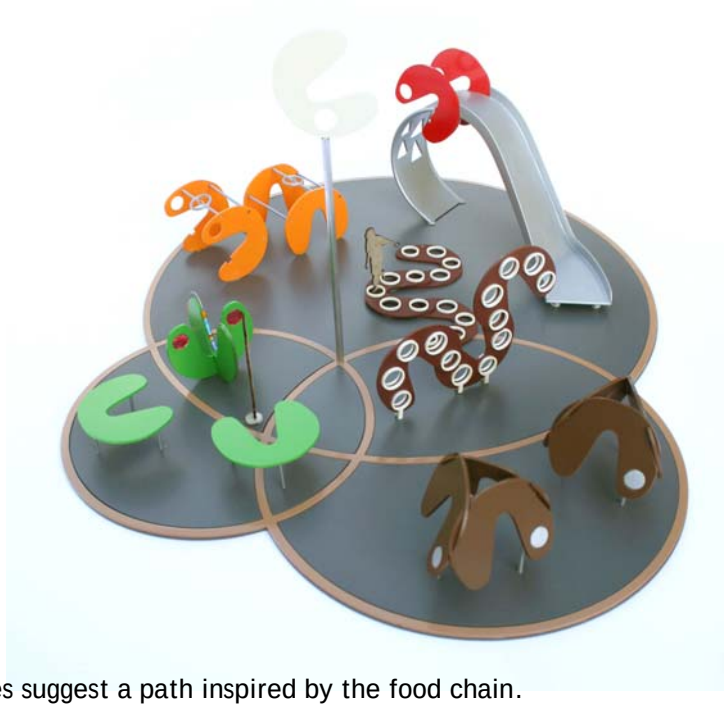


Figure.3 Hungry World playground structures suggest a path inspired by the food chain.

2.1.1 Hungry World's Playground Structures

These six playground structures represent different members of the food chain (below). The experience and colors of each structure mimic the lifestyle of its represented food chain member.

2.1.1.1 Lily Pad Bench

This bench offers a place for children to rest. The still nature of this activity references the immobility of plants.

2.1.1.2 Sprout Rail

The beads on this piece are color-coded and line up to illustrate the components of the photosynthetic reaction. They travel along a rail to develop coordination. Rotating light filters and mirrors suggest absorption and reflection of light by plants.

2.1.1.3 Herb Climber

By climbing on this structure, kids imitate the foraging habit of herbivores. Embedded filters cast green, leaf-like shadows, referencing the changing availability of plants; the herbivores' food. The flat notch in its mouth demonstrates an herbivore's flat teeth.

2.1.1.4 Carn Slide

Climbing and sliding on this structure mimic the stalk and chase of a carnivore's hunt. Passing through the mouth also mimics being eaten. The sharp notch in its mouth demonstrates a carnivore's sharp teeth.

2.1.1.5 Shroo Hut

This shady structure encourages imaginative and quiet play and references the dark, underground environment of many decomposers.

2.1.1.6 Worm Climber / Crawler

This worm climber adds a visual interest when placed upright, or a path when placed flat on the ground.

2.1.1.7 Playground Keys

Optional markers can be placed in playgrounds to give parents and kids a written introduction to the cast and lessons of Hungry World.

Figure.4 Hungry World playground key introduce the structures.

2.2 Formal Learning: Printed Educational Materials

Printed educational materials offer a formal educational complement to the playground that can be taught in the classroom. The materials include exercises that can be taught both on and off the playground, worksheets, and assessment keys. When these materials are introduced in the classroom, the playground serves as a tangible, large-scale demonstration model.

Figure.5 Hungry World educational materials teach formal lessons in the classroom.

2.3 Informal Learning: Online Content and Expansion

Online content supports ecological education outside of the classroom. For kids, the Hungry World website contains stories, games and avatars. Parents and teachers will find educational supplements and community boards on this website. The website serves as an accessible introduction to the Hungry World system.

Figure.6 The Hungry World website provides content outside of the classroom.

Starting with playgrounds, curricula and online content, Hungry World can then expand its offerings to toys, entertainment and graphic novels. Once this system has been established, content can be expanded to incorporate other environmental lessons.

3. Research and Development

3.1 A Need for Tools

Before 6th grade, teachers are not required to have formal science training. In later grades, teachers must communicate abstract ecological concepts with few tools at their disposal.

"Some of my kids have a hard time understanding things that they can't see, like food chains or carbon dioxide. I would really love a tool that could help them understand these larger concepts."

– Dave Dobson, Teacher at Betty Placensia Elementary

Figure.7 Dave Dobson's 5th grade class learn about evaporation.

These facts elucidated a specific goal for this project: to design a tangible way to communicate abstract ecological concepts to school children.

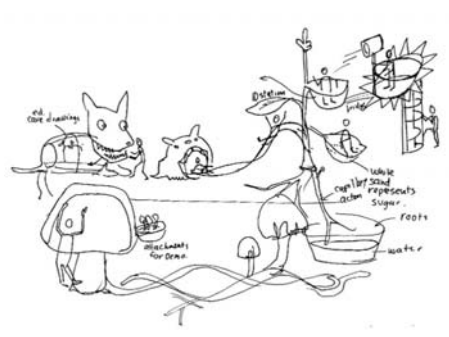
3.2 The Lesson

In fourth grade, students study the environment and learn about food chains. The following is a passage from California's 4th Grade Life Science Education Standards:

Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.

Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals

The design focused on these lessons because they demonstrate the interconnectedness of systems on our planet. This concept is a fundamental building block for environmentalism.



3.3 Initial Concepts: Showing Kids a Cycle

Initial concepts consisted of consumer toys that used light to spark a cause-and-effect reaction to demonstrate the relationships in a food chain. Because toys can be quickly understood and discarded, the food chain concept was better expressed as an interactive exhibit. An exhibit was preferable because it is a more immersive experience

Figure.8 Initial concept depicts an interactive exhibit.

that can be shared by many people. The concept evolved into a playground because permanent representation could have a subtler, more durable message that could be learned over many years).

3.4 Good Playgrounds

An interview with Pasadena's park designer Todd Holmes informed many of the design details of the Hungry World playground. Holmes highlighted numerous specifics within California's playground safety codes. Additionally, because parents monitor their children from a distance, playgrounds need to be transparent. Equipment must be durable because city playgrounds are replaced approximately every 10 years.

Holmes also introduced the concept of 'play value' which dictates that structures incorporate different types of play, such as social play, quiet play, and active play that engages different parts of the body. This maximizes a playground's value by appealing to different children in different situations.

3.5 Education Research

The Los Angeles Unified School District uses the Full Option Science System to teach science. This curriculum incorporates hands-on activities supplemented by readings from text books. FOSS kits come with supplies that accompany teacher-led activities.

In one activity, children moved enthusiastically from desk to desk, pretending that they were transforming water molecules. After the activity, they were able to answer questions about the water cycle. The children enjoyed using their imaginations and moving around *(left)*. Additionally, this imaginative and kinesthetic activity helped them grasp abstract concepts. This dictated that the playground incorporate imagination and movement to teach concepts.

Figure.9 An imaginative child pantomimes the water cycle.

3.6 The Importance of Abstraction

Abstract forms encourage an individual's imagination, requiring them to impose their own attributes to the form. By keeping the forms of this playground abstract, the playground could foster multiple interpretations and be more broadly appealing across different audiences.

4. Design Objectives

This research elucidated the goals of teachers and administrators and the criteria for a safe, fun playground. These goals mirrored the designer's goals and led to a set of objectives for the design.

Teacher / Administrator Goals	Designer's Goals	Design Objectives
Raise test scores and school ranking	Foster a biological perspective	**1. Deliver an educational message** - include California Education Standards
Create a more pleasant campus Differentiate the school	Bring joy, lengthen lifespan of design and message Discourage wasteful turnover	**2. Fun and engaging over many years** - high play value - abstract representations - durable
Avoid scrapes and lawsuits	Provide a pleasant space, appeal to more people	**3. Safe** - 8' or lower - 3' buffer zone - limit moving parts
Maximize use of limited budgets	Reach a broad audience, increase accessibility	**4. Affordable for schools** - streamline manufacturing + materials

Table.1 Research-based design objectives drove the design of Hungry World.

5. Ideas and Exploration

5.1 Food Chain Playground

To emphasize the relationships between trophic levels, early sketches suggested creatures that would already be familiar to children. Most of these consisted of iconic land-dwellers. For clarity, color differentiated each food chain member.

5.2 Abstracting Form

Without a clear reason to portray one animal or specific chain over another, the playground's forms became more abstract and universal. Two- and three-dimensional sketches explored abstract but recognizable forms. The figures created a path that represented the flow of energy through a living system. Though abstract and related spatially, the forms of the different structures did not relate. The next round of exploration sought to visually relate the structures.

5.3 Light and Shadow

Sunlight is the driving force of energy flow in living systems. In parallel with these systems, light was used to create dynamism on the playground. Many of these ideas created interesting visual effects over the course of the day.

5.4 A Compelling Shape

While many ideas were too sculptural to be mass-produced, one shape stood out for its child-like personality. Orienting this shape in different ways suggested a variety of living beings. Linearly repeating this organic shape created an interesting tension between perfect and imperfect geometries.

Figure.10 Initial mock-ups explore different trophic levels, abstraction, light and shadow, and compelling shapes.

5.5 Refining the Form

This 'C-shape' offers a variety of ways to show different members of the food chain. The shape was developed using physical mock-ups.

Figure.11 (far left) Mock-ups of decomposer structures replicated the condition of being a worm or a mushroom in a cold, dark environment. Early experiments proved to be too low, requiring that the enclosure be raised. This was simplified to a more modular form, which was then modified to make an iconic statement from many angles.

(mid left) Various herbivore structures imparted the experience of foraging. An asymmetrical form became a symmetrical form that suggested foraging through the angle of the 'head' instead of depicting a plant. This led to a stronger structure with a clearer message. Adding space to the structure generated interesting shadows, while angling the front outwards physically suggested foraging and added more play space to the climber.

(mid right) Varying the proximity of different structures created different arrangements that explored space and shadows. This arrangement also suggested a clear path for children to follow.

(far right) These full-scale mock-ups helped determine the scale of each piece. The pieces are slightly smaller 4 feet wide to accommodate machining from 4x8 foot sheets of material.

VI. ALIGNMENT TABLE

To reinforce the value of the playground to schools, the features of the playground were aligned with California Life Science Education Standards. This table outlines the play and educational values of the playground.

Struc-ture	Play Value	Age Group	Lessons	Educational Features	California Science Education Standard
Lily Pad	quiet play, rest	young, mid, older grades 1-5	Plants are relatively immobile and must absorb sunlight to make food. Plants receive nutrients from decomposers.	This bench offers a quiet resting area to absorb sun.	Grade 3: Students know sunlight can be blocked to create shadows. Students know light is reflected from mirrors and other surfaces.
Sprout	hand-eye coordi-nation	Young grades 1-3	Carbon dioxide and water react with light to create sugar in the photosynthetic reaction. Plants reflect and transmit different colors of light.	Beads on a track are labeled with the various components of the photosynthetic reaction. Movement on the track represents the conversion of energy. A green mirrored disk shows that plants reflect green light. Transparent disks show that plants absorb red and blue light.	Grades 4 & 5: Students know plants are the primary source of matter and energy entering most food chains. Students know plants use carbon dioxide (CO_2) and energy from sunlight to build molecules of sugar and release oxygen.
Herb Climber	climbing	young, mid grades 2-4	Herbivores eat plants to survive. Carnivores hunt herbivores. Herbivores have flat teeth to grind plants	Climbing on this structure references the foraging of herbivores. Green shadows on ground reinforce the concept of foraging. A notch in the head suggests flat teeth.	Grades 1 & 4: Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs, and may compete with each other for resources in an ecosystem. Students know how to infer what animals eat from the shapes of their teeth (e.g., sharp teeth: eats meat; flat teeth: eats plants).

Carn Slide	climbing sliding running	mid, older grade 3-5	Carnivores hunt and eat other animals. Carnivores have sharp teeth to tear flesh. Animals produce waste after eating.	Climbing and sliding on this slide reference the stalk and chase of hunting other animals. Triangular holes and notches represent sharp teeth. Its proximity to decomposer structures suggests digestion.	Grades 1 & 4: Students know producers and consumers (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs, and may compete with each other for resources in an ecosystem. Students know how to infer what animals eat from the shapes of their teeth (e.g., sharp teeth: eats meat; flat teeth: eats plants).
Worm Path	balance coordination	young, mid grade 1-3	Worms break down waste materials into nutrients absorbed by plants. Worms live in the ground.	This flat structure is close to the ground.	Grade 4: Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.
Worm Climber	climbing	mid, older grade 3-5	Worms break down waste materials into nutrients absorbed by plants. Worms live in the ground.	Crawling on this form references crawling in and out of ground.	
Shroo Hut	imaginative quiet and social play	young, mid grade 1-3	Mushrooms live mostly underground. Mushrooms break down waste materials into nutrients that are absorbed by plants.	This enclosure suggests low dark environment of decomposers.	

Table.2 The playground offers both educational and play value.

References

1. Slater, P. (2007) State Superintendent Jack O'Connell Releases 2007 STAR Results Showing Encouraging, Troubling Trends. [News Release]. Available at <http://www.cde.ca.gov/nr/ne/yr07/yr07rel98.asp> [Accessed December 2008]