

## **Final project-MicroEcoKit**

### **Introduction**

The environmental issue is accelerating at an unprecedented rate. The past fifty years has witnessed a rapid growth of human consumption, urbanization, and industrialization (earth.org, 2020). Researches have shown that “children are presented as a special interest environmental group” because of their symbolic connections to the future and their current vulnerability to the consequences of environmental degradation (Walker, 2016). It is undeniable that children are an important part supporting environmental protection in society and environmental education is necessary. An engaging environmental education and an accompanying constructivist toy kit aim to promote playful and interactive environmental education for children that help them to learn and respect other species on earth, to learn about human impact on the environment, and to learn about basics of ecosystem and biodiversity.

It is designed for children from four to six years old. It is when they have basic knowledge about the nature surrounding them and start exploring nature independently. The curriculum and the kit could be used in classroom settings to assist preschool environmental education and also as a toy for children to play with informally to reinforce their understanding of species on earth.

### **Need**

Humans have detrimental impacts on the environment, which causes numerous environmental issues such as deforestation, loss of biodiversity and climate change. Thus, to enhance understanding of the environment and ultimately increasing ecological behaviors to protect and respect other species on earth is important (Otto and Pensi, 2017). Children’s role in preserving the environment is special as they are “today’s agents of change and tomorrow’s leaders” (Walker, 2016). As Heft and Chawla point out “If sustainable practices are to be carried forward through time, then children must be the bridge conveying their value and ways” (Heft and Chawla, 2006). Children could be positioned as agents of change in ecological practices and policies from the social, material and spatial aspects of children’s independence in the family (Walker, 2016). Thus ecological education is important for children, as they would make changes in the future and would influence their families to make changes.

Researches have also shown that environmental education for children today is too pessimistic and would ultimately cultivate a sense of “hopelessness” (Nagel, 2005). As environmental issues are often discussed in a serious way to the next generation, children might lose in a confusing muddle of learnt helplessness (Nagel, 2005). Thus there is a need for a more playful way of learning to help children fully involved in the process and motivate them to think about ways to preserve the environment.

### **Learning theory**

The design is based on constructivist learning theory. It encourages children to construct personal and creative micro-worlds that are ecological balanced and biodiverse. Children learn biological interactions between species living in the same environment by experimenting with different combinations of plants, animals, and microorganisms. This is supported by the constructionist analogy between constructing something concrete in real life and constructing abstract knowledge in one’s mind (Papert, 1980).

There are diverse approaches to learning a subject, as Turkle and Papert (1990) suggest, the notion of Epistemological Pluralism, and the process of learning and concepts forming is personalized based on their past experiences, personal interests, cultural and social background, etc. For example, e-textile and electronics crafting is a new approach to learn electronic circuit

and coding, and it makes education on technology more approachable for beginners. Unlike the traditional and standardized way of giving lessons about new concepts such as ecosystem, producers, prey, and predators, the kit enables children to learn it by crafting and building an ecosystem of their own, which makes learning biological interaction easier as children at any level can experiment with it.

The design is also inspired by “Four P’s of Creative Learning” : Projects, Passion, Peers, and Play (Resnick, 2020). To learn collaboratively with friends, to be fully engaged in learning, to develop interests for learning about ecosystems, and to build knowledge upon previous experience are what I want to realize in my design.

## **Learning Goals**

The overall goal is to help children learn about ecological interactions between different species on earth and to motivate them to live in harmonious coexistence with other living things on earth. The curriculum introduces children to the following topics:

1. Biotic features of an ecosystem. Learning about living things in a place, including microorganisms, fungi, plants, and animals.
2. How ecosystems function. Learning about food chains and biodiversity.
3. Human impact on ecosystems. Learning about how human activities destroy ecosystems.

## **Design Description**

### ***Introduction***

This curriculum is accompanied by a constructivist game MicroEcosystem and a hardware tool kit that users can experiment with to learn about food chain and energy flow. The curriculum is designed for children aged from six to eight, who have some knowledge about plants, animals and nature surrounding them.

### ***MicroEcoKit***

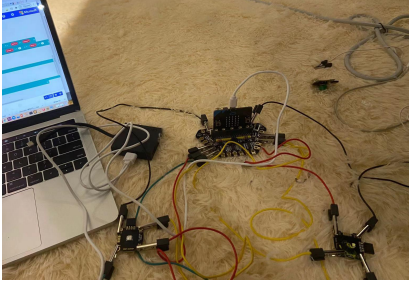
MicroEcoKit is a constructivist toy that helps children to understand food chains better.

The kit has following components:

1. A board that represents the micro ecosystem.
2. Tokens that represent plants, which is the main food source for herbivorous animals (Usually the producers).
3. Tokens that represent herbivorous animals, which is the main food source for carnivorous animals (Usually the first-level consumers).
4. Tokens that represent carnivorous animals, which is dependent on other animals (Usually the second-level consumers).



5. Micro:bit kit with a color sensor which detects the categories of the types of the elements, a RGB light which indicates the condition of the ecosystem, alligator clips, and sample code template.



6. A set of clay modeling tools that children can use to make their own elements.



7. An instruction manual.

Instructions:

1. Connect the micro:bit pad with sensors using alligator clips.
2. Set up the board.
3. Choose tokens that you like from the three categories of biotic elements in an ecosystem, scan it using the color sensor, and put it on the board.
4. Look at the RGB light to see how balanced your ecosystem is.
5. Make your own elements using the clay modeling tools and think about what categories they fall into.

### ***Curriculum***

#### ***Lesson 1. Learning about biotic elements in an ecosystem***

Children will learn about types of ecosystems, including terrestrial ecosystem, forest ecosystem, desert ecosystem, etc. Children will also learn about what biotic components form different ecosystems as animals and plants have different habits and behaviors. For example, tropical plants cannot survive in plateau areas.

Activity: The full version of the kit will provide sample biotic components in different systems. For example, a marine ecosystem will contain marine fish, mammals, and plants such as sharks, whales, and seaweeds. Children can learn about different ecosystems by playing with the tokens representing different animals and plants.

#### ***Lesson 2. Learning about food chains, ecological imbalance, and biodiversity***

Children will gain basic knowledge about food chains and energy flow. Concepts such as producers, low-level consumers, and high level-consumers will be covered in this unit. Children will also learn about ecological imbalance, which happens when a species or a level of species disappear from the ecosystem. Children will learn about what causes ecological imbalance and lack of biodiversity, and the ways to prevent these ecological issues.

Activity: The micro:bit circuit automatically judges whether the micro-ecosystem is biodiverse and ecologically balanced, so children could try different combinations of animals and plants to see if they correctly understand the concepts.



red light: unbalanced ecosystem



yellow light: balanced but not biodiverse



green light: biodiverse ecosystem

### ***Lesson 3. Learning about human impact on earth***

Children will learn about human impact on earth such as deforestation, overpopulation, growing consumption of food, etc.

Activity: Children can mimic these behaviours on their micro-ecosystems to see the consequences. For example, if trees are removed from the ecosystem, it would result in an unbalanced ecosystem.

#### **Design Critique**

##### ***Foregrounded***

These are salient because they are the most important things that children should get from playing with the kit.

- Basic concepts about types of animals and plants and their eating habits and natural enemies.
- Basic concepts about a balanced ecosystem.

##### ***Backgrounded***

These are not salient because either they are not so important or they are too hard for a kid from four to six to understand.

- Micro:bit circuit and coding skills.
- More complex logic about high-level food chains and food web.
- More complex ideas about how human actions have an impact on the environment.
- Advanced knowledge about types of animals and plants.

## Reference

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