PRINCIPLE 7: NATURE DEMANDS LOCAL EXPERTISE

How does nature adapt to different circumstances?

Erasmus+

AGE RANGE

12–16

DURATION

Preparation:
about 20 min.

Activity:
about 45 min. / 1 lesson

SUBJECT(S)

- Science – *Biology, Physics*
- Design, Engineering and Technology
- Arts

KEYWORDS

Biomimicry principles; function; diversity; locality

SUMMARY

Organisms need to adapt to different circumstances: to local habitat, weather, soil, available food, etc. Nature also uses local materials to build. In this module students explore how the beaks of birds are adapted to local circumstances and available food.

BIOMIMICRY PRINCIPLES

7 – Nature demands local expertise

LEARNING OBJECTIVES

- Students understand that organisms have adapted to their locality over a long period of time.
- Students understand that nature only uses locally available materials.
- Students understand that in nature everything is context specific; what works in one place might not work in another.
- Students understand that the form of birds' beaks have a good reason.

LEARNING OUTCOMES

- Students mimic bird feeding habits using different kinds of tweezers for picking up different objects.
- Students experience how natural systems depend on shared rules.
- Students think about locality and adaptation.

BIOLEARN COMPETENCES

- Students are able to abstract principles of sustainability from the way the natural world functions.
- Students are able to identify functional design in nature, develop greater awareness and appreciation for design excellence in nature, and appreciate how nature works as a system which is elegant and deeply interconnected.
- Students are able to identify important needs and opportunities that can be addressed through design innovation for products, processes and systems.
- Students are able to work in groups.
- Students are more motivated in learning STEAM and experience that knowledge of STEAM can be widely used.

SUMMARY OF THE ACTIVITIES

	Activity Name	Short description	Method	Duration	Location
1	Introduction	Presenting the principle 9_principles.ppt	• Teacher presentation • Discussion	10	Indoor
2	Playing beaks	Trying to pick up a range of objects with different kinds of tweezers	• Hands-on activity	25	Indoor
3	Triangles (optional extension)	Students apply the principle of self-organisation	• Game	15	Indoor/ outdoor
4	Review	Discussion after the activity	• Discussion	10	Indoor/ outdoor

Note: You can choose either Activity 2 or 3, or both if you have time.

BACKGROUND FOR TEACHERS

See at Activity 1: Introduction.

For interconnections see *Nine Principles of Biomimicry* module.

LOCATION
Indoor

TOOLS AND MATERIALS

- projector, PC
- 9_principles.ppt; 8th slide

PREPARATIONS

Arrange classroom for presentation and discussion.

RESOURCES

Benyus, J. M. (2002): Biomimicry – *Innovation inspired by nature.* HarperCollins Publisher, New York, U.S.A.

1| INTRODUCTION

» QUESTION

Present the slide about Principle 7: 9_principles.ppt, slide 8.

Nature's systems are inherently local. Certain species thrive under specific conditions; local and regional weather patterns matter, as do other conditions such as soil, air quality and water temperature. Relationships are created locally and local resources are used. Of course, some birds travel long distances but have you seen them take their food with them?

Explanation to 9_principles.ppt, 8th slide:

Climatic adaptation
Some organisms live in varying climates and have strategies to adapt. Hares adapt from the warm summer to the cold winter by thickening their fur and also changing its colour to match with snow.

Extrazonal adaptation
Due to local climatic conditions, some species appear outside their usual habitat zones. For example, Beech appears on the northern slopes and in cold valleys due to the micro- and meso-climatic features there.

Intrazonal adaptation
Within zonal vegetation types, there are intrazonal habitats that are frequently associated with variations in environmental conditions, and that have a microclimate which deviates from the general macroclimate associated with the zone. For example, in an oak woodland, bluebells come into flower before oak trees come into leaf; in this way they take advantage of the light available on the woodland floor before the oak leaves block it out.

Examples (pictures in ppt)

- Debris slopes forests – on steep and rocky hillsides, the main species is the European ash (*Fraxinus excelsior*) and small leaved lime (*Tilia cordata*), they have a roll in soil conservation.
- Open rock lawn – drought-tolerant grasses, succulents (*Sempervivum* and stonecrop species).
- *Sempervivum sp* – they live on sunny rocks and stony places in the mountain. It is possible because they are able to store water in their thick leaves.
- Arctic fox (*Alopex lagopus*) – They are native throughout the Artic tundra biome. They adapted well to living in cold environments. They have thick, warm fur which is used also as camouflage. Their rounded body shape minimizes the escape of body heat.

- Fennec fox (*Vulpis zerda*) – They are native in the desert of North-Africa and Arabian. They have unusually large ears to serve to dissipate heat. Their kidney, ears and coat functions have adapted to high-temperature, low-water, desert environments.
- Pied avocet (*Recurvirostra avosetta*) – They have long, bluish legs used to step in the shallow brackish water. They have long, upturned beaks. They use it to mow from side to side in water, which is a unique feeding technique. With the help of this movement they eat crusanceans and insects feom the shallow water.

The plant species can be classified by ecological indicators.

- T-rate – shows the temperature claim of the species (wide tolerance species, tundra, taiga, coniferous and deciduous mix forest, deciduous tree, sub-Mediterranean deciduous forest, Mediterranean, Atlantic evergreen forest) – except for wide tolerance species the plants are on own climatic area.
- W-rate – shows the water demand of the species, and the place where the plant is most frequently found (extremely dry – fresh – aquatic) – the succulents live dry place, their leaves are dick with reservoir tissue; the tissue of aquatic plants adapted to their habitat.
- R-rate – shows the pH claim of the species, means that acid-calcareous soil type where the species live (wide tolerance species, acid-neutral-calcareous) – the acid soil is liked by e.g. fungi, sphagnum; the soil in the coniferous tree are acidic; the plant living in a open rock lawn prefer calcareous soil.
- N-rate – shows the nitrogen claim of the species (poor in N, reach in N, neutral species) – e.g. nettle and elderberry prefer the soil reach in N.
- Z-rate – shows the degradation tolerance of the species (not tolerant, good tolerant, degradation-phile).

LOCATION
Indoor

2| PLAYING BEAKS

» DISCOVER

TOOLS AND MATERIALS

- different type of tweezers (8 pairs): e.g. toaster tongs/ wooden food tongs, grill or serving tongs, laboratory tweezers, sugar tongs, precision tweezers, staple remover, chopsticks
- different type of seeds ranging from small to large (e.g. rice, sesame, beans, nut, peanut, pine cone)
- four trays
- student worksheet W2.1

PREPARATIONS

Indoor activity: four tables, two tweezers on each table (all together eight different tweezers), different types of seeds on each table placed in the trays (same range on each table).

Complete the table in W2.1 with the names of the different tweezers and also the seeds, then print one copy per group.

The beaks of birds are adapted to the type of food they eat. The shape, size and strength of beak determines what is possible to gather. In this activity students observe the correlation between tweezers and the seeds they are able to gather. Which can be picked up more easily depending on the tweezers used?

Form 4 groups of students and give each the table in W2.1. Each group will start at one of the four tables. Every five minutes they must change and go to the next table. At each station students fill in the table using + if they can get easily collect each seed and with – if difficult (if it is really very easy it also use ++ or even +++.)

Discuss the experiences when every group has filled in their table. What kind of seeds could they pick up easily/with difficulty and with which tweezers? Why?

LOCATION
Indoor / Outdoor

PREPARATIONS

Outdoor or indoor: a large open space e.g. schoolyard or gym.

RESOURCES

Sweenex, L. B.; Meadows, D., Mehers, G. M. (2011): *The System Thinking Playbook for Climate Change.* Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH, Eschborn, Germany p. 123–128.

3| TRIANGLES (OPTIONAL EXTENSION)

» DISCOVER

Many organisms accomplish complicated ends using surprisingly simple means. For example, a colony of ants can find food by walking more or less aimlessly. They deposit a chemical (pheromone) behind them as they travel. When an ant finds food, it follows its own pheromone trail back to the nest. Now this trail is stronger than the others, because the pheromone has been laid on it twice. Ants have a simple rule, which is, when you find a pheromone trail that's stronger than yours, follow it. Thus, the other ants eventually discover the pathway to food.

Ask each student mentally (privately) to choose two other people in the group. Explain that when you say 'go', each student needs to form a triangle with the two other students selected, so that they are equidistant from each of them (i.e. an equilateral triangle). The triangle can be of any size, but you must be an equal distance from both students you've selected. Once you are in an equilateral triangle with them, you can stop moving.

Start the activity and enjoy the action as it unfolds. What will happen is that the group of students will start to move around silently, as each student, keeping an eye on the two other students they have selected to form a triangle with, tries to settle into a stable arrangement and stop moving. Each student has likely selected different students to form a triangle with, so you can see that a stable arrangement in not easy. The fun of the activity is that the mass of students will move about silently and a stable arrangement will emerge out of what seems, at first, like chaos. Getting there will entail a great deal of adjustment, but the adjustments happen 'automatically'. In the end, all of the students will be arranged equidistant from two other students. It is a sophisticated pattern to impose upon a group of people, but it can be achieved readily with each individual student simply operating from a simple rule. No 'central command' is required. In fact, using a central command to achieve the arrangement is generally a much more difficult and inefficient way to do it.

LOCATION
Indoor / Outdoor

PREPARATIONS

Arrange classroom for discussion.

4| REVIEW

» QUESTION

After the activity/ies talk with students about the principle:

- Have you heard about heirloom plants? They are certain varieties of plant (mostly fruit or vegetable) species adapted to a habitat. They can have lower productivity than a modern variety, but in most cases they need no or less pest control. Try to find heirlooms characteristic for your locality.
- Think about how could you use this biomimicry principle; what local solutions can you find?

W2.1 – PLAYING BEAKS

Seeds/ Objects	Tweezers							
	Table 1		Table 2		Table 3		Table 4	
	1. sugar tong	2.	3.	4.	5.	6.	7.	8.
sugar cube	+++							