PRINCIPLE 7: NATURE DEMANDS LOCAL EXPERTISE

How does nature adapt to different circumstances?

Erasmus+

AGE RANGE

11–13

DURATION

Preparation:
about 20 min.

Activity:
about 45 min. / 1 lesson

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.

SUBJECT(S)

This module is part of a series of modules introducing the nine principles of biomimicry. The table below shows possible KS3 Programme of Study links for all the modules. Many of the activities will also be suitable for upper KS2.

This learning module can be used flexibly within the curriculum to support key knowledge about Biology and develop working scientifically competences. The learning links with the Sustainable Development Goals and provides a broader context for student learning. It is suitable for adapting as a STEM activity or Eco Club.

Programme of Study Reference	Working Scientifically
Biology: Material cycles and energy - Photosynthesis • the reactants in, and products of, photosynthesis, and a word summary for photosynthesis. • the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere. • the adaptations of leaves for photosynthesis. Interactions and interdependencies – Relationships in an ecosystem • the interdependence of organisms in an ecosystem, including food webs and insect pollinated crops. • how organisms affect, and are affected by, their environment, including the accumulation of toxic materials. Genetics and evolution – Inheritance, chromosomes, DNA and genes • changes in the environment may leave individuals within a species, and some entire species, less well adapted to compete successfully and reproduce, which in turn may lead to extinction. • the importance of maintaining biodiversity and the use of gene banks to preserve hereditary material.	Students successfully completing this module will have had the opportunity to access these statements: **2a, 2b, 3b, 3c, 3d, 3f**. See Annex 1 for full statements.

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.

Health and Safety
Appropriate consideration needs to be given to health and safety when working outdoors, but this should not prohibit regular use of the outdoor learning environment.

For guidance on using the outdoor learning environment review the Council for Learning Outside the Classroom suggestions on Plan and Deliver. CLEAPSS also provides guidance for members. We recommend you read and act on L196 – Managing Risk Assessment in Science. Finally, check your school policy on learning outside the classroom.

The Institute for Outdoor Learning provides a good overview into the risks and benefits of outdoor learning here. They also offer specific guidance and advice for schools here.

ACTIVITY DETAILS

LOCATION
Indoor

TOOLS AND MATERIALS

- 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.

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	+++							

ANNEX 1

Key Stage 4 Working Scientifically Statements

Through the content across all three disciplines, students should be taught so that they develop understanding and first-hand experience of:

1. THE DEVELOPMENT OF SCIENTIFIC THINKING	a. the ways in which scientific methods and theories develop over time b. using a variety of concepts and models to develop scientific explanations and understanding c. appreciating the power and limitations of science and considering ethical issues which may arise d. explaining everyday and technological applications of science; evaluating associated personal, social, economic and environmental implications; and making decisions based on the evaluation of evidence and arguments e. evaluating risks both in practical science and the wider societal context, including perception of risk f. recognising the importance of peer review of results and of communication of results to a range of audiences
2. EXPERIMENTAL SKILLS AND STRATEGIES	a. using scientific theories and explanations to develop hypotheses b. planning experiments to make observations, test hypotheses or explore phenomena c. applying a knowledge of a range of techniques, apparatus, and materials to select those appropriate both for fieldwork and for experiments d. carrying out experiments appropriately, having due regard to the correct manipulation of apparatus, the accuracy of measurements and health and safety considerations e. recognising when to apply a knowledge of sampling techniques to ensure any samples collected are representative f. making and recording observations and measurements using a range of apparatus and methods g. evaluating methods and suggesting possible improvements and further investigations
3. ANALYSIS AND EVALUATION	a. applying the cycle of collecting, presenting and analysing data, including: i. presenting observations and other data using appropriate methods ii. translating data from one form to another iii. carrying out and representing mathematical and statistical analysis iv. representing distributions of results and making estimations of uncertainty v. interpreting observations and other data, including identifying patterns and trends, making inferences and drawing conclusions vi. presenting reasoned explanations, including relating data to hypotheses vii. being objective, evaluating data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error b. communicating the scientific rationale for investigations, including the methods used, the findings and reasoned conclusions, using paper-based and electronic reports and presentations

4. VOCABULARY, UNITS, SYMBOLS AND NOMENCLATURE	a. developing their use of scientific vocabulary and nomenclature b. recognising the importance of scientific quantities and understanding how they are determined c. using SI units and IUPAC chemical nomenclature unless inappropriate d. using prefixes and powers of ten for orders of magnitude (e.g. tera, giga, mega, kilo, centi, milli, micro and nano) e. interconverting units f. using an appropriate number of significant figures in calculations