PRINCIPLE 8:
NATURE SEEKS BALANCE
Self-regulation in nature

Erasmus+

AGE RANGE

11–13

DURATION

Preparation: about 20 min.

Activity: about 45 min. / 1 lesson

KEYWORDS

Biomimicry principles; needs; self-regulation

SUMMARY

Nature is a fine-tuned system; everything is carefully regulated. In this module students explore how deer live in-tune with their habitat.

BIOMIMICRY PRINCIPLES

8 – Nature seeks balance

LEARNING OBJECTIVES

- Students understand nature as an interconnected system.
- Students understand how nature self-regulates.
- Students understand supply and demand in nature.

LEARNING OUTCOMES

- Students become deer and role play meeting their needs.
- Students experience how in a healthy ecosystem natural resources fluctuate within limits.
- Students reflect about how human life depends on natural resources.

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 important needs and opportunities that can be addressed through design innovation for products, processes and systems.
- 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 deer and natural resources game	Students become deer and mimic how they meet their needs	• Role play	25	Outdoor
3	Review	Discussion after the activity	• Discussion	10	Indoor/ outdoor

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; 9th 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 8: 9_principles.ppt, slide 9.

Ecosystems will always try to keep in balance. More mice? Then you will see more owls to feed on the mice and keep the population in balance. Forest fires are a great example of a natural phenomenon that renews and refreshes, reducing excessive growth and allowing for regeneration. Every natural system has a tipping point, a carrying capacity or a state of disequilibrium that triggers a change to a different state.

Explanation to 9_principles.ppt, 9th slide:

Ecosystems are self-regulating, maintaining a dynamic balance free from extreme fluctuations. For example, every fourth year increases in lemming numbers create a shortfall in food availability. This results in mass migration of lemmings to seek new food sources and the local population to reduce back to sustainable levels.

Predator control on prey population (Lotka-Volterra model)
If the number of prey species increases, so does the number of predator species; this results in a decrease in the number of prey animals, which in turn will reduce the number of predator species. This basic mechanism was described by two mathematicians: Alfred J. Lotka (American) and Vittorio Volterra (Italian). An example is the interaction between Canadian lynx and polar rabbit (changes occur over a period of about 10 years). This cyclicality could only be detected in the Arctic, where few species of prey live, so the predator cannot switch from one prey to another.

In reality, the predator-prey relationship is much more complicated. It has many components, including multiple prey and predators, the impact of weather conditions and availability of food for prey organisms. Most predators are actually polyphagic, meaning they consume a variety of foods. As a result, their headcount changes are much smaller. In the case of a complex food web there is a high degree of stability, resulting a smaller curve swing (amplitude).

ACTIVITY DETAILS

Carrying capacity of the environment

If a species lives in the right conditions, it will produce more than two offspring during its lifetime (i.e. the father and mother will not replace only themselves). If we imagine an ideal population where the individuals are not affected by the environment, then the number of individuals would increase exponentially, that is to say, a dramatic change in the number of individuals. In nature, however, environmental factors prevent this exponential growth (e.g. weather, food, predators, disease). As the density of individuals increases, density-dependent limiting factors appear, for example as the number of individuals increases the amount of food per individual decreases; disease and parasites can spread more easily. So, the growth of the population slows down and stops.

The density of a population above which the population cannot permanently be greater is called the environmental maintenance capacity. The number of individuals in a given habitat must not permanently exceed its carrying capacity. In species-rich habitats, the numbers of individuals in a population are not prone to extreme fluctuations, while in species-poor associations (e.g. monoculture) there may be extreme fluctuations.

Stability of natural communities = resistance to disturbance

If a system is exposed to external influences, it may provide a resistant or a resilient response. In the first case it prevents the attack, in the second case it successfully adapts to the new conditions and a new system emerges. Resilience is also an organizing force. In shock, the system shifts from its original equilibrium and then reorganizes and recovers at another level.

LOCATION
Outdoor

TOOLS AND MATERIALS

- paper and a pen for writing the number of deer in each round

PREPARATIONS

Outdoor activity: schoolyard or a large level area is needed.

2| PLAYING DEER AND NATURAL RESOURCES GAME

» DISCOVER

Animals have four essential needs for survival: food, water, shelter and space. This game models the balance between these elements.

Divide students into two groups: one group will be the deer, the other the conditions in nature which the deer need. Each of the four needs is represented by:

- food: hands on stomach;
- water: hands at mouth;
- shelter: hands form roof above head;
- space: arms spread out wide.

The two groups line up in rows 15–20 m apart facing backwards (no looking). The deer choose what they need (making the correct sign), as do the students playing the conditions (needs) for survival.

When instructed, both groups turn around to face each other. They are not allowed to change their signs. The conditions (needs) stay where they are whilst the deer run to grab a condition matching the need they have selected, bringing it back with them. When two deer run for the same need, the fastest wins, the slower dies. Any deer who have not found their need die, and become the conditions (needs) in the next round together with any unclaimed needs.

Play at least 5 rounds, preferably 10, writing down the number of deer and conditions (needs) at the start of each round.

Observe how the number of deer change and what caused the change. You can plot the number of deer and needs in each round on a graph to clearly observe the relationship.

Discuss with students how the numbers of deer were regulated by the conditions (needs).

ACTIVITY DETAILS

LOCATION
Indoor / Outdoor

PREPARATIONS

Arrange classroom for discussion.

3| REVIEW

» QUESTION

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

- This principle is very important for humans to remember and apply. Try to collect examples of where humans have ignored this principle.
- What can be the effect(s)?
- How could it be avoided?

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