MARVELLOUS MODELS

Introduction module to practice skills for nature-inspired learning

Erasmus+

AGE RANGE

11–13

DURATION

Preparation:
20 min.

Activity:
100 min. / 2 lessons

KEYWORDS

Research; formulating questions; biology; nature

SUMMARY

Learning from nature to address a challenge or opportunity starts with asking the question "how does nature manage a similar challenge?" This introductory module focuses on the basic skills that are needed to be able to learn from nature.

BIOMIMICRY PRINCIPLES

The 9 principles will not be addressed in the module because this a basic introduction to skills.

LEARNING OBJECTIVES

- Students understand that besides learning about nature, they can learn from nature.
- Students understand the importance of asking the right questions.
- Students develop a different way of looking at nature.

LEARNING OUTCOMES

- Students critically observe different organisms and ask questions to learn more about each organism.
- Students choose one organism as their model and work out what they can learn from it.
- Students identify specific features and functions of an organism, and consider how these can be adapted for different uses.

SUBJECT(S)

This learning module can be used flexibly within the curriculum to support key knowledge about Biology, Design Engineering & Technology, 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: KS4 Photosynthesis • photosynthesis as the key process for food production and therefore biomass for life. • the process of photosynthesis. Ecosystems • some abiotic and biotic factors which affect communities; the importance of interactions between organisms in a community • organisms are interdependent and are adapted to their environment • the importance of biodiversity • methods of identifying species and measuring distribution, frequency and abundance of species within a habitat. Evolution, inheritance and variation • developments in biology affecting classification. KS3 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 • differences between species • the variation between species and between individuals of the same species means some organisms compete more successfully, which can drive natural selection • 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. **Design, Technology and Engineering:** KS4 • Design and making principles (links with most areas). KS3 • Design (links with most areas).	Students successfully completing this module will have had the opportunity to access these statements: **2a, 2b, 2c, 2d, 2e, 2f, 3c, 3d, 3f**. See Annex 1 for full statements.

BIOLEARN COMPETENCES

- Students can 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 can use analogical thinking to innovate, using biological models to inspire solutions to design challenges.
- Students can 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	Description	Method	Duration	Location
LESSON 1. Star bursting					
1	Observing animals	Students undertake investigations about different animals	• Observation • Research	15	Indoor
2	Domains	Students investigate the domains of animals	• Research	15	Indoor
3	Observation in nature	Students go outside to observe and investigate nature	• Observation • Research • Synthesis	20	Outdoor
LESSON 2. Your marvellous model					
4	Choosing and observing model	Students choose a model from nature and undertake research about it	• Research	10	Indoor
5	Learning from your model	Students learn more about their chosen organism and produce a poster about it	• Research • Hands-on activity	15	Indoor
6	Poster presentations	Teams present their posters to each other	• Student presentation	15	Indoor
7	Applying the ideas	Students think more about what they can learn from their model	• Design activity	10	Indoor

BACKGROUND FOR TEACHERS

In biology you learn *about* nature. For example, how animals live and what a food chain is. In nature-inspired learning the approach is different. We see nature as a model and as a mentor. As a model because plants and animals have many ingenious solutions that we as humans also have. As a mentor biomimicry always asks “how would nature solve that?” In BioLearn we learn from nature and that requires a different way of looking. In this module students will learn to observe like a biologist does and students will explore what they can learn from well-known organisms. Students start brainstorming what they can learn from it and apply this to solve a challenge.

ACTIVITY DETAILS

LESSON 1. Star Bursting

LOCATION
Indoor

1| OBSERVING ANIMALS

» DISCOVER

TOOLS AND MATERIALS

Student worksheet: W1.1

This activity asks students to start closely observing animals. It guides them to learn about plants and animals by asking different questions. They will choose an animal and look for answers to different questions about it. Students work in pairs using student worksheet W1.1.

LOCATION
Indoor

2| DOMAINS

» DISCOVER

TOOLS AND MATERIALS

Student worksheet: W2.1

In this activity students choose two domains they want to investigate further for their chosen animal. They ask questions about each domain. Students continue working in pairs using student worksheet W2.1.

LOCATION
Outdoor

3| OBSERVATION IN NATURE

» DISCOVER

TOOLS AND MATERIALS

Student worksheet: W3.1

Students continue working in pairs with the help of student worksheet W3.1. They go outside and search for living creatures to observe. They ask numerous questions about the creature using the star questionnaire.

PREPARATIONS

Outdoor: find a place with some trees, plants, and preferably insects and other animals to be seen. This activity could also be done at home. Any place where you can find these elements of nature is suitable for this activity.

LESSON 2. Your marvellous model

LOCATION
Indoor

4| CHOOSING AND OBSERVING MODEL

» DISCOVER

TOOLS AND MATERIALS

- student worksheet: W4.1
- books on flora and fauna of your country/ neighbourhood
- computer or smartphone with internet access

In this activity students select one organism to work with as a 'model' from nature. Over the following 4 activities students will expand their understanding of their chosen organism and use it as a model to inspire new ideas. Using student worksheet W4.1, students work in pairs to research their chosen organism with the help of internet, books or interviews.

LOCATION
Indoor

5| LEARNING FROM YOUR MODEL

» DISCOVER

TOOLS AND MATERIALS

- student worksheet: W5.1
- poster paper
- flip chart (if available)
- markers, scissors and glue per group

Students continue working in pairs using student worksheet W5.1. They observe and research their organism, identifying key features and characteristics about it. They produce a poster describing key features of their organism, then carry on to explore what functions these features provide and what we can learn from that for other uses.

PREPARATIONS

Indoor: arrange the classroom with space for students to prepare posters.

LOCATION
Indoor

6| POSTER PRESENTATIONS

» DISCOVER

TOOLS AND MATERIALS

Student worksheet: W6.1

In their pairs, students prepare a presentation using the questions on student worksheet W6.1 to help them. After each presentation they discuss the topic.

PREPARATIONS

Indoor: prepare the room for poster presentations by groups.

LOCATION
Indoor

7| APPLYING THE IDEAS

» DISCOVER

TOOLS AND MATERIALS

Student worksheet: W7.1

In groups of 4 (two pairs), students put together the new understanding and knowledge they have gained during the two lessons. Using student worksheet W7.1 to help, they identify new ideas which have arisen and new applications for these. After the group work, they discuss together what they have found.

PREPARATIONS

Indoor: arrange the class-room for group work.

STUDENT WORKSHEETS

W1.1 OBSERVATION OF ANIMALS

TEAM MEMBERS: _____ & _____

Practising

In this lesson you will learn more about plants and animals by asking different questions. About which of these animals do you want to know more?

Heron (the Netherlands)

Monitor Lizard (Costa Rica)

Just have a good look at the physical appearance of your animal. Can you tell something about the food it is eating? Does it have teeth? A beak? Can it run fast? What do you think it will eat?

Now look at the environment it is living in. Warm? Cold? What kind of skin and protection do you see? What does that tell you?

W2.1 DOMAINS

Choose two domains that you want to investigate further for your animal. Try to write three or more questions for two of these domains:

1. Environment
2. Food
3. Physical characteristics
4. Reproduction (life cycle)
5. Threats and survival

DOMAIN	YOUR QUESTIONS
	1. 2. 3.
	1. 2. 3.

W3.1 OBSERVATION IN NATURE

For real

Go out and choose an organism that you find in nature. If it runs away, you can carefully place it in a box to observe it. You can also find a picture of it on the internet. Ask yourself the following questions:

1. What animal did you choose?
2. Try to come up with 10 questions at each point of the star. Observe carefully without trying to answer your questions.
3. Take another look at your questions. Are they specific and as concrete as possible? If necessary, rephrase your questions.
4. Go back inside and discuss the questions with your teacher. Are they well formulated?
5. Save the questions for the next assignment, they will come in handy!

QUESTIONS ABOUT ENVIRONMENT (HABITAT)

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

QUESTIONS ABOUT FOOD

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

QUESTIONS ABOUT PHYSICAL CHARACTERISTICS

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

QUESTIONS ABOUT LIFECYCLE

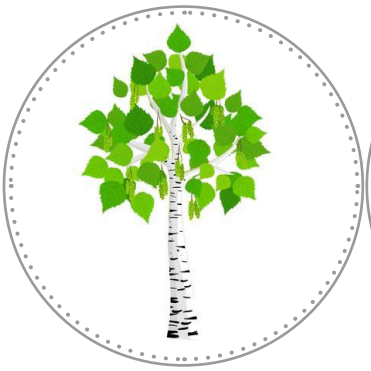
1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

QUESTIONS ABOUT THREATS AND SURVIVAL

1. .....
2. .....
3. .....
4. .....
5. .....
6. .....
7. .....
8. .....
9. .....
10. .....

W4.1 CHOOSING AND OBSERVING MODEL






What organism is your model for this lesson?

. . . . . .

RESEARCH

You are now going to search as much information about your model as you both can. You can look on the internet, in the library or ask around by conducting interviews.

1. What striking external features are there?
   - Where does it live (what kind of area)?
   - How does it live (sources of energy, mode of reproduction)?
   - What capabilities does this organism have?
2. Go back to the questions in the 'star bursting' exercise. Can you find some more ideas for questions to ask yourself?

   . . . . . .

   . . . . . .

   . . . . . .
3. Do a second round of research.
4. Make the first draft of a leaflet (1 A4 page) with characteristics and a picture of your model.

W5.1 LEARNING FROM YOUR MODEL

Selecting a special quality or feature

What particular characteristic strikes you about this organism? Is there something your organism is particularity good at? What is something that is very obvious (green plants can absorb light, elephants have big ears)?

Create a poster

Now create a poster about your organism with the following components:

a. A picture of the organism.
b. General description.
c. Habitat challenges, specific physical features and adaptations.
d. A special feature the organism has that you want to learn from.

Discussing the models

Discuss in pairs why this model is so skilled:
Think of a unique part of the organism such as: the animal can turn their head in 180° (owl) or the plant has flowers that open and close during twilight (evening primrose) or the animal can adapt the colour of its skin to the colour of the background (octopus).

What can we learn from your organism? Fill in the table below:

Feature	What function does this feature provide?	How does it work?	What can we learn from that?	Can we apply this for a different purpose?

Go and see the teacher and discuss your results and if sufficient, add this to your poster.

W6.1 POSTER PRESENTATIONS

You are going to present your findings. All groups will give a presentation and explain what they learned from their marvellous model. Use the following questions to create a 7-minute presentation:

1. What did you choose as your model?
2. Describe the three most striking features of your model.
3. What can we learn from your organism?
4. How and where can we apply these ideas?

After the presentations, your fellow students will have the opportunity to ask questions.

W7.1 APPLYING THE IDEA'S

During the presentations you have learned about the ideas of other groups. You have also heard about possible applications. Maybe some groups had the same model, or they had a very exiting plant or animal that intrigues you. Now you are going to learn from the other teams.

Combining ideas
Sit together in groups of 4 (two pairs) and explain how you want to apply the wisdom of your model in practice. Now brainstorm together:

a. Do you have more ideas?
b. Can you combine ideas?
c. Are there new fields of application?

	Model 1	Model 2
New ideas to learn from		
New fields of application		

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