TEACHING IDEAS SHARED FROM SAILS TEACHER EDUCATION PROGRAMME

Piscivorous birds

This resource has been developed through the SAILS Teacher Education Programmes (2012-2015) but was not developed as a finalized SAILS Inquiry and Assessment Unit. These materials are shared to inspire further use of inquiry and assessment of inquiry skills in the science classroom.

Strategies for Assessment of Inquiry Learning in Science

Author[s]	Mária Nagy, Gábor Horváth, Katalin Radnóti
Organisation	University of Szeged
Project Coordinator	Dr. Odilla Finlayson, Dublin City University.
Website	www.sails-project.eu
Email	info@sails-project.eu

This resource has been produced within the scope of the SAILS Project. The utilisation and release of this document is subject to the conditions of the contract within the Seventh Framework Programme. The SAILS Project has received funding from the European Union's Seventh Framework Programme for research technological development and demonstration under grant agreement no 289085.

Roland Eotvos University
Faculty of Science
Institute of Physics

Radnóti Katalin

Piscivorous birds

Section 1: Topic

The preying techniques of piscivorous birds and its links with refraction in water
Physics and biology classes
Optics, experimentation, ornithology
Age group: 14-15 years of age
Time: 90 minutes
Studying of scientific literature; demonstrating the process of scientific inquiry, developing environmental consciousness.

Section 2: Content - Key concepts and ideas

Refraction, speed (direction, magnitude), piscivorous birds, classification, the methods of scientific inquiry, stages of an experiment

Section 3: Inquiry and reasoning skills and scientific literacy

Skills for development:

- Competences in professional subjects:
  - *interpreting the terminology:* mainly related to refraction in physics and the feeding habits of piscivorous birds in ornithology
  - *Transfer:* linking the subject of biology and physics
  - The task is not only to understand a scientific text, but also to follow a scientific experimental process:
    - developing a hypothesis
    - planning an experiment
    - setting up a control environment
    - collecting data
    - recording information
    - formulating conclusions

- Developing thinking skills
  - critical thinking
  - following an experimental situation
  - developing abstract thinking

- Communication skills
  - The students have to interpret a given text, than talk about it in small groups and finally present it to the whole class.

- Attitudes
  - Natural occurrences can be observed and interpreted
  - The natural world has certain regularities
  - The creative questions (9, 10, 11), allow students to free their thinking. From this, students may get the impression of science being a fun and creative task.

Section 4: Suggested Learning Sequence

2x45 minutes

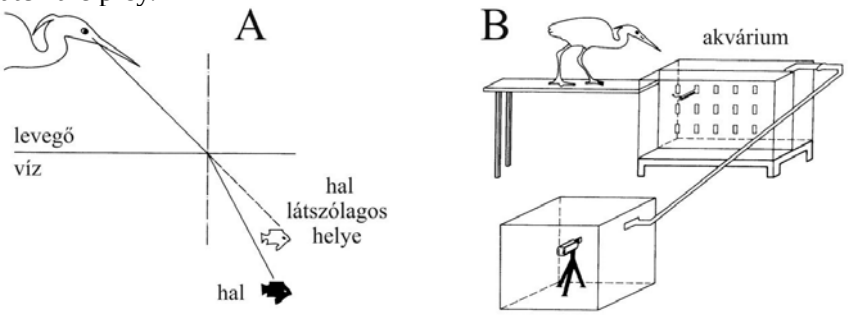
Student Learning activity	**Supportive Teacher activity**	**Inquiry skills and processes**
Evaluation of prior knowledge, both in respect of text interpretation and scientific understanding	Evaluation of prior knowledge: optics: • What is light? • What is refraction? × laws of refraction × occurrences due to refraction biology: • piscivorous birds Prior understanding of inquiry***:*** • Why is it useful to make inquiry? • How does scientific research look like? • What steps must be taken? • ***How does inquiry relate to the subjects in class***? • What problems can occur during scientific research? In what instances would the students find such inquiry useful? If an experiment cannot be made, what other ways can inquiry be performed?	Discussing and formulating prior student knowledge. Expressing opinion about a scientific process or inquiry
The students should read the text on their own		Understanding scientific text
The students formulate answers to the 11 questions that follow the text		Formulating an extract to aid understanding a scientific text
The students form groups to discuss the questions they have answered.	The teacher observes the discussions within the groups	Communicating ideas with others, cooperating in a group, listening to

		other's arguments.
The students modify their answers, according to the conclusions they reached in the groups		Revision of one's opinion according to other's observations. Formulation.
Discussing the answers as a whole class	The teacher observes and gives guidance to find the correct answers	Observing and considering the process of scientific inquiry. Critical thinking. Developing creativity by finding new ways of inquiry.

The text to be processed:

Predatory animals, for effective preying, must determine the exact location of the prey, therefore its direction and distance. The prey of piscivorous birds is found underwater, this way the location of the prey appears to be elsewhere, compared to where it actually is, due to refraction. This demands some optical correction from the preying bird. There are some species of piscivorous birds, like herons and egrets that stalk their prey in shallow water.

Scientists observed in laboratory conditions, if the little egret can make the necessary corrections to catch the prey.



The experimental setting shown above on image AB was constructed. Small fish (prey) were put into the aquarium. Then the process of the egret striking the fish was recorded by a video camera.

In part of the experiments the aquarium was filled with water and then with air, where the fish were fixed. The video recordings of each strike, in each situation were compared with the aid of a computer.

During the experiments the egrets had a very high probability of success they almost never missed, regardless of the prey being in water or air.

Analysis of the videos revealed that the egret's strike could be divided into two phases if the prey was in water: The first, slow (50 cm/s) phase the beak points approximately towards the prey. Later the second phase begins suddenly when the strike accelerates to more than five times (270 cm/s) the speed of the first phase. The beak points directly at the prey despite appearing elsewhere. The beak only opens just prior to reaching the prey.

In case the prey is not underwater, the beaks movement cannot be divided into phases: The beak is directed at the prey from a distance and is accelerated continuously.

The experiments showed that the little egret can compensate the few centimeters difference in position and appearance due to refraction. In such cases the bird can get very close to the prey and can strike from an almost vertical position with close to 100% accuracy.

Questions related to the text

1.) What was the initial question?
2.) What was the presupposition? Hypothesis?
3.) What simplifications were made by the researchers during the experiment?
4.) What measurements were made by the researchers?
5.) What were the experimental and the control measurements?
6.) How did they analyze the observations?
7.) What sort of mistakes could have occurred during the experiment?
8.) What conclusions were made by the researchers?
9.) What other inquiry questions could you formulate about the experiment?
10.) What sort of experimental setting would you have used?
11.) What other measurements would you have conducted?

Section 5: Assessment opportunities

Student Learning activity	**Inquiry skills and processes**	**Assessment (concepts, inquiry skills, reasoning and scientific literacy)**
Evaluation of prior knowledge, both in respect of text interpretation and scientific understanding	The students talk about their prior scientific knowledge. Formulating opinion about a scientific inquiry.	The ability to express one's self. The extent of student's knowledge of physical and biological laws. How accurately can they express their observations?
The students should read the text on their own	Understanding scientific terminology.	How much can students understand from a scientific text?
The students formulate answers to the 11 questions that follow the text	Formulating an extract to help understanding a scientific text.	Recognition of scientific inquiry steps in an experiment.
The students form groups to discuss the questions they have answered.	Communication, listening to other opinions. Cooperative work skills.	Discussing scientific literature, ability to talk about scientific research
The students modify their answers, according to the conclusions they reached in the groups	Reconsidering own opinion according to other's opinion.	Ability to listen to other's opinions and consider them.

	Formulation.	
Discussing the answers as a whole class	Understanding scientific procedures. Critical thinking. Creativity Developing new measurement methods	Processing scientific literature, developing critical thinking. Formulating experiments to support their own studies and to work cooperatively with others to carry out an experiment. Developing scientific thinking that can be utilized in the future to process other scientific problems.

The evaluation of each answer given to the questions
Questions 9. 10. 11. are directed towards the student's creativity and are suitable for measuring the knowledge of students who are not typically effective during classes

Section 6: Case studies- Evaluation of evidence of learning

The above text analysis has been tested multiple times in real classroom conditions. The text has been discussed by different student age groups. In total 83 students took part in such lessons, aged 12-16. The students found both the text and the teaching method interesting; despite the fact that it differed a lot from the conventional teaching methods and that they haven't been thought like this before. The questions following the text were found to be strange by the students. The lesson was 45 minutes long.
We expected the following answers to the questions:

1) What was the initial question?

Can the little egret make the necessary corrections during hunting?

We expected the students to answer this question with a question.

2) What was the presupposition, hypothesis?
Yes the little egret can make the corrections.

It is important however to discuss the situation when the experiment doesn't support a hypothesis, as this can occur also. Nature doesn't always work as expected, for instance when reaction time depends on temperature. Such discussions help students understand the problems of scientific study.

3) What sort of simplifications did the researchers make during the experiment?

The researchers only focused on the prey and its surrounding medium

During the discussions it is important to note, that such simplifications often occur in science, for instance in physics when we readily discard the effect of friction on an object, if otherwise friction is not the effect studied.

4) What measurements were made by the researchers?

Initially the researchers studied the hunting methods of piscivorous birds using the experimental setup with the aquarium and with the help of a computer. Then they measured the movement of the birds head in time, they measured speed and angle of the strike. They observed the rate of success per strike.

Sometimes the students failed to realize how the experimental instruments were set up and had difficulty in understanding what measurements were made.

5) What were the experimental and the control measurements?

Measurements were taken not only of prey in water, but also in air.

The students found this to be one of the hardest questions and failed to realize what part of the experiment should they describe here. Often the stages of the bird strike were copied falsely.

6) How did they analyze the observations?

During the analysis the researchers were measuring the success rate in percentages.

7) What sort of mistakes could have occurred during the experiment?

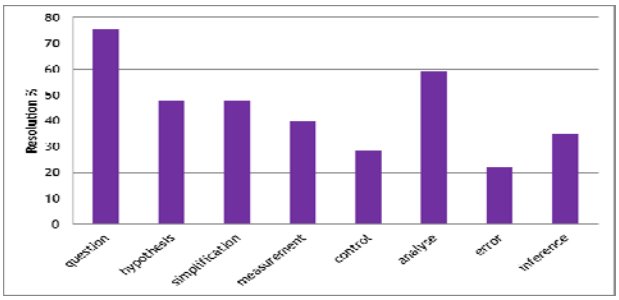
Mistakes may have been: wrong video recorder setup, bird too far from aquarium, disturbing the bird, etc.

8) What conclusions were made by the researchers?

The success rate of the little egret was almost 100%.

The received student answers were collected and analyzed. To get a picture of how effective the students were in studying the text and answering the questions, a code was rendered to each question, and a marking system was developed. During evaluation the answers were divided into two groups. Because the first eight questions were entirely related to the text, they could be simply read out of the text and copied as answers. The questions 9., 10. and 11. required a certain creativity from the students and some prior understanding of the natural environment and reality.

To questions 1-8 3 points were given if correct, 2 points if partially correct, 1 point if largely incorrect and 0 points if nothing was written. To questions 9-11 0 points were given if there was no answer, 1 point was given if there was one idea and 2 points if there were more than one idea written. The marks were recorded in Excel. The Excel table was statistically analyzed and the results are given in the table below. Since we had only a small sample, the given table should only be taken at an informative level.



The evaluation of the questions related to a scientific research text, given in percentages per question type .

The bar chart shows the percentage of correct answers for all the 83 students who took part in the experiment. It clearly shows that students had the most problem answering the questions on possible mistakes and control measurements. These are exactly the questions that are most important to scientific thinking.

9) What other inquiry questions could you formulate about the experiment?

The possibility to study other bird species, the importance of beak size

The possibility of studying inverted refraction problems in case of archerfish

10) What sort of experimental setting would you have used?

Conducting the experiment in a small controlled lake, or using inexperienced, young birds

11) What other measurements would you have conducted?

Measuring bird distance from water
Measuring water temperature and reflexes
Measuring beak pressure during preying

<u>Other methodical solutions:</u>

When discussing the entire experiment, it would be good to ask the students on how they would use these methods for their own experiments. Asking if they would use their own experimental methods to prove one of their hypothesis or they would rather use an available method. It would be important to ask this sort of questions after all demonstrated hypothesis and to reveal the history of various scientific claims.

The scientific text was given as an individual task to the students during our research in order to allow the evaluation, but in everyday teaching it could be solved in teams instead and this is our general recommendation.

The text source:

1. Gadi Katzir and Nathan Intrator: Striking of underwater prey by a reef heron, Egretta gularis schistacea. *Journal of Comparative Physiology A* (1987) 160: 517-523.
2. Gadi Katzir, Arnon Lotem and Nathan Intrator:Stationary underwater prey missed by reef herons, Egretta gularis: head position and light refraction at the moment of strike. *Journal of Comparative Physiology A* (1989) 165: 573-576.

In Hungarian: Horváth Gábor (2004): *A geometriai optika biológiai alkalmazása*. ELTE Eötvös Kiadó, Budapest.

- Own articles on the topic in Hungarian:

Nagy Mária – Horváth Gábor – Radnóti Katalin (2013): Kutatási szöveg tanórai feldolgozása. Iskolakultúra 2013/9. 96-109. oldalak
http://www.iskolakultura.hu/ikultura-folyoirat/index.htm