

Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science

PROFILES IBSE Teaching/Learning Materials – Teacher Guide

Compiled by the PROFILES Working Group of the Masaryk University, Czech Republic



Safety of human body: swimming and diving



A Module for IBSE

Instruction: **Science** (especially **Physics** and **Biology**)

Grades: **5th to 9th**

Abstract

The main objective is the safety of the human body investigated by students with use of simple experiments. The safety of the human body in everyday living is the significant content for effective teaching-learning because of practical use and interest. This content can be implemented in family education as the transfer of information about the safety risks from school into families by means of students. This content develops better perceptions of science for students and society. Students are acquainted with human body parameters which can be expressed with the aid of quantities, units and laws. Also external conditions are very important for preservation of vital functions of the human organism including health. This module can develop students' knowledge, understanding and skills to understand science law; measuring unites; applying knowledge in every day practice, interdisciplinary (science) integration of knowledge from separate subjects (Physics + Biology). The maim advantage of this module is his very high level of motivation.

MODULE DESCRIPTION:

1. Objective of the module:

To provide students and teachers with motivational content “Safety of human body: swimming and diving” based on science inter-disciplinarily, knowledge and skills application in everyday life.

2. Learning outcomes of the module:

Students will be able to:

- Understand and explain application of Archimedes law in daily life.
- Investigate the processes in human organs and organism during swimming and diving.
- Evaluate the risks of human body during swimming and diving.
- Design and conduct set of experiments to model the behaviour of human organs during swimming and diving.

3. Curriculum content:

Archimedes law applications, swimming and diving injury prevention.

4. Prior knowledge:

Archimedes law, floating, hovering, sinking, density, hydrostatic pressure, breathing, hearing.

5. Kind of activity:

Inquiring, experimenting, creating of hypotheses, development of experimental apparatus, group activities etc.

6. Anticipated time:

3 lessons (per 45 minutes)

TEACHER GUIDE:

Scenario:

➔ *Read the stories and think about them:*

Scenario (story) is used to motivate students and stimulate of problem situations, when students ask questions that they want to solve. A student should read a story in peace.

The first story concerns with the problem of vasoconstriction which is caused by sharp cooling down of the body. Vasoconstriction of the surface vessels increases the blood pressure in the central artery. This sudden increase in blood pressure can cause the collapse of the body or even death.

Who is right?

Peter went cycling with his parents. At noon they came to a river. It was really hot and Peter was very sweaty and looked forward to cool down. He wanted to jump into the cold water immediately. His mother stopped him and told him he had to wait to cool down, because otherwise he could even get drowned. Peter laughed, thinking it was a superstition that parents tell their children, because they are afraid that they might catch a cold. But he is hardy and is not afraid of cold water.

The second story introduces problems concerning endangering health and even life while diving.

Death during diving.

News from a TV broadcast: Yesterday famous singer D.N. tragically died during a scuba-diving in the seaside resort of H. Local police spokesman said that the exact cause of death will be clarified by means of autopsy ordered by the court. Senior instructor diving L.T. answered our query what can cause tragedy during diving - it may be a small injury, which is e.g. ruptured eardrum. Details will be included in subsequent news.

Problems and questions:

➡ *Carefully re-read the stories and write down the questions that occur to you:*

All students have again carefully read the text of stories with a challenge to subsequently write their questions which occur to them during reading stories.

- 1.....
- 2.....
- 3.....
- 4.....
- 5.....

➡ *If you have just no ideas, select some of the following questions:*

Less able students, who cannot create their questions about the story they can choose from a compiled questions that are directed to the core problem of both stories.

- (a) What properties of water can cause health risks or even death of a man?
- (b) Which organs of the human body and why can be damaged during swimming and diving?
- (c) What kinds of swimming and diving in the water are risky?
- (d) Which rules of safe swimming and diving we follow?

These overviewed questions will be together answered at the end of module in the whole class and linked to students' questions.

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The following experiments help to answer questions:

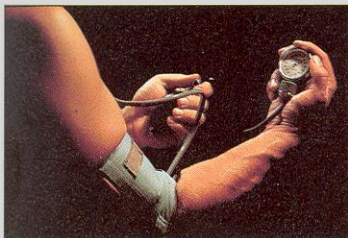
In this place series of experiments are presented, using those students discover necessary phenomena and laws.

Experiments are selected and arranged so that their results help to answer students' questions. These are the model experiments, when the students have to use e.g. analogies between phenomena concerning to air and water (experiment 2-4). It is the application of the second and third level IBSE, where student using exploration (experimentation) is looking for answers to the assigned questions or own questions.

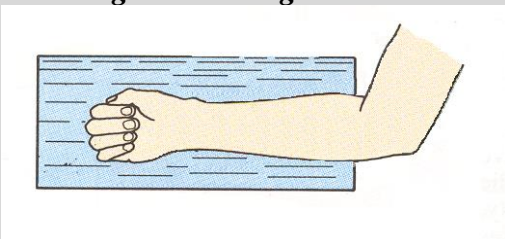
Tasks and experimenting:

❖ Experiment 1: Cold test of blood pressure

- ▶ *Measure and write down temperature of air in the classroom.*
- ▶ *Measure the normal blood pressure in the left arm using sphygmomanometer. Write this result down.*
- ▶ *Let the cuff on the arm - you will repeat the measurement again.*



- ▶ *Measure the temperature of cold water ready to cool the right hand classmates.*
- ▶ *Put the right arm into the bucket of cold water. Measure the pressure in left arm again. Once again write down the result.*



- ▶ *Compare the results and evaluate the condition of your vessels.*

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The experiment allows the student to discover blood pressure dependence on cooling of the human body - in this case the arm. We use barometer - (preferably a digital one) and container with cold water as tools. Experiment is safe, it can be carried out without the risk of students. We also use a thermometer to determine the temperature in the room and a thermometer to determine the temperature of cold water.

Results and implications of experiment:

- *The cold phenomenon is caused by the vasoconstriction of vessels and decreased blood flow in the organs - primarily the skin and muscle capillaries are affected. If we are in a cold environment, the vessels in less important tissues, especially surface tissues such as skin and muscle, contract so the blood doesn't cool down and doesn't cool the body core temperature.*
- *Vasoconstriction of the surface vessels increases the blood pressure in the central artery. The amount of change depends on the condition of the vessels, on their reactivity. If the temperature change is rapid and in addition on the large surface of the body, can cause a rapid rise in blood pressure and the collapse of the body, which can cause death.*

The worksheet is used to write down the detected values of measured quantities and leads students to formulate and write down the results of experimentation and observation. Thus, students acquire the skill science inquiry.

<i>Worksheet</i>	Cold test of blood pressure			
1.	<i>Room air temperature:</i>		<i>Left arm blood pressure:</i>	
2.	<i>Cold water temperature:</i>		<i>Left arm blood pressure after cooling of right arm in water:</i>	
3.	<i>Difference of temperatures of air and water:</i>		<i>Difference of blood pressures:</i>	
4.	<i>Results of measuring and observing:</i>			

Students compare the results of their inquiry (observation and experimentation) with the correct scientific interpretation.

❖ Experiment 2: Modelling of ear-drum rupture under high water pressure of ear-drum rupture under water

The basic experiment aid is a plastic bottle with a wide neck.



The bottle cap is drilled and valve of tire is screwed into it.



Overpressure in the plastics bottles in all experiments is made out by hand-pressing or by a small velocipede tire-pump.



Experimental kit is easy to be built. For time reasons, it is advisable to prepare it before experimentation. From a security point of view it is necessary to use protective goggles or face shield. Plastic bottle is designed to withstand high pressure, yet we permit students to pump only a few times. It must be checked proper and secure closure of the bottle.

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We put individual experimental instruments, which are further described, into plastic bottles.

Instruments in plastics bottles are fixed on stands made out of copper wire, metal stick and wooden small plates.



- ▶ *Cover the mouth of the test tube by the rubber membrane (of an inflatable balloon) and secure with a rubber band.*
- ▶ *Connect the velocipede tire-pump to the valve and pump - you produce overpressure of air in the bottle.*



- ▶ *The membrane under the influence of pressure is bent into the test tube.*



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- ▶ *The deflection of the membrane increases with increasing overpressure.*



- ▶ *Replace the rubber membrane with a thin plastic membrane.*
- ▶ *Under the influence of pressure it is also bent into a test tube*



- ▶ *If overpressure in the bottle is sufficiently great, the plastic membrane ruptures.*



The rubber and plastic membranes simulate behaviour of ear-drum during swimming, bathing and diving. Water in ear (ear canal) pushes on ear-drum similarly as air on membranes in the case of our experiment. The result of this pressure is deformation of the eardrum and in the case of high pressure (overpressure) rupture of the ear-drum.

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Results and implications of experiment:

- *Deformational effect of overpressure force is demonstrated by the rupture of covering membrane on the test tube made out of a piece of plastics bag.*
- *The plastics membrane simulates the terminal behaviour of ear-drum during swimming, bathing and diving. Water in ear canal pushes on ear-drum by heavy force. The result is the rupture of ear-drum. The implication of this rupture is cutting pain and the loss of space-finding. This is the danger of death for the diver.*

Students compare the results of their inquiry (observation and experimentation) with the correct scientific interpretation.

❖ **Experiment3: Compression of lung**

- ▶ *Inflate the rubber balloon inside a plastic bottle.*



- ▶ *The over pressure in the bottle, caused by velocipede tire-pump, causes reduction in volume of the balloon.*



- ▶ *After opening the bottle balloon expands again.*



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Students perform experiment according to given instructions.

Results and implications of experiment:

- *Deformational effect of overpressure force is demonstrated by changing volume of an inflated small rubber balloon.*
- *The overpressure under water during diving reduces the lung volume. We are able to breathe spontaneously only about one metre under the water surface. Air must be pumped into our lung by overpressure during diving. At a depth of ten metres the lung volume is reduced to half. If diver emerges too quickly, his lung can be fatally damaged.*

Students compare the results of their inquiry (observation and experimentation) with the correct scientific interpretation.

❖ **Experiment 4: Dissolving of an air in blood**

- ▶ *The water in a pressurized bottle more air (gas) dissolve than under the normal atmospheric pressure.*



- ▶ *After opening a bottle air bubbles from water will begin to release.*



- ▶ *After the moment it is released large amounts of bubbles.*



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Students perform experiment according to given instructions.

Results and implications of experiment:

- *Air is dissolved into the water in the over pressured plastics bottle. The air (nitrogen) is dissolved into blood during diving. Air embolism is the frequent reason of death after fast emergence.*
- *During diving the greatest danger is barotrauma which can cause varying degrees of damage of organs or even death. Barotrauma is caused by a pressure change within body which has been exposed to a certain period of overpressure and fast emergence on the surface leads to a sudden reduction in pressure. Due to the blood vessels dilate, pressure is changing and blood gases are released and blood starts to froth.*

Students compare the results of their inquiry (observation and experimentation) with the correct scientific interpretation.

Decision making:

Answers to questions:

- Briefly answer the questions that you are expressed at the beginning of your inquiry.

1.....

Answer:

2.....

Answer:

3.....

Answer:

4.....

Answer:

5.....

Answer:

(a) What properties of water can cause health risks or even death of a man?

Answer:

(b) Which organs of the human body and why can be damaged during swimming and diving?

Answer:

(c) What kinds of swimming and diving in the water are risky?

Answer:

(d) Which rules of safe swimming and diving we follow?

Answer:

Students individually write down answers to the questions before starting the inquiry.

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Conclusions and recommendations to the stories:

- ➔ In the left column of the table write down your suggestions and recommendations that in your opinion belongs to these stories. Discuss with classmates and teachers about your opinions. Corrections and additions write down in the right column.

Worksheet: Who is right?		
	My opinion:	Correction and supplement after the discussion
1.		
2.		
3.		
4.		
5.		

Worksheet: Death during diving		
	My opinion:	Correction and supplement after the discussion
1.		
2.		
3.		
4.		
5.		

Based on own inquiry, the student the earliest fills himself/herself worksheets (tables) in the left part. Then during the discussion student conclusions are clarified and repaired.

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COMMENTS AND RECCOMENDATIONS:

Before the implementation of the module teacher should get as much information about diving. Diving is becoming very popular. There are manuals for divers where they are given e.g. tables showing the time required for safe emergence, the principles of safe diving or first aid, etc. Teachers (and students) can find a lot of important information in these manuals. In case of interest it is possible to arrange a discussion with a diving instructor.