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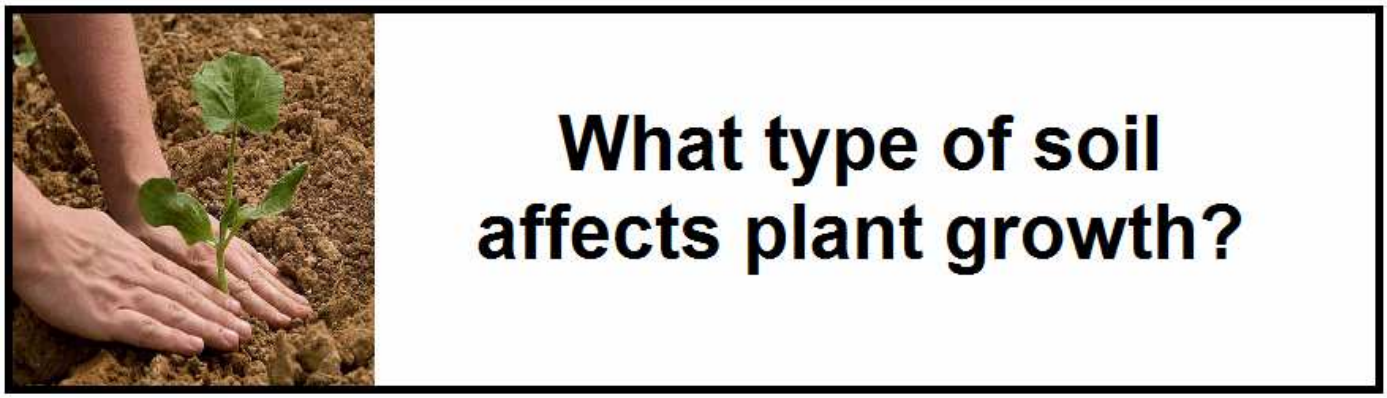
Uniwersytet Marii Curie-Skłodowskiej

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

PROFILES IBSE Teaching/Learning Materials for Teachers
compiled by the PROFILES Working Group of the Maria Curie-Skłodowska University, Lublin - Poland



A Module for Biology Instruction - for Grades 1st to 2nd of junior secondary school.

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Abstract
The module "What type of soil affects plant growth" deals with structure and properties of soil and its exploitation for cultivation of plants for consumption. Pupils will get acquainted with the factors influencing crop quality. Realization of this module will be possible when pupils have learnt about solutions, acids and bases. The contents presented in this module are discussed from the point of view of soil users such as pedologist, formers, owners of allotments etc. Discussion of the problems is accompanied by pupils' numerous practical activities including experiments which will allow them to get to know and understand functioning of soil habitat. Realization of teaching material should proceed according to the rules of learning through problem solving.

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For further information see: www.parsel.eu.

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Course of module realization.

The lessons should start with finding the answer to the question: What elements does soil consist of? There should be discussed the problems connected with processes of soil formation including factors of soil formation, profiles of soil, types of soil and their role in plant life. The object of pupils' observation are soil samples taken up by them in different places (e.g. garden, allotment, cultivated field, street lawn, river bank area or natural water basin etc.) as well as soil bought in a horticultural shop. Samples should be taken up from different layers at different depths it can be found in successive tasks and experiments designed for pupils.

In order to determine various components of soil, samples should be taken up at the depth of about 15cm, then dried (this can be a task done at home by pupils). Thus they should be spread on a few newspapers in a warm and dry place. The time needed for soil drying is usually 1-2 days. During lessons at school pupils spread about 10 day of soil on sheets of paper and separate components of soil using a wooden stick or a glass rod and then observe them by means of a magnifying glass.

During separation of soil there can be distinguished mineral (grainy) and organic (fibrous) elements and other unidentified particles of soil. Based on the table pupils write down the elements of the soil sample studied by them.

Mineral components	**Characteristic features**
Quartz	Bright grey, transparent grains
Feldspar	White and yellow or reddish opaque grains
Mica	Glittering, small plates
Shale	Dark blue, black or dark brown irregular grains of sharp edges, rarely round
Hornstone	Black chippings
Organic components	Small fibres, fragments of leaves, pieces of plants etc.

One of the most important characteristics of soil is the mechanical composition that is the division of soil components into fractions in accordance with size of soil particles. Physical and chemical properties of soil depend on the percentage contents of individual fractions in soils. In order to determine the mechanical contents of samples of various soils they should be dried (about 30 day each) and divided into fractions putting each to them into a separate container. At first there should be chosen from the sample stones of a diameter larger than 20mm which constitute fraction I. The most should be passed through the sieve. The particles left on the sieve are fraction II and those sieved fraction III (see the table below). Each fraction should be weighed and their percentage share in the studied soil determined.

Diameter of particles	**Fraction**
Larger than 20mm	Fraction I; stones
From 1-20mm	Fraction II; gravel, sand
Less than 1mm	Fraction III, dust flotable parts (dusty)

In the further part of the module there should be discussed physical and chemical properties of soils and their influence on plants as well as problems connected with colour of soil, its firmness, plasticity, porosity and permeability. Pupils will have to determine colour of the studied soil samples. From the colour there is determined type of soil that is brown, podzol, black-earth, red-earth, yellow-earth. Humus imparts dark

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colour to soils. Iron (III) compounds give colour from yellow to red. White colour of soils can come from silica, calcium carbonate or gypsum. Grey-green colour comes from iron (II) compounds.

Another task for pupils will be determination of type of soil by means of a simple method called “finger test”. Soil samples should be taken up at a depth of about 30cm from its surface. They should be stored in tightly tied foil bags (soil can lose its inherent humidity).

A soil pellet should be kneaded as long as a glossy trace of moisture on its surface disappears. In determination of type of soil there should be taken into consideration the following criteria: granularity (during kneading one should feel individual grains) capacity of shaping (while kneading it should be formed into some shapes) – firmness – stickiness (whether it is possible to stretch a piece of kneaded soil between fingers), lustre of being kneaded surface (whether a soil pellet which is rubbed and smoothed between two fingers glitters if we look at it against the light). The key for determination of type of soil is in the pupils’ working card.

Soli pH is the most important chemical property having an effect on plant growth. Pupils will also study the presence of sodium, potassium and phosphorus carbonates in soil (experiments: 1, 2, 3)

Experiment 1. Studies of soil pH
Into a test tube there should be put a small amount of soil (about 1 cm high), poured 3cm^3 of distilled water, then the test-tube should be corked and shaken for a few minutes, then put away for 2-3 minutes. A drop of water should be put on the universal indicator paper with a dropper and dried. The value of pH should be read.
Experiment 2. Detection and determination of calcium carbonate contents in soil. A small amount of soil must be placed e.g. on watch glass and poured drop wise (with pipette or a dropper) with 10% HCl solution (concentrated acid should be diluted with distilled water at the 1:3 ratio) and the result should be observed. Approximate amounts of calcium carbonate can be determined from the data in the table:

Response of soil to the contact with 10% HCl	**% content of calcium carbonate**
Lack of turbulence	0-1%
Poor turbulence	1-3%
Strong but short-lasting turbulence	3-5%
Strong and long-lasting turbulence	over 5%

The calcium carbonate content in soil is favourable as it contributes to formation of modulous structure of soil, formation of humus, increase of pH and control of soil butter properties.

Experiment 3. Detection of sodium and potassium presence in soil.
A 3cm high sample of dried soil should be put into a test-tube and 5cm^3 of distilled water should be added. The test-tube content should be shaken for two minutes, moistened soil should be put on a trough bent strap of aluminum foil and next placed in a flame of a gas burner. There should be observed change of flame colour (yellow colour indicates the presence of sodium, the presence of potassium can be confirmed looking through blue cobalt glass – visible red flashes).

Experiment 4. Detection of phosphorus in soil.
Into a conical flask there should be put 4 teaspoons of soil, poured with concentrated nitric (V) acid, then shaken with caution for 10 minutes and filtered. Into the filtrate there should be added a few drops of ammonium molybdenum and the test-tube walls should be rubbed with a glass rod (yellow sediment precipitates including the presence of phosphate ions.

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Realization of the further part of the module will make it possible for the pupils to check how growth of plants. Pupils conduct experiments consisting in modification of pH of the studied soil samples. They compare germination and growth of plants on soil samples differing in pH (experiment 5) and concentration of the used mineral fertilizer (experiment 6).

Experiment 5. Effect of different values of pH on plants.
Soil samples must be prepared two weeks before sowing seeds. Four plastic or paper mugs should be numbered I-IV and filled with soil from the same sample (note there should be used the samples which were studied earlier during the lesson).

- mug I – only a sample of soil (control)
- mug II – a sample of soil and a small amount of sulfur (S) which must be mixed with the upper longer of soil.
- mug III – a sample of soil and the same amount of calcium carbonate.
- mug IV – a sample of soil and a four times larger amount of soil carbonate.

Finally, the chemical substances added to mugs II, III and IV should be mixed with the upper layer of the soil samples. 20 or 30 seeds of charlock or cuckoo-flower should be sown into mugs. The samples should be watered with a small amount of water and the growth and extension should be observed. The results must be written down in the table and the conclusions must be drawn up.

Experiment 6. Effect of the fertilizers contained in soil on growth and extension of plants.
There should be prepared 4 containers with the same volume of soil and the same number of seeds (20-30) e.g. of charlock or cuckoo-flower should be sown into each of them. Each sample should be watered with the solution of multicomponent fertilizer e.g. “Flora” of concentrations: 5%, 3%, 0,5% and water (the control sample). Seed germination and then growth should be observed. The results must be given in the table. Finally, the numerical results should be presented on the graph of co-ordinates. The conclusions should be drawn up based on the analysis of the obtained graph.

As the summary, there should be described the components of soil which can be hazardous for human health after consumption of the plants growing on it and there should be justified the need of rational exploitation (including fertilization) of the soil designed for cultivation of plants for consumption.

During the lessons of realization of this module you will study soils differing in properties and will conduct experiments whose results will allow to estimate the effect of some properties of soil due to different factors on crops. Thus in the future as potential owners or persons buying ground to cultivate plants (e.g. vegetables), you will be more aware what ground to choose for cultivation of plants for consumption.

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