



**Project: “For the Love of Nature:
Explore and Discover Europe through Nature”**

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GUIDEBOOK FOR TEACHERS

"METHODOLOGY ON DIFFERENT KIND POLLUTION COOPERATION FOR INNOVATION AND THE EXCHANGE OF GOOD PRACTICES ASSESSMENT AND CONTROL"



The methodological material was prepared according to the Erasmus+ project "For the Love of Nature: Explore and Discover Europe through Nature" carried out by three countries: Lithuania, Estonia and Italy. It contains descriptions of research, descriptions of lessons and activities implemented by teams of schools participating in the project. This methodological material is useful for teachers who want to raise awareness and understanding of natural processes and promoting natural sciences. Also, Empowering Students to Search for the Solutions to Improve the Quality of Nature by Learning Together Through Active and Effective Methods. The students will reach this goal by making observations and researches on different kinds of pollution of the places they live in, analyze and discuss the results, and brainstorm the ways to improve the situation.

The purpose of this publication is to support all project participants to acquire and develop new skills/competencies, the purpose of this publication is to help all project participants to acquire and develop new skills and competencies, to promote STEAM activities in schools.

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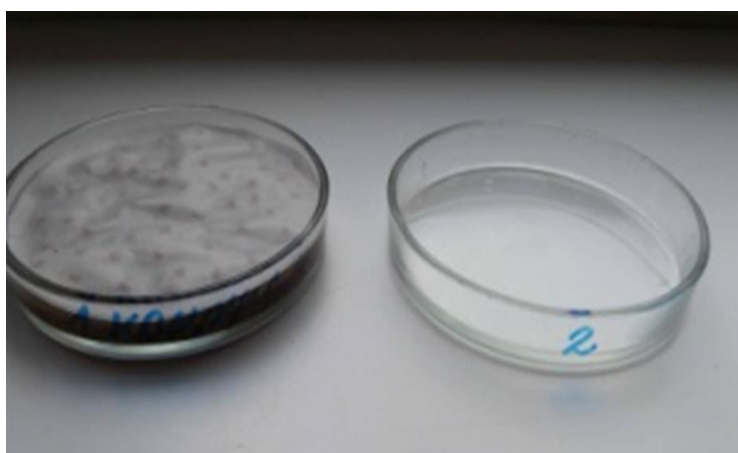
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PROCESS AND DESCRIPTION OF SOIL RESEARCH

Pollution is considered to be one of the most actual problems of the mankind. Accumulated waste makes harm to nature.

The method of biotesting was chosen for soil research. This method suggests studying the state of living organisms, to get information about their habitat. Bioindicators are often plants growing in wild surroundings. They negatively react on high level of pollution and let fix the accumulation place, the ways of harmful substance's appearance degree and expressiveness of tocsin's influence on living creatures and also humans.

It is recommended to use watercress for soil research. This is a rapidly growing plant and it grows up very quickly (100%).



Aims and tasks of investigations:

1. To study the influence of pollution on growing watercress seeds.
2. To find and study information about bioindication, harmful influence of different pollution on living organisms.
3. To study the possibility to use watercress prout seeds as the object of biotesting.
4. To master the biotesting method.
5. To make a test of soil and water to estimate its level pollution.
6. To study influence on growing watercress seeds.
 - different car exits;
 - plastic;
 - substances, which batteries contain;
 - salt, used on roads in a winter period of the year;
 - Oil (petrol) products;
 - Substances found in cigarette-butts.
7. To make an experiment on growing seeds in different conditions, to compare results.
8. To estimate the sample and write down the results of the experiment.

Hypothesis: Growing watercress' seeds depends on the quality of the environment. The cleaner soil and water, the better conditions for quality seeds. If there are polluted substances, the growth will be worse.

Method: Before the experiment some watercress seeds were examined on growth. Watercress seeds were grown in Petri cups, where washed lake sand was spread on 1 cm. level. It was covered with filter paper on top and moistened. 50 seeds were laid. They were covered with filter paper on top and covered with glass, but not densely.

The process of growing up took place under temperature 20-22° C. The percent of grown-up seeds, compared with planted ones is called growth. Watercress growth was 100% for 2 days.

Then the experiment started.



Petri cups were $\frac{1}{2}$ filled with substrate:

No. 1 – soil from the lawn, where cars were parked (20 m. from the place where sample N2 was taken);

No. 2 – soil from the side of a motor way;

No. 3 – soil from the lawn, in a park zone (130 m. from the place where sample N2 was taken);

No. 7 – soil in a garage co-operative near the stock of water;

No. 8 – soil in a garage co-operative near the barrels where oil products are poured;

- Clean substance was put into a cup No. 4, which will be moistened by solution, contained in batteries;

- Clean substance was put into a cup No. 5, which will be moistened by water solution, taken from the cigarette-butts. Substances dissolved in water came from cigarette-butts into water;

- Clean substance was put into a cup No. 6, which will be moistened by solution, taken from mixture of sand and salt, which is used in the struggle with glassy ice (100 gr. mixture on 500 ml. water);

- Clean substance was put into a cup No. 9, which will be moistened by solution, taken from different types of plastic.

In order to prepare solution to moisten samples No. 4, 5, 6, 9 water was heated up to the temperature of boiling. The examined objects were watered.

- Clean substance was put into a cup No. 9, it will serve as a control variant.
- Substances in cups No. 1, 2, 3, 7, 8 were moistened by still tap water.
- 50 watercress seeds were put on the surface of substance in every cup.
- Seeds were covered with the same substances.
- Top levels of substances were moistened to make it equal to low levels.
- Wait for 10 days watching for growing seeds, supporting the humidity of substances on the same level. The results of the experiment were written down in a table.

The results of the research carried out by our project participants:

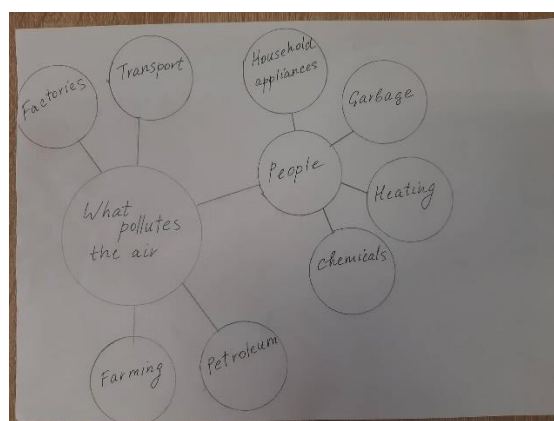
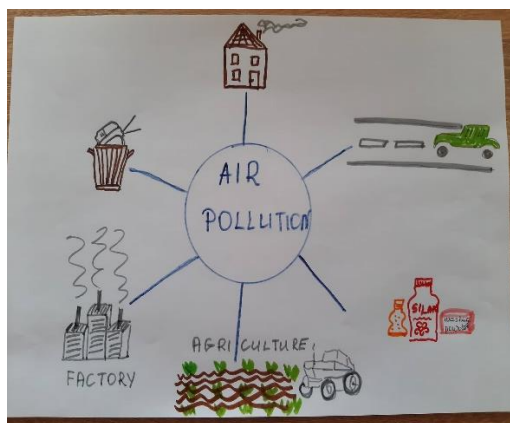
Growth was 100% on the second day. This fact proves that it's possible to make an experiment with this lot of seeds.

All tests were divided into two groups. Experimental group 1 – samples of soil No. 1, 2, 3, 7, 8. Experimental group 2 (No. 4, 5, 6, 9) clean substance with seeds were moistened by different solution, may be they contain different dangerous substances.



PROCESS AND DESCRIPTION OF AIR POLLUTION RESEARCH

The first part of the study is theoretical. The goal is to find out what knowledge students already have about air pollution. Also, an important aspect is to encourage their critical thinking, teaching them to draw conclusions and make decisions. For this, the mind map method is used. Students are divided into groups of 4-5 people. Together they form a mind map (they can be different). Some examples:



Each group presents their work and analyzes the results. Then, there is a discussion about air pollution and ways to reduce it.

The following questions can be used to engage students in the discussion:

- Can a person survive without air? How long?
- How can we reduce air pollution?

- What household appliances could we get rid of?
- What mode of transportation is comfortable and environmentally friendly? Why?
- How will plastic affect air pollution?

The second part is practical and takes place on the street.

Method: When performing this kind of work, we adhered to the bioindication method, when the response of a biological object to environmental influences is assessed. Plants (for example, pines) are very good indicators, as their external signs show changes in the environment.

The method for indicating the purity of the atmosphere by pine needles is as follows. From several lateral shoots in the middle part of the crown of 5-10 pine trees at the age of 15–20 years, we selected 100 pairs of needles of the second and third years of life.

Having determined the class of damage and the life span of the needles, it is possible to estimate the class of air pollution according to the following table:

Maximum needle age	Needle damage class		
	1	2	3
4	I	I - II	III
3	I	II	III - IV
2	II	III	IV
1	-	IV	V - VI

*Air pollution class symbols:

I - perfectly clean

II - pure

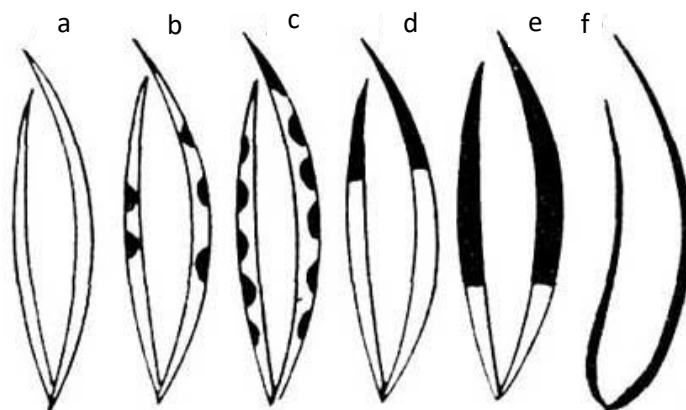
III - relatively pure ("norm")

IV - polluted ("alarm")

V - dirty ("dangerous")

VI - very dirty ("harmful")

Types of damage and drying of needles can be as follows:



Pic. Types of damage and drying of needles:

a - needles without spots, no dry areas

b - needles with a small number of small spots, no dry areas

c - needles with a large number of spots, the tip has shrunk 2-5 mm

d - a third of the needles have dried up

e - more than half of the length of the needles has shrunk

f - all needles are yellow and dry

The results of the research carried out by our project participants: A pine's needles in different parts (areas) of the town hasn't got damage, they're healthy. There are many lichens on the trees and bushes' trunks. Thus, we came into a conclusion that Visaginas town is rather clean.

We estimated the ecological problems in order to choose the object pollution investigation. We examined yards, streets and a forest zone. The level of air purity was estimated looking at the plants (bioindicators) (an ordinary pine, different kinds of lichen).

Unfortunately, there are some problems, which can cause land and water pollution:

1. We found lots of cigarette-butts under balconies of some high-rise building.
2. Mixture of sand and salt which is used to powder the roads in a winter period, appeared to be on the lawns.
3. We saw much plastic rubbish in the forest, not far from Visaginas lake. Rotten paper is on the trees not only the first year.
4. We found unapproved car parks on the town lawns.
5. There were batteries in melted snow.
6. Oil products appeared to be various. We saw the in rather unexpected places of our town.
7. Household waste is regularly found near rubbish bins.

Thus, observation is a method of knowing the world that arouses students' interest, which motivates them to learn and search for something new.

PROCESS AND DESCRIPTION OF WATER RESEARCH

Methods to determine the quality of water

Water is the second most important substance for human beings that goes after oxygen. The significance of water is very broad, and a sufficient intake of water is one of the basic conditions for health. Firstly, water delivers nutrients to every cell and removes toxins, impurities, and excess salts. Moreover, drinking enough water is one of the best ways to prevent kidney stones. Not forget to mention that water regulates body temperature, and blood pressure, and ensures skin elasticity. Also, water is essential for normal digestion. By participating in metabolism, this unique liquid helps to reduce fat accumulation and weight loss as well.

The loss of water in the human body is more dangerous than starvation: a human without food can survive more than a month, however, a human without water can survive no more than a few days.

Even though water is beneficial for a human, it can and disadvantages too. Primarily, this relates to the quality of the water.

According to the World Health Organization (WHO)-85% of all diseases in the world are transmitted through water. Diseases that are transmitted through contaminated water cause deterioration in health, disability, and a loss of a huge number of people's lives, especially children's lives. Every year, 25 million people die from these diseases.

Organoleptic indicators (simple methods of estimation) of drinking water quality.

There are a few ways to determine whether the water is clean or contaminated.

The first method is the simplest and often quite reliable – to assess its smell, transparency, and colour.

If there is a suspicion that unnecessary or hazardous substances may have entered the water, you should beware of:

- smell;
- any colour or sediment;
- oily stains;
- any taste.

It is not recommended to drink such water in which these suspicions are found.

Determining the colour of water

To determine the colour of the water, take a glass vessel and a piece of white paper. Fill the vessel with water and identify the colour of the water on the white background of the paper.



Determining the transparency of water

A transparent measuring cylinder with a flat bottom can be used to determine the transparency of water. A sheet of paper with text printed in Times New Roman 12 pt is placed under the cylinder and water is poured in until the font can be seen from above through the water. By measuring the height of the water column with a ruler, we express the level of transparency in centimetres. The higher the height of the pole, the greater the level of transparency.



The smell of water

The smell of water is caused by odorous substances in it, that enter naturally and with sewage.

100 ml of water is poured into a flask, corked and shaken intensively for 5-10 seconds. Then the cork is taken out and the smell of the water is determined using the sense of smell. The intensity of the odour is estimated on a scale (of 1-5 points). The analysis is taken place at a room temperature and when the water is heated to 50-70 °C.

An experiment to determine dust contamination of meltwater

To determine the dust contamination in the snow, the meltwater is filtered through filter paper. By using such a method, dusty sediment and greasy spots are detected on the filter paper.

JBL EasyTest 6in1

Unfortunately, simple methods of evaluating the quality of water do not determine the presence of harmful soluble impurities in water, such as nitrates, nitrites, and other salts, chlorine. Therefore, the JBL EasyTest 6in1 water test can be used for this purpose. The test is convenient, precise, and easy to use.

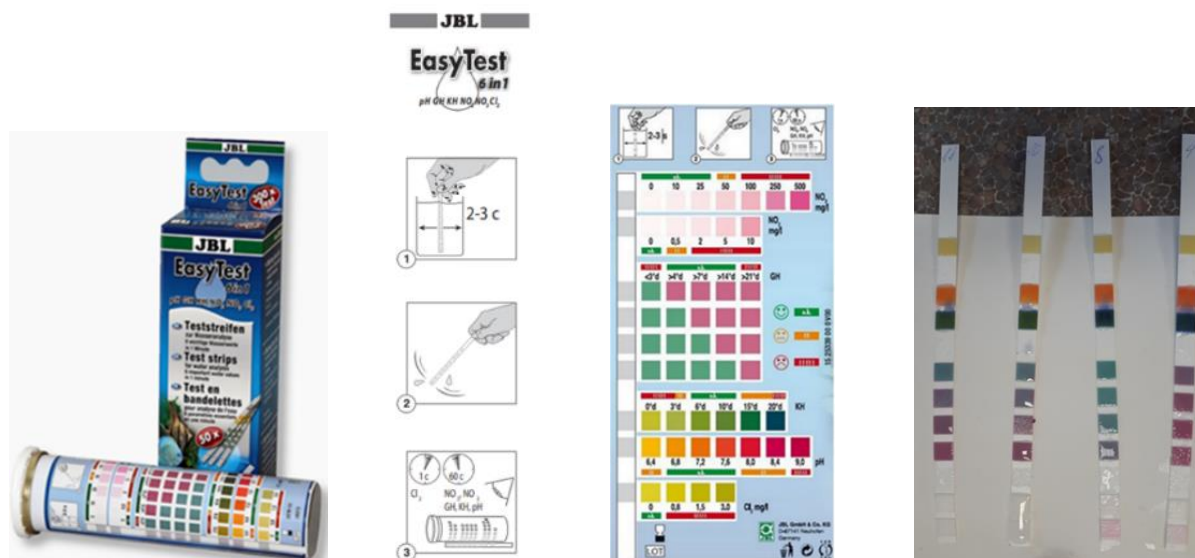
Water test strips can be found here: <https://www.exoticaquatics.co.uk/jbl-easytest-6-in-1-50-strips>; and here: <http://aquascape.ae/product/jbl-easy-test-6-in-1/>.

Quick water test strips determine the following values:

- Disinfectant in tap water: Chlorine test;
- Water acidity: pH test between 6.4 and 9.0
- Water stability: KH test from 0 to 20°dH
- Total water hardness: GH test <1 to > 21°dH
- Toxic nitrogen compounds: NO₂ 0 to 10 mg/l
- Cause of algae: NO₃ 0 to 250 mg/l

To get precise results, the strip must be dipped in the water for 2-3 seconds, taken out and shaken off.

By holding the strip vertically let the water go through the test and after 1 minute compare the results by using the colour scale on the package.



The hypothesis of our experiment

Fresh tap water, *Nestle* drinking water and lake water taken from different sources are clean enough. In these samples, the values will not exceed the norms. Whereas water that was taken near the garage and from the sewage pipe does not meet the standards.

Conclusion

Various results from these methods confirmed the hypothesis. Trusting the indicators that were approved by studies, Lake water taken from all sources is clean. Samples taken from the lakes turned out to be the cleanest. Water hardness standards were slightly exceeded.

Moreover, lake water, in which cyclops were found, had smell and colour. This is due to the location of this lake on a high bog.

The samples of drinking water *Nestle*, and fresh tap water met the requirements of clean water. Water hardness standards were slightly exceeded as well.

Samples that were taken from the aquarium water and tap water that were both infused for 10 days, had a characteristic smell and yellowish colour. Water hardness standards were slightly exceeded.

Spring water taken from the gardening community was hard and the number of nitrate ions exceeded the norms. According to these indicators, water from lakes is even cleaner. Therefore, the use of spring water is not recommended.

The dirtiest water was taken near the garage and from the hotel drains.

LESSON PLANS

Integrated subjects, class	IT, nature, 12 – 15 year old students.
Name of the project	"Moisture. How to measure soil moisture?"
The aim of the project	Investigate soil composition and develop an electronic device to measure moisture.
Project tasks	When working in groups: 1. Using natural science research, determine the amount of water and salts in the soil. 2. Repeat the concepts of an electrical circuit, a constant source, a conductor. 3. Using a computer and a micro:bit with accessories, build an electronic moisture meter. 4. Measurement of soil moisture using the developed device.
Duration	3 lessons (45 minutes each)
Stuff	Computer (portable or stationary), microcontroller board (Micro:Bit), USB connection cable, connection cables (crocodile), nail (2 pcs), battery, handout (sheets with finished tasks), dry and wet soil in pots. Chemical beakers, glass rod, filter paper, conical funnel, teaspoon, spirit lamp, mesh over the burner, set of mechanics (laboratory stand with brackets), spirit lamp or heating plate*, porcelain plates, matches, test tube stand, samples of various natural waters, rain or melt water and distilled water, wash bottle with distilled water, Pasteur pipette.

Methods	Brainstorm, discussion, work in pairs, groups, research work.
Students' motivation and required initial knowledge	Know how to use micro:bit at least minimally.
Lesson activities	Students are introduced to the project, its progress and the learning outcomes they should achieve. Lesson 1 description Problem situation - parents went on vacation, flowers need to be watered on time. Talk about safe behavior at home, plant care. The nature teacher explains the composition (structure) of the soil. Students are divided into 4 groups. Each group completes a given test. (Appendix No. 1) Students fill in tests, each group presents the results of their work, shares their experience. Lesson 2 description Work in pairs (IT). The composition of the scheme. programming Students work according to the instructions. (Appendix No. 2) Step 1. Making a soil moisture sensor Step 2. Humidity Sensor Data Value Experiment Filling out the report. (Appendix No. 3) Lesson 3 description Smileys will help us. An experiment Program analysis. (Appendix No. 4) Presentation of results (each group presents its results to the other groups - visually shows whether it succeeded).
Evaluation system and monitoring of student progress	Students develop a positive attitude towards learning. Students are supported by the teacher, and students are encouraged to do their work. Reflection at the end of the lesson. Each student completes the chosen sentence: <i>It was difficult for me because...</i> <i>It was helpful for me because.....</i> <i>I was very interested because...</i>
Recommendations for the teacher	Class or group of no more than 20 students It is easier to experiment with microbit than with sand.

APPENDIX

Appendix No. 1

Experiment No. 1

TOPIC: Detection of water by evaporation of a soil sample

HYPOTHESIS: _____

STUFF _____

The soil is a mixture. Describe this mixture.

1. Weigh the soil sample.

	Before drying	After drying	The difference between the masses of wet and dry soil
Mass (weight)			

Rules for the use of electronic scales

Weigh with dishes!

- Turn on the scales. The screen will display HELLO followed by 0.00 g.
- Place the test tube with the soil sample on the weighing pan. A mass of soil sample with a test tube will appear on the screen. Record its mass in the table.

2. Dry the soil with a heating device. Weigh the dried and cooled soil. Record its mass in the table.

3. Find the difference between the mass of wet and dry soil. Record the result in a table.

CONCLUSION: Why did the soil mass change? _____

Experiment No. 2

TOPIC: Detection of water by evaporation of a soil sample

HYPOTHESIS: _____

STUFF _____

PROCESS

1. The soil is a mixture. Describe this mixture.

Heat the soil with a heating device. Using **crucible tongs**, bring the glass slide to the soil to be calcined.

2. Record the results of the experiment. Fill in the missing words in the sentences.

Water when heated You can see on the glass

New substance(formed or not). The appearance of water vapor is
.....(physical or chemical) transformation..

CONCLUSION_____

Experiment No. 3

TOPIC: Detection of salts in the soil

HYPOTHESIS: _____

STUFF_____

PROCESS

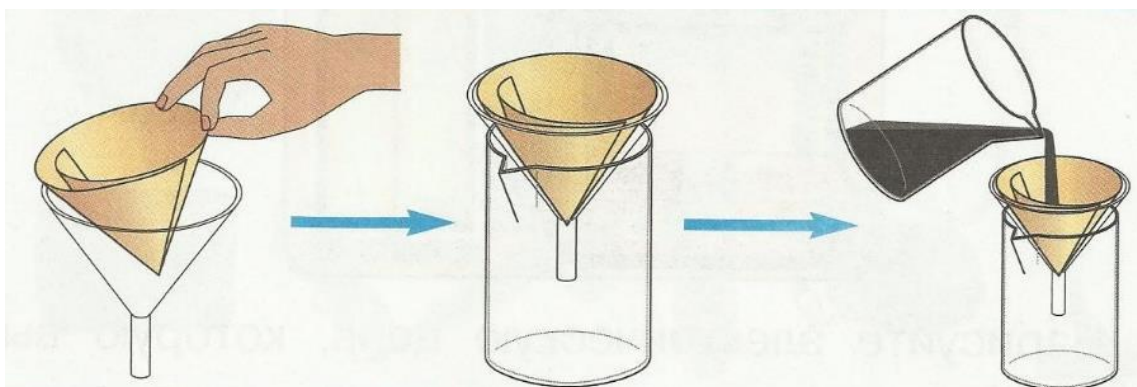
1. The soil is a mixture. Describe this mixture.

Fill in the missing words in the sentences.

Aggregate state of the soil, the soil contains soluble in water.

2. Place a soil sample in a beaker. Pour 50 ml of water into the graduated cylinder. Pour the water into a beaker with earth and stir with a glass rod.

Prepare your filtration equipment. **Filter** water with substances dissolved in it from solid soil particles.



3. Place a few drops of the filtered solution on a glass slide.

4. Fill in the table. Describe the resulting filtrate. Name the substances that form the filtrate.

Steps	Questions	Answers
1. Dissolution of radioactive compounds contained in the soil.	What has dissolved?	
	What hasn't dissolved?	
	What did the solution of soil in water look like (homogeneous or heterogeneous mixture)?	
2. Filtration	What's left on the filter?	
	What did the filtered solution look like (homogeneous or heterogeneous mixture)?	
3. Evaporation	What has evaporated?	
	What is left on the glass slide?	

CONCLUSION _____

Experiment No. 4

ELECTROLYSIS (demonstration)

Distilled water is chemically pure water.

1. Can fish live in it? Explain your answer? _____

2. Can distilled water conduct electricity? Why do you think so? _____

3. Underline the sentences that describe the conditions necessary for the flow of electric current.

Conditions for the presence of current:

1. Wires - metal contains free electrons.
2. Source of electric current - makes free electrons to move in one direction.
3. Switch - current cannot move through the air.

4. Consumer - consumes electricity.

4. Check out the experiment. Fill in the table:

Experiment number	Object under study	Bulb	
		The light bulb is on	The light bulb is off
1	Distilled water		
2	Filtered solution		

CONCLUSIONS (Where in further work and for what purpose can an electric circuit be used?) _____

For the smart ones 😊

1. Add half a teaspoon of salt to the filtered solution. Dissolve it by stirring. Let's do electrolysis. Watch the light bulb glow.
2. Describe how the light bulb glow changes when the amount of dissolved salt changes.
3. Why is distilled water not conductive?
4. Do you think distilled water will conduct electricity if we add sand to it?

The soil has some electrical resistance, which depends on the amount of water and minerals in it. The combination of water and minerals in the soil makes it electrically conductive. Thus, the more water combined with nutrients, the less electrical resistance the soil has. (and the more electric current).

To measure soil moisture, we read the voltage on pin P0 using an analog read pin that returns a reading between 0 (no electric current) and 1023 (maximum electric current). The reading is a graph on the screen (histogram).

Step 1. Making a Soil Moisture Sensor:

1. Connect a nail to the 3V pin with an alligator stick it into the soil.
2. Connect another nail to pin P0 with a crocodile clip and stick it into the soil.
3. Create a program that will display a bar soil moisture readings from LEDs (light-diodes) using the following commands:



clip and

graph of emitting



4. Upload the program to micro:bit
5. Disconnect the micro:bit from the computer and connect the batteries to the micro:bit

Experiment

6. Stick nails into dry soil and you will see that most of the LEDs are off.
7. Stick a nail into wet soil and you will see most of the LEDs are on.
8. Explain why (fill in a **student activity sheet**)

Step 2. Humidity sensor readings

In the previous program, we only had a rough idea of the sensor reading (only a small screen has been used)

Let's add a code that displays the current sensor reading when button A is pressed.

This code should go in an endless cycle. **forever** We will also add a variable **reading** to save the reading data.

9. *Change the program using new blocks*
10. *Upload the program to micro:bit*
11. *Connect batteries to micro:bit*

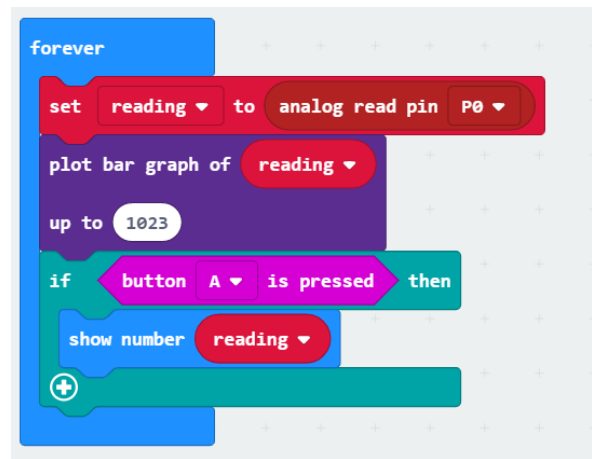
Experiment

12. *Insert nails into dry soil, press button A and record the reading (**student activity sheet**). You should see a reading of about 250 for dry soil.*
13. *Insert nails into wet soil, press button A and record the reading (**student activity sheet**). You should see a reading of about 1000 for wet soil.*
14. *Finish filling in (**student activity sheet**).*

Explain why the two readings are different.

Step 3. Smilies will help us.

15. *Change the program so that the screen displays a smiling smiley if the soil is wet (greater than 900), a sad one in all other cases. To do this, you need to use a conditional statement (if).*



Name, Surname

Student Activity Sheet

Step 1. Making a Soil Moisture Sensor

1. Explain why more LEDs (light-emitting diodes) light up in wet soil than in dry soil when running programs on micro:bit _____

Step 2. Humidity sensor readings

1. Record the readings _____ in dry soil

2. Record the readings _____ in wet soil

3. Why are these readings different? _____

Step 1. Production of soil moisture sensor



```

forever
  plot bar graph of analog read pin P0
  up to 1023

```

Step 2. Humidity sensor data values

```

forever
  set reading to analog read pin P0
  plot bar graph of reading
  up to 1023
  if button A is pressed then
    show number reading

```

Step 3. Smileys will help us.

```

forever
  set reading to analog read pin P0
  plot bar graph of reading
  up to 1023
  if button A is pressed then
    show number reading
    pause (ms) 500
    if reading > 900 then
      show icon [happy smiley]
    else
      show icon [sad smiley]

```

Thanks for your work 😊