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| ACTIVITY PLAN | | | | |
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| **Theme** | **Subtopic** | **Activity Title** |
| Creative and Critical Thinking in EcoSTEAM Education | Design Thinking for Eco-friendly Solutions | 1. Making ECO Fertilizers.  2. Testing Plants with ECO Fertilizers. |

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| Introduction part (or activity overview) |
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| **Introduction part (or activity overview)** | In this subtopic, we will discuss a project related to ecological fertilizers, their production, and use in monitoring the tested plants, and we will talk about the application of eco-friendly fertilizers in "friendly" agriculture or gardening. The goal of this project, guided by critical thinking, is to create an effective and innovative system that would allow the conscious and efficient use of ecological fertilizers, reducing the negative impact on the environment. |
| **SETTING** | A classroom equipped with a projector and computers. Chemistry classroom - a laboratory with the necessary equipment. This is a long-term project-based - team work carried out by groups of 3-4 students. |

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| Materials Needed |
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| **Materials Needed** | **Materials:** Prepared ecological fertilizers made from ashes, coffee grounds, yeast, banana peels (their preparation is described in the activity content), test plants can be; garden cress (Lepidium sativum L.), spinach (Spinacia oleracea), and others, distilled water or clean tap water (the pH of the water should be 6.0–7.5).  **Tools:** Petri dishes or shallow disposable packaging containers 1.5-2 cm in height, filter paper (paper towels are also suitable), millimeter ruler, tweezers or a stick for arranging seeds in Petri dishes, a special marker for labeling Petri dishes. |

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| **Learning Outcomes** | * Critically evaluate information about ecological fertilizers, analyze various sources, and make reasoned decisions regarding their use. * Expand understanding of the importance of ecological fertilizers for plant growth and development, their impact on the environment, and human health. * Enhance practical skills in how to properly use ecological fertilizers for plant nourishment. * Encourage interest in sustainable development principles and contribute to environmental protection. |  |
| **Activity Contents** | **Information for the Teacher**  Plants require three main components for growth: nitrogen, phosphorus, and potassium. Nitrogen is needed for leaf growth, phosphorus is necessary for the development of flowers and fruits, and potassium is responsible for overall plant health. Besides these primary elements, plants also need many other substances, known as micronutrients, such as magnesium, calcium, and sulfur.  There's no need to buy fertilizers – you can produce all the nutrients needed for every stage of your garden plants' life cycle at home. This can significantly reduce the costs of garden maintenance and help you grow organically clean products.  Vegetable growers and gardeners identify several of the most effective biological additives that increase fertility, such as organic fertilizers like compost, manure, chicken manure, liquid fertilizers from weeds, fertilizers from yeast, growing green manures, fertilizers from ashes, coffee grounds, and banana peels. You can experiment with these fertilizers, changing the composition, proportions, and fertilization timing.  **Activity 1: Observation and fertilization of a control plant with ash fertilizers.**  **Theoretical Part (Duration: 10 min.):** Introductory talk. It is discussed that ashes are left from the burning of plant residues. They contain 74 elements from the periodic table of chemical elements, i.e., more than half of all the elements in the Earth's crust. Due to their composition, ashes are an excellent alternative to mineral fertilizers. There's just one downside – ashes completely lack nitrogen, which is quite necessary for plants in spring and early summer. Phosphorus from ash fertilizers is better absorbed than from chemical fertilizer - superphosphate.  Furthermore, ash fertilizers help solve the disposal issue of hard household waste generated in a homestead or home garden.  **Task (duration 35 min., plant observation for 1-15 days):**  Step 1: Students are divided into groups of 3-4.  Step 2: Make fertilizers from ashes:  Dry ashes can be added directly to the soil while digging it over.  Create a solution by dissolving 10-15 g of ashes in 1 L of distilled water.  Step 3: Students read the work description (Appendix 1) and conduct the experiment.  Step 4: Observe, analyze, and record the results.  **Activity 2: Observation and fertilization of a control plant with yeast fertilizers.**  **Theoretical Part (Duration: 10 min.):** Introductory talk. Yeast is a well-known product to all. We constantly consume it with food, eating bread, various baked goods, and many other food products, drinking kvass. Its biomass primarily consists of fungi rich in proteins and other beneficial substances such as organic iron, amino acids, various micro and macro elements. Yeast also contains B vitamins, calcium, iron, magnesium, manganese, phosphorus, zinc, etc.  How do yeast work as fertilizer? Since yeast contains fungi, they productively alter the soil composition. They activate the activity of microorganisms, creating a favorable environment, which accelerates the process of organic matter decomposition and releases nitrogen and potassium into the soil.  **Task (duration 35 min., plant observation 1-15 days):**  Step 1: Students are divided into groups of 3-4.  Step 2: Make fertilizers from yeast:  Yeast infusion can be made from stale bread, breadcrumbs, or other flour products containing microbial decomposition products.  Various types of yeast can be used: both wet yeast sold in blocks and dry yeast. Dissolve 20 g of fresh yeast in 1 L of water, or 1 g of dry yeast in 1 L of water, let it sit for 2-3 hours, and water the plants.  Step 3: Students read the work description (Appendix 1) and perform the experiment.  Step 4: Observe, analyze, and record the results.  **Activity 3: Observation and fertilization of a control plant with coffee grounds.**  **Theoretical Part (Duration 10 min.): Introductory talk.** It's discussed that useful substances in ground coffee help plants stay healthy. Such fertilizer improves soil composition and even helps repel pests like snails, slugs, and insects. Natural coffee grounds are an excellent fertilizer for both outdoor and indoor plants. Coffee enriches the soil with nitrogen, phosphorus, minerals, and potassium (elements that plants often lack), making it lighter. Such fertilizer is very suitable for plants that prefer acidic soil.  **Task (duration 35 min., plant observation 1-15 days):**  Step 1: Students are divided into groups of 3-4.  Step 2: Make fertilizers from coffee grounds:  First, dry them out;  Mix the coffee grounds with soil at a ratio of 1:4, then pour the mixture into the soil near the plant stems.  Step 3: Students read the work description (Appendix 1) and perform the experiment.  Step 4: Observe, analyze, and record the results.  **Activity 4: Observation and fertilization of a control plant with banana peel fertilizers.**  **Theoretical Part (Duration 10 min.): Introductory talk.** It's discussed that banana peels contain plenty of nutrients, starting with potassium and magnesium, ending with sodium and phosphorus. Plants respond very well to such fertilization because there are practically no allergic reactions to bananas.  **Task (duration 35 min., plant observation 1-15 days):**  Step 1: Students are divided into groups of 3-4.  Step 2: Make fertilizers from banana peels:  Soak banana peel in 200 mL of water and leave it for a day. The next day, you'll have fertilizer. Discard the peel, and mix the liquid with 1 L of water. Use this liquid to water plants.  You can also use the banana pulp. Mash it with a fork, pour 100 mL of room temperature water. Before watering, dilute the obtained solution with 1 L of water.  For preparing fertilizers, you can use dried banana peels. Banana peels can be dried in the oven or simply in the sun. After drying, grind them into powder and pour boiling water over them. Keep the solution in a dark place for two days.  Step 3: Students read the work description (Appendix 1) and perform the experiment.  Step 4: Observe, analyze, and record the results. |  |
| **Assessments** | Each student evaluates their work according to the provided Appendix No. 2. Each group presents the results of their work, assesses successes and failures, their contribution to the group work, and conducts an oral reflection. The final result is graded. All students in the class are included in the evaluation. |  |
| **Kompetencijos**  **Key Competences** | * Cognitive competence * Creativity competence * Communication competence * Social, emotional and healthy living competences * Citizenship competence * Digital competence * Cultural competence |  |
| **Connections with Eco STEAM** | Eco - choosing eco-friendly and biodegradable fertilizers.  Science - knowledge in biology, chemistry, economics, and environmental sciences.  Technology - the use of biodegradable fertilizers.  Engineering – the production of organic fertilizers from household waste is one of the innovative engineering solutions aimed at reducing waste quantity while simultaneously benefiting agriculture.  Art - familiarization with nature and its cycles, which can be utilized in the production of eco-friendly fertilizers.  Math - application of mathematical calculations. |  |
| **References** | <https://www.delfi.lt/agro/sodinu-auginu/pelenai-puiki-trasa-taciau-viena-klaida-gali-pridaryti-daug-zalos-89607355>  <https://www.delfi.lt/gyvenimas/namai/7-trasos-darzui-kurias-gali-pasigaminti-pats-taip-aisku-dar-nebuvo-84822701>  <https://www.jaunasis-tyrejas.lt/lt/naujiena/sejamoji-pipirne---bioindikatorius/>  <https://www.manonamai.lt/lt/kiemas/g-11104-pipirnes-auginimas-pavyks-kiekvienai-seimininkei>  <https://www.delfi.lt/agro/sodinu-auginu/kada-mieles-puiki-trasa-kada-ju-geriau-nevartoti-87593665>  <https://www.manonamai.lt/lt/sodas-aplinka/g-1727-kavos-tirsciai-kaip-is-ju-pasigaminti-trasu>  <https://www.delfi.lt/gyvenimas/namai/ne-visi-zino-kodel-naudinga-uzpilti-banano-zieve-vandeniu-84323955>  <https://www.delfi.lt/gyvenimas/namai/ne-visi-zino-kodel-naudinga-uzpilti-banano-zieve-vandeniu-84323955> |  |
| **Notes** |  |  |
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| Appendix 1. Work Description |
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| Work description | |
| 1. | Garden cress (Lepidium sativum) seeds or seeds of another test plant. The experiments use healthy, clean, dry, untreated seeds. |
| 2. | An equal number of seeds are placed in Petri dishes or disposable packaging containers. It's important that the seeds are not too close to each other, i.e., there should be enough space for each seed to germinate and grow. |
| 3. | Substrate: filter paper (paper towels are also suitable). The paper must be dry, clean, not contaminated with chemicals, porous, and able to absorb water well enough to provide moisture for the seeds to germinate and the seedlings to grow. |
| 4. | Initially, while the seeds are germinating, the substrate is watered with distilled water. If it's not available, clean tap water can be used (the pH of the water should be 6.0–7.5). |
| 5. | After 7 days, when the seeds have germinated, the substrate is watered with the chosen ecological fertilizer. Organic fertilizers need to be prepared a few days in advance. |
| 6. | The control container is moistened only with distilled water. |
| 7. | We observe the germination and growth of the test plant for about 1-15 days. |
| 8. | Based on the selected data and time, we fill in the table. Appendix No.2 |
| 9. | Summarize and present the results. |

**Appendix 2. Indicators of germination and seedling growth of the test plant on days 12-14 when fertilized with different ecological fertilizers (filled out by each group separately)**

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|  | Watering of the test plant with selected fertilizer | Seed germination, % | Average stem height, mm | Average root length, mm | Average total shoot height, mm | Relative shoot height, % | Observations |
| Control 1 | + |  |  |  |  |  |  |
| Control 2 | + |  |  |  |  |  |  |
| Control 3 | + |  |  |  |  |  |  |
| Control 4 | + |  |  |  |  |  |  |
| Control 5 | Watered only with distilled water |  |  |  |  |  |  |

**Appendix 3. Evaluation/Self-Assessment**

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| Skills in performing theoretical and practical questions | I know very well, excellently | I know well | I know satisfactorily | What I didn't understand/couldn't do and what I would need to learn more about |
| 1. Formulate the research work hypothesis, objectives, and tasks |  |  |  |  |
| 2. Create a plan for the research work |  |  |  |
| 3. Independently conduct the research work |  |  |  |
| 4. Calculate the amount of fertilizer needed for fertilization |  |  |  |
| 5. Independently describe the experiments |  |  |  |
| 6. Process the obtained results |  |  |  |
| 7. Formulate conclusions and present the work |  |  |  |