# MANUAL FOR ONLINE TEACHING

## CONTENT

## INTRODUCTION

The main goal of project „Innovative methods, approaches and practices for effective teaching STEM in an electronic environment“ 2020-1-BG-KA226-SCH-095199 - to build capacity in teachers teaching science in junior and high school through: * development of Digital pedagogical competencies and * development and implementation of innovative online resources so that they can provide high quality, motivating and inclusive digital education.

The global pandemic has forced rapid changes in the way things are done. One of them is how to teach children STEM when they are at a distance, and this has become a key point that brings together the aims of our project when it comes to teaching STEM using a variety of digital resources and methods. Virtual learning is becoming routine and convenient for working at a distance and contributes new features to formal education: increasing the openness and accessibility of learning, the effectiveness of educational materials, the digitisation of content and the optimisation of educational processes.

**Distance learning** is a way of organising the teaching/learning process at a distance using information and communication technologies with characteristics such as openness, flexibility and the use of information technologies.

A type of distance learning - **hybrid learning** combines distance and face-to-face learning in parallel. In this type of training, part of the students learn on a daily basis and part of the students are simultaneously connected to the lesson externally.

The following are distinguished:

- synchronous distance learning (where the teacher and students interact at the same time, although in different locations);
- asynchronous distance learning (where the teacher and students communicate at different times and in different places) and communication between the learners is through messages.

## DISTANCE LEARNING ORGANISATION FEATURES

Modern, high-quality education cannot be achieved without information technology and purposefully developed methodological materials adapted for distance learning. In this context, distance education, as Targamadze (2020) claims, has to meet the requirements of modern education: quality, efficiency, accessibility, diversity of content and effective communication. On the other hand, it must comply with the elements of the pedagogical framework, which are highlighted in Table 1.

Table 1

| An element of the pedagogical system | Definition |
|---|---|
| Teaching / learning objective | It is the knowledge, skills and understanding acquired in the teaching / learning process. The objective of the teaching/learning process is elaborated in terms of expected outcomes. |
| Teaching / learning | It is the combination and interaction of objectives, organisation, tools |

| | |
|---|---|
| content | and evaluation. |
| Teaching / learning instrument | A physical or virtual object used in the teaching/learning process (virtual teaching/learning materials, interactive games, etc.) |
| Teaching / learning methods | It is a system of learning/learning activities that creates the conditions for the acquisition of knowledge and the mastery of skills. It is the realisation of a teaching /learning method or a combination of teaching methods. |
| Teaching / learning conditions | It is a component of the teaching/learning process that describes the situation, environment and constraints within which the learner is expected to demonstrate a particular behaviour. |
| Communication | It is an exchange of experiences, thoughts, experiences and information between student and teacher. |
| Assessment | It is the systematic collection and analysis of information about a learner or the delivery of a training programme. |

Compiled by authors based on
*Targamadze A., Virtualus mokymasis: teorija ir praktika. Vilnius:Vitae litera, 2020 m.*
Pedagoginės sistemos elementus galima atvaizduoti schematiškai (Targamadze A.,2020)

The characteristics of the elements of the pedagogical system and their definition in the context of distance learning are detailed.

**Objectives of the teaching / learning**

The defined learning objectives focus on the acquisition of learners' competences. The learning objectives do not vary spatially. Planning is an important element in the context of achieving the objectives. It is recommended not to make long-term plans for distance working, as the situation is constantly changing and the teacher needs to be ready to adapt here and now. Time should be allocated for the following activities: greetings, introduction, rules, reflection, evaluation. Each lesson should have a goal and objectives, which are presented to the pupils like a plan. It is recommended to: choose one virtual learning environment, create rules for working remotely with the students, prepare precise instructions (where and what to find, how to connect, etc.), have a backup (asynchronous) lesson plan ready (e.g. think about additional tools that each student could find at home; take time to strengthen the personal connection in distance learning (individual chats, classroom-building activities, conversations).

**Teaching / learning content**

Virtual space offers more possibilities for content creation, presentation and accessibility. The content is delivered to the learner via e-learning, a variety of educational applications and other IT tools are used for the mastery of the material.

**Teaching/learning instruments**

The teaching/learning tool is becoming more varied and diverse. A variety of task simulations, videos, multimedia and other virtual reality tools are used.

**Teaching / learning methods**

Traditional teaching methods are easily transferable to distance learning. They can be easily adapted and modified by the teacher in a virtual environment. In order to engage the students, the teacher has to vary the process by providing creative thinking tasks such as: games, role-playing, etc. The teacher can also use a variety of activities such as role play, debates, concept and mind mapping, repetition, reinforcement, experimentation, interactive books, flipping classrooms, small group discussions (virtual rooms), feedback, various surveys, conferencing, use of online discussion forums or chat.

**Teaching / learning conditions**

A component of the teaching/learning process that describes the situation, environment or constraints in which the learner must demonstrate a particular behaviour. The teaching conditions are analysed by reviewing the initial situation and assessing the educational and learning environments in which the teaching/learning takes place. The learning conditions are very diverse. These may include: accessibility to the educational establishment, availability of IT tools, learner characteristics, motivation to learn, autonomy, complexity and availability of learning materials, teacher's preparation for distance working, etc.

**Assessment**

Distance assessment is the assessment of pupils' skills and achievements delivered through digital technologies. Assessment includes formative and summative assessments and increasingly progressive digital tools and instruments allow for the collection of information on learners' competences.

The dominant type of assessment is formative assessment. These are regular, frequent and varied assessments of students' learning, either during or after a lesson which help the teacher to plan the next steps in teaching. Research shows that formative assessment (2-5 times a week) increases children's learning by around 70 per cent (Dodge J., 2009).

Formative assessment in a digital environment allows to diagnose learning needs, to describe learning progress and to predict future progress. This can be done through a variety of assessment methods such as cumulative scoring, feedback, discussion, peer assessment (Formative assessment - Promoting individual progress, Methodological tool, 2018)

Formative assessment in a digital environment allows:

- identify learning needs;
- describe the progress made in learning and anticipate future progress;
- make use of the full range of possibilities (e.g. cumulative score, feedback, discussion, peer assessment).

*Summative assessment* summarises and determines the level of competence achieved by students. Summative tests are tests on topics covered, end-of-year or standardised tests. They are designed to measure, assess and compare pupils' abilities at a given stage. The data from such assessments can continue to be used in a formative way (Petty G., 2009).

*Pre-assessment* (diagnostic assessment) done at the beginning of the semester (preferably with the topics) is designed to help the teacher to find out what and how much students already know about the upcoming topics and what life contexts they relate to. The information gathered from diagnostic tests helps the teacher to plan teaching in a way that best meets the needs of the students (Petty G., 2009).

| Types of (self)assessment: | Definition |
|---|---|
| Regular registration | The student is registered and identified using a virtual learning environment of the school's choice |
| Chat | Opportunities for students to ask questions and share their work |
| Open communication | Providing students with information on how they can assess their own abilities and progress through specific learning activities |
| Agreements | Consideration and agreements on how to adapt formative assessment methods and ways of collecting evidence of student learning |
| E mails, calls | Virtual or telephone calls to discuss the student's achievements and assessment of their progress |

Based on the Distance Education/Distance Learning Handbook. National Agency for Education, 2020.

## IMPLEMENTING THE STEM METHOD IN DISTANCE

**STEM** combines science, technology, engineering and mathematics. The term STEAM is already used in many countries around the world - and the arts are also included.

In general, it is an interdisciplinary teaching/learning approach that connects academic concepts to the real world through science, technology, engineering and mathematics, while aiming to stimulate students' curiosity and make STEM subjects more attractive.

**What makes STEM education innovative?** The following characteristics can be identified (F. Banks and D. Barlex, 2014):

- Traditional classroom instruction is being replaced by project-based learning;
- Teaching is integrated into unified experiential activities (all STEM subjects);
- Student-initiated/experiential learning is at the heart of teaching;
- Emphasis on the application of knowledge and skills in real life;
- development of logical, critical thinking.

The importance of problem-based learning is also highlighted in the organisation and implementation of the STEM teaching/learning process. Problem-based learning (PBL) is defined as a method of teaching that involves students learning by solving problems with the support of the teacher (C. E. Hmelo-Silver, 2004). Problem-based learning focuses on a complex problem with no single right answer. In problem-based learning, students learn by working collaboratively in groups to identify what they need to know to solve a problem. Learners engage in self-directed learning, applying their new knowledge to the problem and reflecting on their learning and the effectiveness of the strategies used. Problem-based learning (PBL) is learning where the outcome of the work is

understanding and solving a problem, and in the learning process the problem is first defined (Barrows 1980).

The basic principles and features of problem-based, student-centred learning:

· Learning is initiated and organised by real-world situations that do not have a single, clear-cut solution;

· education is organised through problems rather than subject topics;

· students work in small groups and learning takes on the character of a group activity.

· Students are engaged in active cognitive activities when solving a problem.

· individual learning objectives are pursued.

· as independence increases, teacher‘s control decreases;

· the teacher becomes a facilitator, a mentor

· emphasis is placed on developing cognitive skills and motivation, developing lifelong learning skills.

Teachers often face challenges in distance teaching/learning, such as time management and student participation in distance lessons. Problem-based learning in STEM activities increases student engagement in the teaching/learning process and the problem itself becomes a stimulus for learning. As Gerulaitis Š., Vaivadienė E. (2019) state, it is a student-centred approach.

In order to ensure students' mental health, it is particularly important to limit students' screen time in distance learning, which is recommended to be taken into account in the planning of the teaching/learning process; to differentiate the teaching study. STEM activities should be appropriate to the students' abilities and address relevant problem situations.

STEM lessons are experiential education (STEM) lessons. The aim of these lessons is to develop students' creativity, interest in exploration, ability to apply theoretical knowledge and cooperative learning in groups. Students can put their creative and experimental ideas into practice through a range of activities that actively engage them in the learning process and increase their motivation as they try and discover new things through exploration, and stimulate their interest in new things. By taking part in STEM education activities, pupils have the opportunity not only to acquire new subject knowledge but also to improve their personal and general competences.

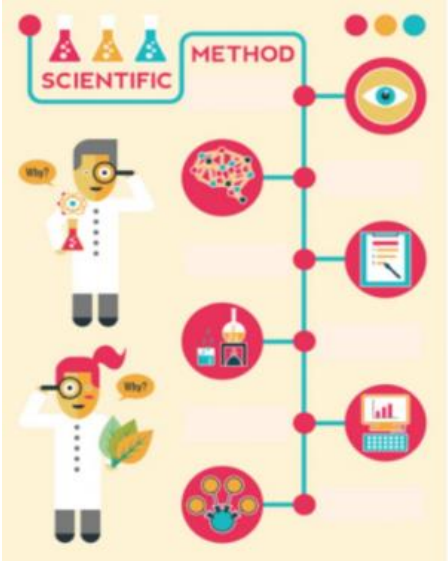
STEM activities should give students the opportunity to model solutions, practice problem-solving and receive constructive feedback from peers and/or the teacher. It is important that the learning task is very specific, clear and the learning environment is engaging and realistically focused on the individual needs and interests of the learners.

The following methods can be distinguished in a STEM classroom:

Using the **scientific method** in STEM activities.

The scientific method encourages creative learning in STEM-integrated sciences and the joy of exploration and discovery.

The phases of scientific research are: observation; formulation of a question; formulation of a hypothesis; design and conduct of an experiment; analysis and presentation of results; and formulation of conclusions. Additional stage: Discussion and presentation of the results (for senior students).




| The Steps of the Scientific Method: |
|---|
| **Step 1: Make an Observation (Theory Construction).** By making observations, researchers can establish an area of interest. |
| **Step 2: Question (Ask a Question).** Topic for research and experimentation or question that needs to be answered. |
| **Step 3: Hypothesis (Make Predictions).** Predict the outcome to the prolem. |
| **Step 4: Experiment (Gather Data).** Develop a procedure to test the hypotesis. |
| **Step 5: Analysis (Analyze the Data).** Examine / analyze the data. |
| **Step 6: Conclusion. (Draw Conclusion).** Compare the hypothesis to the experimnts results. |

Quality education in technology, science and technology education should be based on students' own investigative activities: observation, analysis, testing, modelling, etc. Natural phenomena and processes that are elucidated through inquiry make it possible to grasp more deeply the meaning and integrity of the sciences, to discover their usefulness in all spheres of life, and perhaps to develop a love for them.

At school and even in kindergartens, we want to make children be aware that knowledge in one subject is often not enough to identify and solve problems, that different sciences complement each other, and that their integration allows innovation to be born.

Working independently or in small teams, students can carry out research: formulate hypotheses, formulate the aims and objectives of experiments, plan the course of research and record their progress on videos. Although researches are often carried out in teams but during the lockdown students are able to make observations individually, compare their observations with each other, communicate remotely, and draw common conclusions. When possible, the work is carried out in schools and laboratories.

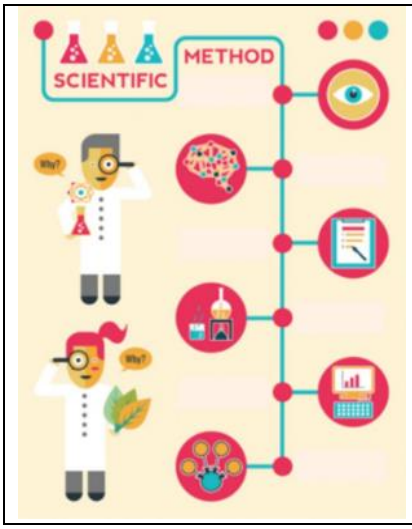
STEM practical research activities are particularly effective in non-traditional (non-classroom) settings. School educational environments (STEM classrooms) should be supplemented with tools for science education. STEM classrooms are equipped with complete sets of tools, ranging from conventional laboratory utensils and science teaching tools to light and hand-held digital microscopes and kits for mechanics experiments. In STEAM classrooms, teachers would not only find the tools, but could also prepare for investigations, collect research materials, share experiences, etc.

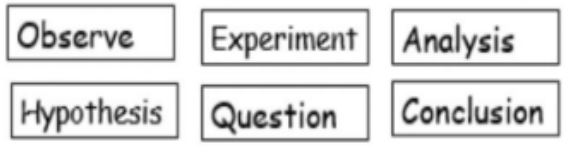
It is very important to think through the process of the experiment, to formulate clearly the purpose of the experiment and to explain the methodology used to observe the phenomenon. Without this, in a more complex experiment, students may only perceive that something is happening without understanding what is happening and why. The experiment should be a discovery for the pupils and not a test of a proposition made by the teacher or a book. Once the teacher has been proved right the next time there is no more "intrigue" for the pupils.

**Integrating games into STEM activities.**

For students in elementary and lower classes the game is perhaps the best way to help them find themselves. The aim is to teach children to look critically at the current situation in life, to pose problems (from domestic to global, etc.) and to find ways to solve them successfully. Children's autonomy and responsibility in dealing with real life situations are developed. This method is used in all subjects. Educational games provide knowledge and help children to understand and memorise the material better. For example, many science and biology lessons involve games. In topics such as "Forest food chains" or "River food chains" pupils act out the inhabitants of a forest or river. Pupils make up an outfit or draw a label for the animal they are representing, which they wear during the lesson. The pupil has to make gestures (or say words) corresponding to the function of that plant or animal in the food chain. This helps the pupils to remember the place of the plant or animal in the food chain of the ecosystem. In the game "Leaf Splitters", they divide into 4 groups and draw a card with a picture on it. Starting with the "earthworm" group, the pupils rip up the leaves in the boxes and pass them on to the next group, the "myriapods", this group to the "bacteria", then to the "fungi", until the boxes are filled with small pieces of "inorganic material". These are poured into the flower pot and it is explained that these substances have become food for the plants.

Educational games with pictures and word/concept cards release students' imagination and stimulate thinking. Linking pictures to word cards on an interactive whiteboard is much more fun and effective.




**Integrating the project into STEM activities.**

When a project-based approach is used, project-based education takes place in the group/classroom with project activities, either long-term or short-term (mini-project). The project approach has a well-established structure and follows clear and specific steps. On the other hand, it is highly flexible and contextual: it is about relationships, agreements, meaningful activities for children. Importantly, classroom-based project activities allow educators to apply practical innovations effectively, while creating unique opportunities for children to both learn and experience.

Project activities not only educate pupils, they also help to bring out the active, participative, dynamic and proactive side of a child. It is an excellent way to meet the child's needs

for security, activity, play, communication, cognition, movement, self-expression and recognition. Project-based education differs from conventional, traditional education - pupils create their own lives by participating in the planning of activities.

Project-based education allows for more effective integration of subjects. Environmental projects are a particularly good opportunity for collaboration between teachers of different subjects. Problem-specific approaches encourage pupils to look for information that is not available in textbooks and to find their own solutions to problems. It is very important to involve pupils in the investigation of local problems and their causes, to give them the opportunity to contribute to their own solutions, and to introduce them to the activities of various organisations.

**Integrating the "Patchwork" method into STEM activities.**

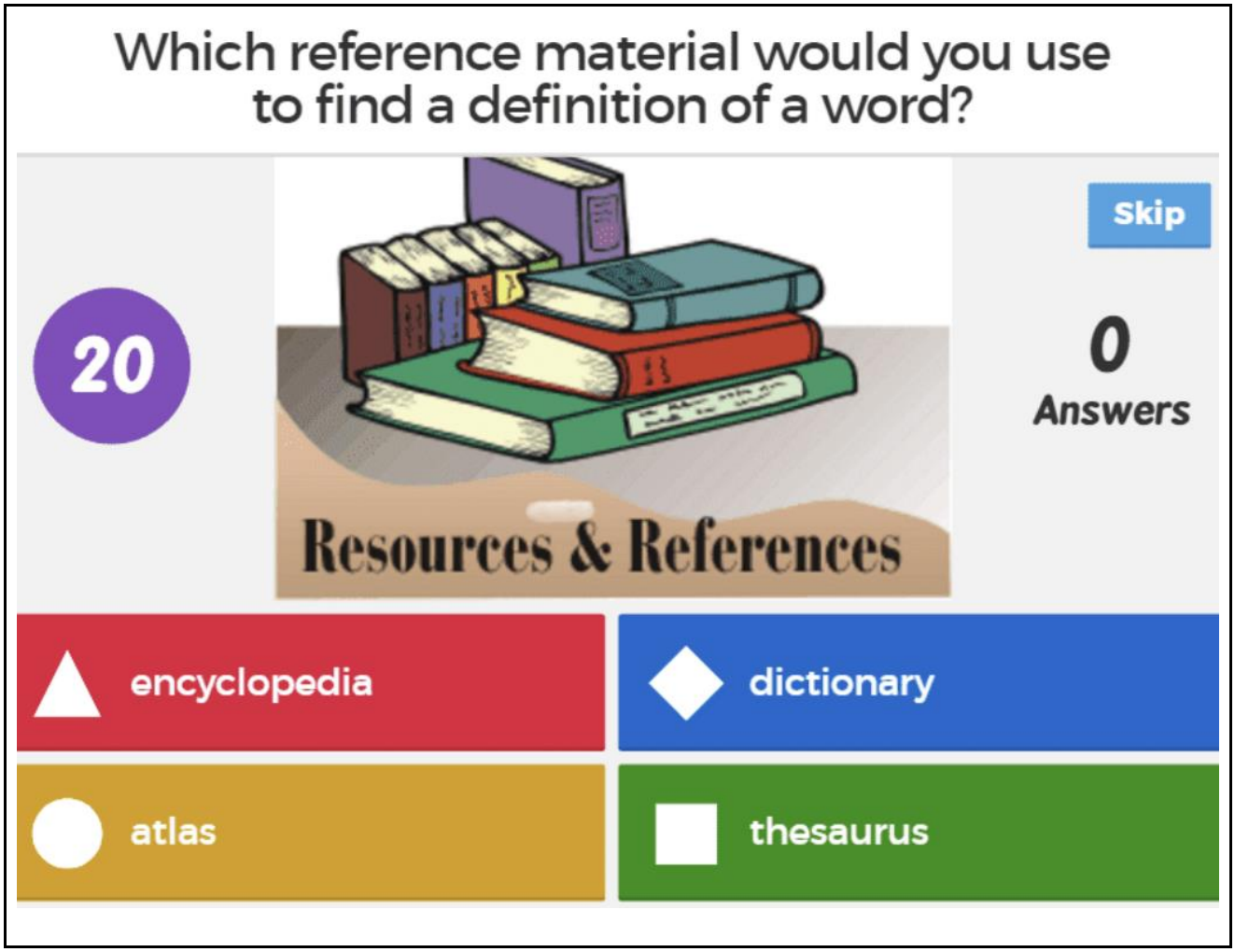
The Patchwork method is suitable for the development of communication, cooperation and learning competences. Working in groups, students take on the role of "experts": they share information, explore a problem question, analyse the learning material presented. This method is suitable for quicker assimilation of information and for identifying the key features of the task as a whole. For example, in the lesson on 'The digestive system'. The class is divided into 3 groups. The first group has to find out information about digestion in the mouth, the second - in the stomach and the third - in the small intestine. Then the pupils count off. The first group gathers at the table to analyse digestion in the mouth, the second group will analyse digestion in the stomach and the third group will analyse digestion in the small intestine. When the groups have finished their work, the 'experts' return to their previous groups and explain to the group members what they have learned. The teacher can ask any randomly selected member of the group about the information given by the "expert". A test task can also be given at the end to assess the understanding and mastery of the material. This method can be successfully transferred to distance education in the upper grades.

**Using ICT (information communication technologies) in STEM activities**

The use of information technology in distance learning allows for the integration of various STEM (science, technology, engineering, mathematics) subjects into the educational process. The use of ICT in distance learning makes it possible to deliver more visual and memorable lessons, making the learning process interesting and dynamic.

Schools can use technologies such as Formative, Kahoot, Keynote, Quizizz, Quizlet, Socrative, etc., to create teaching materials.

Didactic tests are particularly important in the classroom to assess how well students have learned a subject or part of the curriculum. Tests can be administered to one pupil (individual) or to a group (group). For example, the online tool Kahoot allows the organisation of surveys and quizzes. It is available in all web browsers and works on a variety of devices. It is fun for students to use it because it encourages competition. Each answer is followed by a personal score and a ranking. Teachers, students or groups of students can use the app to create a variety of quizzes based on topics, student abilities, and lesson goals and objectives.




Another virtual tool is Prezi It is one of the best online services for creating visually beautiful presentations. The results are always pleasing. They are dynamic, elegant and original.

MS PowerPoint presentations can be made much more interesting by turning them into an interactive test. We can also find out what students already know and reinforce their knowledge with new material. At the end of the lesson, using the tablets, students not only test their knowledge but also make self-assessment. This makes learning playful and engaging.

MS Paint is a drawing programme that many people are probably familiar with, and helps you develop your drawing skills in a different way - with a computer mouse.

Another option is to organise and run STEM activities in STEM centres. STEM Centres are introduced to reinforce science education. STEM centres are designed to engage students in the sciences (including science, technology, engineering, arts, mathematics). They are designed to improve achievement, strengthen practical skills, and develop the creativity, initiative, entrepreneurship and leadership competences they need for a successful career. STEM will encourage students to take a more specific interest in science and science education and to pursue these study fields. The aim is to rediscover STEAM activities in the centre that will motivate pupils to take an interest in the processes taking place in their environment and understand them better.

**STEM activity scenarios.**

**Scenario 1**

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|---|---|
| **Experiment title** | **Research of Fungi Causing Rot of Apples** |
| **Class, students' age** | 13 - 14 years |
| **Main (teaching) subject** | Biology |
| **Integrated subjects** | Chemistry (chemicals used for plant protection; fungicides, their effects on organisms and the environment). |
| **Duration** | ~ 45 min. |
| **Recourses** | Magnifying glass, Petri dishes, microscope, coverslips and object slides, a set of dissection tools, a rotten apple (grayish-yellowish carpels arranged in circles should be visible on its surface). |
| **Experiment' aim** | To find out the cause of rotting apples (what rotted the apples?) |
| **Students abilities/skills needed** | Research skills |
| **Hypothesis/Questions** | What made the apples rot? |
| **Preparation for activities** | If possible, this stage of activity is organized in autumn in the apple orchard. Apples damaged by rot are found and taken for examination (i.e. several apple samples are taken for the experiment). |
| **Activities: conducting a study; data analysis; conclusions** | Study steps:<br>1. Familiarize youself with the course of the investigtion, the necessary tools.<br>2. Examine the apple samples through a magnifying glass. Describe the visible signs.<br>3. Prepare the preparation. Using a dissection needle, carefully remove the carpel-shaped plaque from the surface of the apple and place it on an object slide in a drop of water, then spread it with a needle or scalpel and cover it with a coverslip.<br>4. Examine under a microscope. Draw or photograph the visible image of the mushroom, label and name the visible structures (hyphae, spores).<br>5. Carry out research analysis - complete the research sheet (*Annex*). |
| **Ideas how to develop / adjust experiment for different classes or levels** | The test is simple, low-resource, and easily adaptable for students of different abilities. |

**Scenario 2**

| | |
|---|---|
| **Experiment title** | **Invertebrates study. Earthworm.** |
| **Class, students' age** | 10 - 12 years |
| **Main (teaching) subject** | Biology |
| **Integrated subjects** | Math (drawing diagrams, comparing lengths, calculating average lengths), native language (use of adjectives, verbs). |
| **Duration** | ~ 45 min. |
| **Recourses** | Tools: magnifying glass, sheet of paper, ruler or measuring tape, shovel, disposable gloves (optional). |
| **Experiment' aim** | To introduce students to the invertebrates living in the immediate environment - earthworms: body structure, way of life and to discuss the natural and practical significance of earthworms. |
| **Students abilities/skills needed** | Research skills |
| **Hypothesis/Questions** | Adaptation of earthworms to live in the soil. |
| **Preparation for activities** | Find a suitable place where earthworms live and it would be easy to dig, such as a flower garden, wooded area, etc. |
| **Activities: conducting a study; data analysis; conclusions** | Study steps:<br>1. Familiarize yourself with the course of the investigation, the necessary tools. Safety briefing: safe handling of shovel, scissors or knife. Exercise caution when collecting, releasing and inspecting animals.<br>2. Earthworms dug out of the soil are placed in Petri dishes and examined through a magnifying glass. It is found where the head, chest, tail parts are located, the thickening is the saddle (it is closer to the head part). The segments that make up the earthworm's (it is possible to calculate how many of them approximately the earthworm has).<br>3. The earthworm is touched by hand. It is ensured that it is moist (it breathes over the entire surface of the body). The way of life of earthworms is discussed (their role in agriculture, farmers is emphasized).<br>4. An examination is carried out to ensure that the body of the earthworm is covered with small bristles. The earthworm is placed on a piece of paper and gently pulled. A faint sound is heard as the bristles touch the paper.<br>5. Observed movement of earthworms. The length or thickness of the worm is due to the contractions of the muscles in each segment. The worm is placed on a ruler and its length is measured. The data is recorded on the activity sheet (*Annex*). *Worms used for research are safely released where they were collected!* |

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| **Ideas how to develop / adjust experiment for different classes or levels** | The test is simple, low-resource, and easily adaptable for students of different abilities. |

**Scenario 3**

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|---|---|
| **Experiment title** | **Cell – the smallest part of the body** |
| **Class, students' age** | 11 - 12 years |
| **Main (teaching) subject** | Biology |
| **Integrated subjects** | Math, IT |
| **Duration** | ~ 45 min. |
| **Recourses** | Petri dishes, set of dissection tools, magnifying glass, microscope, objective and coverslips, pipettes, beaker with water, paper napkins, leaf moss. |
| **Experiment' aim** | To find out that organisms are made of cells. |
| **Students abilities/skills needed** | Research skills. Safety instruction on how to behave safely when making preparations. |
| **Hypothesis/Questions** | What are those cells? What are they like? What is inside them? |
| **Preparation for activities** | A few examples of green leafy mosses are collected in nature. |
| **Activities: conducting a study; data analysis; conclusions** | Study steps:<br>1. At least 2 different types of moss leaves are studied: students are given Petri dishes with moss samples.<br>2. Moss leaves are examined through a magnifying glass, their shape and color are described.<br>3. Preparations of studied moss leaves are made: a leaf is separated with tweezers and placed in a drop of water on an object slide. Covered with a coverslip. Excess water is wiped off with a paper napkin.<br>4. Preparations are observed through a microscope. Visible images are photographed or represented by a biological drawing. Cell wall, cytoplasm, chloroplasts are marked.<br>5. The visible parts of the cells are described, their structure is linked to the functions they perform. The studied mosses are compared: how are they similar and what are the differences between the cells of the studied moss leaves.<br>6. A research conclusion is drawn. Fills out the research sheet (*Annex*). |

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| **Ideas how to develop / adjust experiment for different classes or levels** | The test is simple, low-resource, and easily adaptable for students of different abilities. |

**Scenario 4**

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|---|---|
| **Experiment title** | **Research of nitrate and nitrite levels in vegetables** |
| **Class, students' age** | 11 - 14 years |
| **Main (teaching) subject** | Biology |
| **Integrated subjects** | Chemistry (what are nitrates, nitrites), IT (presentation on the effects of nitrates and nitrites on the human body, etc.). |
| **Duration** | ~ 45 min. |
| **Recourses** | Petri dishes, laboratory beakers, set of preparation tools, set of water parameters test (indicator) strips, fine grater, cheesecloth, paper towel, vegetables (cucumbers, lettuce, potatoes, carrots, onions and/or others). |
| **Experiment' aim** | Find out which vegetables accumulate the most nitrates and why? To determine the quality of the vegetables we eat. |
| **Students abilities/skills needed** | Research skills |
| **Hypothesis/Questions** | What are the amounts of nitrates and nitrites in the vegetables we eat? |
| **Preparation for activities** | Various vegetable sets are being prepared. It is recommended to collect vegetables from different places: shops, markets, etc. |
| **Activities: conducting a study; data analysis; conclusions** | Study steps:<br>1. Sets of vegetables are distributed (each student examines at least 2-3 different vegetables).<br>2. The vegetable is grated and juice is squeezed through cheesecloth.<br>3. The indicator strip is dipped in vegetable juice and kept for the time specified in the instructions.<br>4. The color reactions of the strip are observed. The color change is compared with the control scale provided in the instructions.<br>5. The change in color reaction is recorded (photographed).<br>6. Research data are written into a table on the student's activity sheet, average values are calculated on the activity sheet (*Annex*).<br>7. Based on the obtained data, a research conclusion is drawn: which vegetables accumulate the most (or least) nitrates and nitrites. |

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| **Ideas how to develop / adjust experiment for different classes or levels** | The test is simple, low-resource, and easily adaptable for students of different abilities. |

**Scenario 5**

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|---|---|
| **Experiment title** | School indoor air testing |
| **Class, students' age** | 11 - 14 years |
| **Main (teaching) subject** | Biology |
| **Integrated subjects** | Biology, math, chemistry, physics |
| **Duration** | ~ 90 min. |
| **Recourses** | List of tools (annex) |
| **Experiment' aim** | Išsiaiškinti tiriamų patalpų oro būklę. To find out the air condition of the tested rooms. |
| **Students abilities/skills needed** | Research skills |
| **Hypothesis/Questions** | Air quality depends on the room being tested.<br>(i.e. the air quality of the room and the time of sampling affect the abundance of micro-organisms in the sample). |
| **Preparation for activities** | - |
| **Activities: conducting a study; data analysis; conclusions** | Study steps:<br>1. learn about the procedure and the necessary tools;<br>2. label the petri dishes according to the instructions provided;<br>3. take air samples in the classroom and in the canteen/gym/etc. in the morning and in the afternoon.<br>4. carry out the test according to the instructions provided (Annex). |
| **Ideas on how to set up an experiment for different cases or levels** | The test is simple, low-resource, and easily adaptable for students of different abilities. |

**Assessment**

Assessment is a crucial part of teaching and learning. What students experience through assessment is something that follows them throughout their lives and largely determines their ability to learn in the future. Assessment encourages students to take an active part in the learning process. Assessment is not possible without explaining the learning objectives to students. But assessment helps students to know and understand what they are trying to achieve. Assessment and evaluation can take place not only in the classroom, but also remotely, through a video communication system (video conferencing) such as the ZOOM platform.

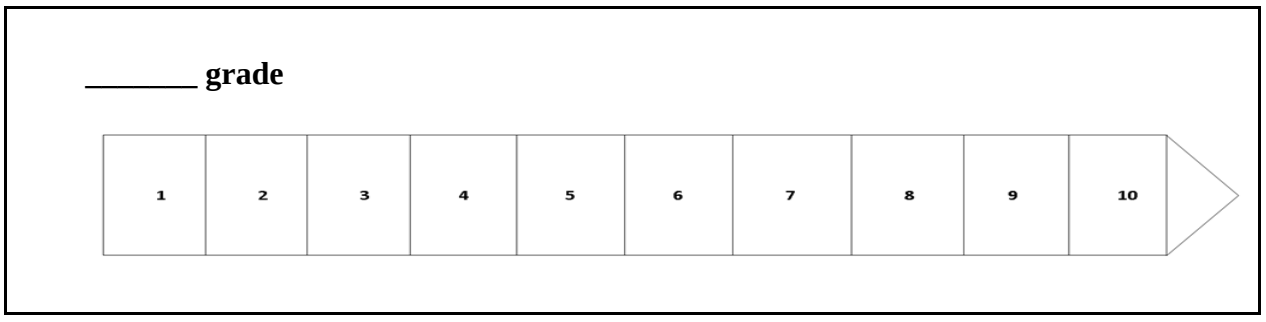
Self-assessment is a decision made by the student about his/her own progress and achievements in order to clarify his/her strengths and weaknesses. Self-assessment not only promotes a student's self-esteem but also their motivation. There is a wide variety of methods of assessment in the classroom, allowing the teacher to choose and test the most optimal forms and to monitor the impact of assessment on the learning process.

Self-assessment is an integrated and planned part of the educational process. It is important to take into account the content of the learning material and the development of skills when planning self-assessment.

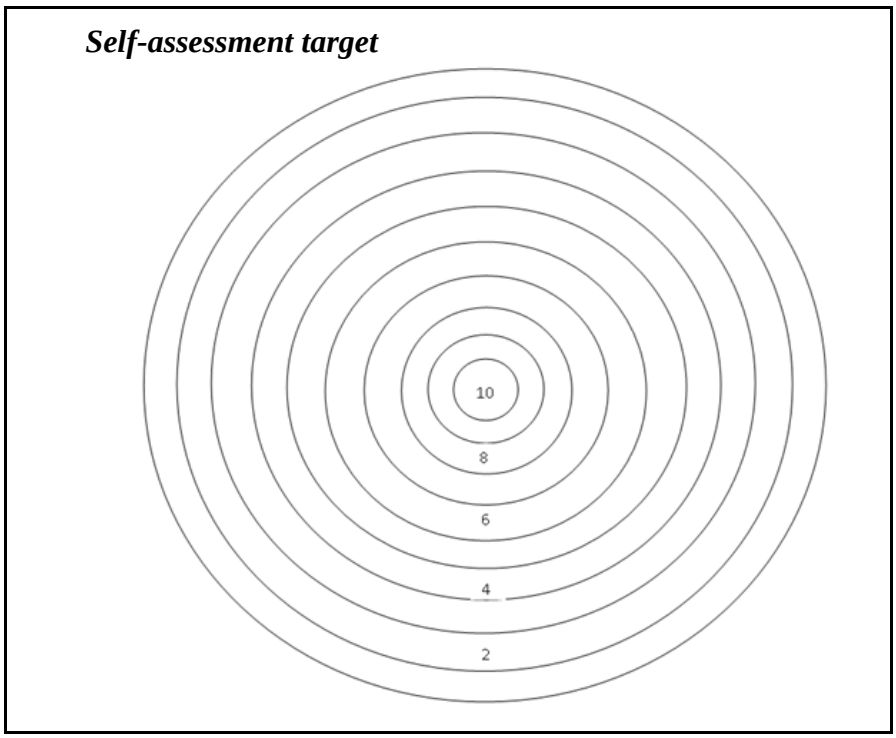
Self-assessment needs to be linked to the learning objective, success criteria and examples of interpretation. Self-assessment should be task-related and not learner-related (e.g. "What did you find difficult and why?" rather than "Who found it difficult?"). Allow students to choose and use tasks that allow them to assess their progress.

After the task or after the lesson, all students self-assess by marking themselves on a scale or target.

- **Scale.**



- **Target.**




- **Face emoji**. How students understood the lesson and how they felt is noted by a smiling face:

 - I understood everything, I'm very good at it (I feel great),

 - I didn't understand everything, I'd like to learn better (I feel normal: sometimes good, sometimes not so good),

 - I didn't understand anything, I don't know enough (I feel bad).

Instead of face emoji elementary school students may colour the circles with the colours of the traffic lights: got it - green; didn't get everything - yellow; didn't get it anything- red.

For elementary school students:

| DATE | FACE EMOJI |
|---|---|
| _____ | |
| _____ | |
| _____ | |
| _____ | |
| _____ | |

For 5-6 grades students:

| DATE | FACE EMOJI (How do I feel?) Self-assessment: 1 2 3 4 5 6 7 8 9 |
|---|---|
| _____ | 1 2 3 4 5 6 7 8 9 10 |
| _____ | 1 2 3 4 5 6 7 8 9 10 |
| _____ | 1 2 3 4 5 6 7 8 9 10 |
| _____ | 1 2 3 4 5 6 7 8 9 10 |

Senior students could additionally answer the following questions: why do you feel this way? Explain. What would you need to do differently next time to do better?

Students could self-evaluate their larger-scale activities, i.e. the stages (tasks) they have completed, both in the classroom and at home or in other learning environments.

| Symbols for self-assessment | 1 task | 2 task | 3 task | 4 task | 5 task | Evaluation |
|---|---|---|---|---|---|---|
| ⊕ | | | | | | |
| + | | | | | | |
| ⊥ | | | | | | |
| T | | | | | | |
| − | | | | | | |
| ⊖ | | | | | | |

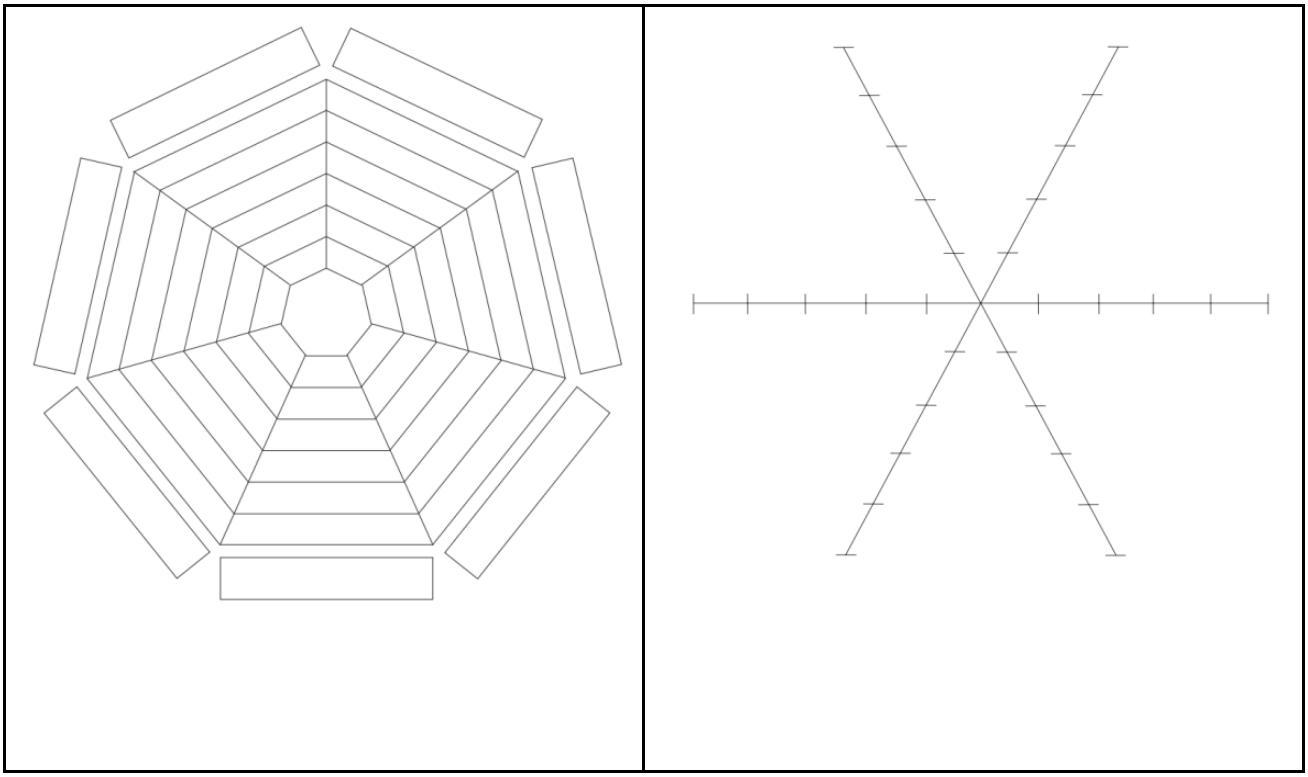
Desctiprions of symbols:

| | | | | |
|---|---|---|---|---|
| ⊕ | excellent | | T | Satisfactory |
| + | Very good | | − | Poor |
| ⊥ | good | | ⊖ | Very poor |

.

- **Spider Web and Star**

Spider Web and Star are graphical forms for self-assessment. On the axes of the shapes, students should mark the intensity of certain characteristics (skills, attitudes, knowledge and understanding). The teacher names the axes according to the lesson objectives. Students may be asked to assess both the subject competences and the general competences. These graphical forms can be used to assess work in the lesson and to monitor and record learning progress over a longer period of time. In this case, the chart is started at the beginning of the learning phase and is systematically completed over the planned learning period.

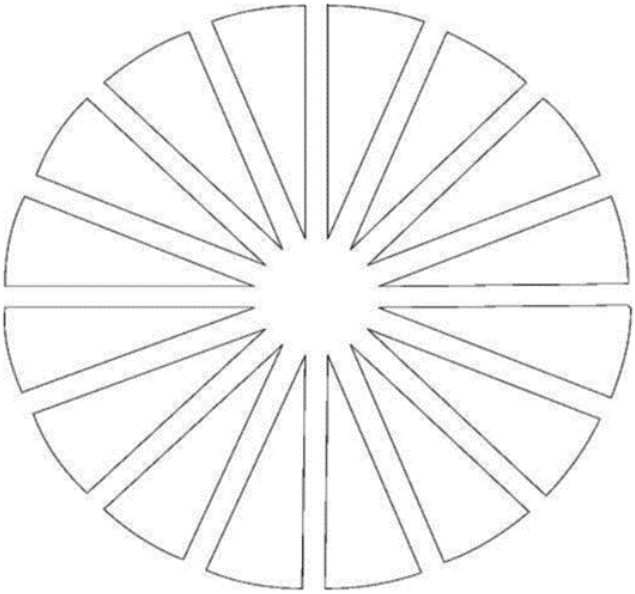


- **Dividing the cake.**

When the work is finished, group students are given a piece of paper with a circle drawn on it. The group members should divide the "cake" into parts that represent the contribution of each member to the group's work.

_____

*Group number and name*



Group members:

_____
_____
_____
_____
_____

**Self-assessment:**

1 . How was the group collaboration? Why?

……..…
…….....….

2. Why did you feel this way about your contribution to the work of the group?

……..…
…….....….

3. Do you agree with this division of the cake? Why?

……..…
…….....….

4. What would you do differently the next time you work in a group? Why?

……..…
…….....….

The ways and forms of assessing group work may be different from individual assessment.

- **Matrix of competency assessment.**

At the end of a learning activity/cycle/phase, a group of learners assess their progress following the competency assessment tables. At the end of a practice work or other activity, groups receive a competency assessment grid. After discussing their activities in the lesson, the pupils write the names of the pupils who were most successful in developing the competences in the table next to the competences they have written.

For long-term assessment and self-assessment, this form is recommended, in which both the pupil and the teacher mark their assessments and discuss progress with the teacher and parents at the end of the semester or school year. These sheets are only for students in the upper grades.

## MY PROGRESS SHEET

SELF-ASSESSMENT OF PERSONAL PROGRESS

Subject: **_____.** Teacher: _____. Period: **_____**

Class: _____. First and last name of student _____

| **Lesson content (topic) and date** | **Self-assessment** | **Teacher's assessment** |
|---|---|---|
| **1.** | 1 2 3 4 5 6 7 8 9 10 | |
| **2.** | 1 2 3 4 5 6 7 8 9 10 | |
| **3.** | 1 2 3 4 5 6 7 8 9 10 | |
| **4.** | 1 2 3 4 5 6 7 8 9 10 | |
| **5.** | 1 2 3 4 5 6 7 8 9 10 | |
| **6.** | 1 2 3 4 5 6 7 8 9 10 | |
| **7.** | 1 2 3 4 5 6 7 8 9 10 | |
| **...** | 1 2 3 4 5 6 7 8 9 10 | |

| **Attitudes, skills, efforts** | **Self-assessment** | **Teacher's assessment** |
|---|---|---|
| 1. I work hard in my lessons and do not disturb others. | 1 2 3 4 5 6 7 8 9 10 | |
| 2. I do my **homework** on time and diligently. | 1 2 3 4 5 6 7 8 9 10 | |
| 3. I'm not late for lessons, and I don't skip classes without a good reason. | 1 2 3 4 5 6 7 8 9 10 | |
| 4. I always have everything I need for a lesson. | 1 2 3 4 5 6 7 8 9 10 | |
| 5. I am satisfied with my learning results. | No / Yes | - |

| **Question** | **Answer** |
|---|---|
| My **favourite** thing about this semester... | |
| My biggest **dislike** this semester... | |
| I did **better** in ... | |
| **I failed** ... | |

My grade for the ___ **semester** will probably be ___ . Final grade ____.

(filled by teacher)

Date of completion of the progress sheet _____

**Resources**

In hybrid teaching, the teacher should use appropriate virtual learning environments (e.g. Microsoft Teams, Moodle) or video communication systems (e.g. Zoom, Teams Meeting, Skype).

**Recommended apps for distance learning platforms:**

· **The ZOOM https://zoom.us/ platform is used for videoconferencing - a way of sharing files and your computer screen with your students. There is also a chat box where you can ask students written questions.**

**- Hangouts Meet https://gsuite.google.com/products/meet/**

**- The simplest solution is an electronic diary ('Tamo, My Diary). Teachers share online links to learning tasks or materials.**·

**„Google Classroom“** https://edu.google.com/workspace-for-education/classroom/ allows schools and teachers to create virtual classrooms to share learning materials and communicate with classmates in a safe environment.

· **„Micrososft Office 365 for education“ –** a toolkit for education **https://www.microsoft.com/lt-lt/microsoft-365/academic/compare-office-365-education-plans?activetab=tab%3aprimaryr1**

· **„Edmodo“** https://new.edmodo.com/ – A free and easy-to-use virtual learning environment, suitable for primary and secondary education, or even grammar school classes. The app offers a safe way for students and their teachers to communicate with each other both during and after class. The environment is similar to the social network Facebook

· **MOODLE** www.moodle.org a learning management system that allows you to create virtual environments for the learning process, where teachers can host learning materials, submit assignments, and create tests for self-testing or knowledge checking.·

**„Slack“** https://slack.com/ like MS Teams, it allows you to create individual and group chats, make calls and share files. "Slack has the advantage of being able to connect with Google Drive or Microsoft Office 365 platforms, so that each user receives reminders or alerts in the way that suits them best.

· **BITDEGREE** Blockchain-based digital learning platform. https://www.bitdegree.org/

· **„SeeSaw“** https://web.seesaw.me/ **–** the simplest virtual learning environment, suitable for even the youngest learners. It has no assessment tools, but you can share various links, learning materials, comments, observations, etc.·

**Skype** https://www.skype.com/en/ – a less commonly used application for synchronous communication.

· **Facebook messenger** https://www.messenger.com/ can be used as a means of asynchronous communication.

· To create material or to test and assess knowledge can be used**: EdPuzzle, Socrative, Wordwall, Quizlet, Quizizz, Kahoot!, TesTeach, Edmodo ClassDojo.**

· **MS Photo Story –** video creation software. With this application, students can turn photos and pictures into videos. It is also possible to voice your video material (i.e. record a narration of the material being shown, add a desired music track).
· **Filmstreet –** enables you to make a film. The app allows you to choose the background, characters, props and music you want. Students can save their work and show it at any time.

· **A classroom/group website** is a modern teacher's everyday work tool. The website is clearly useful for the webmaster himself, as it is an obvious tool for his continuous development and knowledge building. A website is an opportunity for collaboration, a powerful HTML medium, a compact and capacious variety of modules and a virtual educational space.

· **Google diskas.** "Cloud Storage is compatible with Drive, Gmail and Google+ Photos, so you can store files, email attachments and back up photos directly in Drive. This environment is perfect not only for communication and collaboration, but even for surveys and gardening.

**Learning apps. The following learning apps are recommended and provide a wide range of examples of learning objects:**

· **Anatomy 4D+, Ocean 4D+, Animal 4D+, Space 4D+, Dinosaur 4D+,**

**Kubic, SkyView, Quiver - 3D Coloring App, Chemistry Answers, Simple Physics.**


**The Google page also includes sources such as:**
**- Science Journal - conduct scientific experiments, record observations and analyse results in activities that open students' minds and save teachers' time; https://www.science.org/journal/science**

**Scientific method:**
· **https://carlyandadam.com/thecarlyandadam/the-engineering-design-process-or-the-scientific-method**
· **https://owlcation.com/academia/FormulaForUsingScientificMethod**
· **https://www.thinglink.com/scene/971584136760262659**

**Examples of STEAM research, experiments:**
**- "Is 1°C high or low?"**
**https://www.youtube.com/watch?v=8CpTtDNB9UE&ab_channel=%C5%A0iaur%C4%97slic%C4%97jus**

**· Let's sort. Protect nature. An eco-robotics project.**

**https://www.youtube.com/watch?v=UW2kBaqiHAQ&ab_channel=AstaRad%C5%BEvilien%C4%97**

**· Effects of plastic on water**

**https://www.youtube.com/watch?v=16dWbXTLlPg&ab_channel=KristinaStankevi%C4%8Dien%C4%97**

**Resources:**

**https://www.emokykla.lt/nuotolinis/aplinkos-ir-irankiai**

**https://www.iklase.lt/nuotolinis-mokymas-is-mokyklose-pagrindai/**

**https://sites.google.com/itc.smm.lt/nuotolinis/aplinkos/virtualios-mokymo-aplinkos**

**https://www.bite.lt/profai/nuotolines-pamokos**