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DEVELOPING SOIL PROTECTION TRAINING MATERIALS BASED ON EXPERIMENTAL PROCEDURES FOR AGE BETWEEN 10-14 IN HUNGARIAN PUBLIC EDUCATION

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Abstract: The choice of this study was inspired by recognition of gaps around the general knowledge and protection of soil. The poor knowledge of society today about soil protection puts the livelihoods of all life forms on Earth at risk. Loss of soil natural functions could have serious consequences in the future. Regeneration of soil as a non-renewable resource is too long to be defined on a human scale. The Food and Agriculture Organization of United Nations raised the awareness of the importance of healthy soil in connection of healthy, nutritious food production and importance of public awareness of soil protection. Therefore, it is necessary to integrate the basic theory and practice of soil protection into public consciousness, general and public education, and higher education too. Further generations will grow up without tangible knowledge and voluntarily or unintentionally destroy the essential foundation of our existence, the fertile soil. For this reason, it is important to thoroughly investigate the existing materials in the topic of soil protection in the National Core Curriculum and teaching materials. After a thorough research in the Hungarian Core Curriculum, it is clearly recognizable, that the topic of healthy soil is currently insufficient. The main question is, how to integrate more thoroughly the protection of this essential natural resource into education? My answer is in a precisely planned, practice oriented, age-appropriate educational material based on previously performed experiments, which experiments meant to provide the framework of the compiled teaching aid.

Keywords: *Awareness raising, Education, Healthy food, Healthy life, Soil protection*

INTRODUCTION

The 68th UN General Assembly in 2013 declared 2015 the International Year of Soils and December 5th for the World Soil Day. The Food and Agriculture Organization of the United Nations (FAO) aims to inform civil society and decision-makers, promote investment, make policy decisions, strengthen the Sustainable Development Goals and gather information on soil protection. Loss of soil natural functions could have serious consequences in the future. The status of soil health has a major impact on all living being and mankind on Earth. It not only affects the balance of biodiversity and natural communities, but food production, health and life of future generations as well. The FAO called attention to the importance of public awareness. So, it is a major issue to pay attention to awareness raising and education in the topic of soil health and its protection. Although soil education is already

part of the primary school curriculum, but knowledge of soil protection provides a negligible opportunity for both students and teachers to acquire and transfer an understandable, tangible knowledge material. During the research for several textbooks used for education, we had the opportunity to observe these shortcomings. As a result, the knowledge of the rising generations can be said to be poor on the subject. Hungarian general and public education would be in great need of an illustrative aid, which clarifies, makes the importance of soil protection goals interesting and complements the curriculum with colorful, interesting, easy-to-interpret and processable information. The primary goal of my work is to help bridge the gaps in primary school curricula. Accordingly, a number of experiments demonstrating the physical, chemical, biological properties, functions, and degradation of soils were processed and described, all of which served as the basis for the preparation of worksheets, illustrations, and aids. The auxiliary material related to the completed curriculum is in close accordance with the requirements of the National Core Curriculum (NAT2020) and mainly provides professional help for its students and teachers in subject of natural science and biology year 5-7 thanks to its simple, understandable, illustrated design. It partly completes the suggestions of the recently released Hungarian Soil Protection Action Plan released by the Hungarian National Food Chain Safety Office (NÉBIH) as well. [1], [2], [3], [10].

MATERIALS AND METHODS

The teaching material

Based on the knowledge of soil science and soil protection, taking into account the methodological requirements of the National Core Curriculum, documentation of several experiments was prepared. This documentation package is the basis for compiling the teaching aids. For the teaching aid, in the thematic order of soil properties and soil protection knowledge, worksheets were prepared for each topic in an age-specific division. Worksheets are supported by a photo gallery for a more accurate understanding. We compiled the experimental worksheets in a way to meet the expectations that are interesting for the 10-14 years old students and make them suitable for the development of their knowledge. The requirements I set for the worksheets are as follows:

1. Fit into the curriculum and meets its requirements.
2. Develop the key competencies named by the curriculum requirement.
3. Contains integrated knowledge from other disciplines.
4. The compiled knowledge and practice should be age-appropriate.
5. The materials used are easy to obtain, could be found in any household and suitable for home and school experiments and can be used safely.
6. The knowledge is easy to understand, the practical instructions are easy to follow.
7. Experiments can be repeated at any time.
8. It takes into account the different abilities of the students, so that any student from the given age group can carry out the experiments without restrictions.
9. Interesting, eye-catching, thematically relevant illustration and helpful information.

The structure of the worksheets is based on the same schematic order. Each section has its on purpose to create and interesting, informative and complex teaching aid. The Figure1 illustrates the structure of worksheets. The description of each section is as follows:

Section 1: The illustration is closely related to the topic processed on the worksheet, which is informative in itself.
Section 2: The main and subtitle contains the exact title of the topic, using the terminology of the literature.
Section 3: The “Soil smarty” section contains a short and interesting description of the knowledge and facts related to the topic.

Section 4: The thematic text part contains the comprehensive knowledge of soil science and soil protection. It integrates different disciplines at the same time and gives a global picture of the contexts.
Section 5: Describes the tools and steps required to process the experiment.
Section 6: Introductory questions related to the experiment that need further processing.
Section 7: The "Did you know?" part contains additional interesting facts about the topic, which encourages further research, include curiosities related to experiments and also help to develop key competencies.

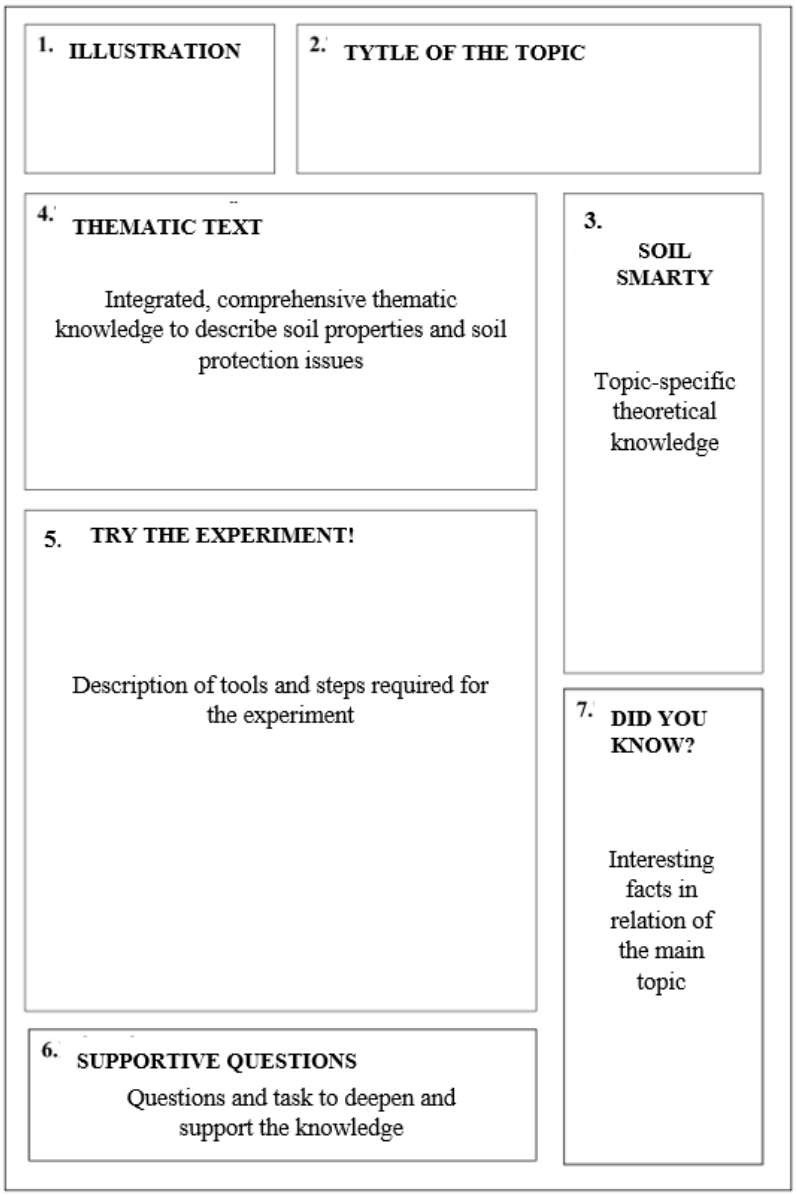


Figure 1: Schematic structure of the worksheets, own illustration

The performed experiments

We performed various experiments at home and in the Institute for Soil Sciences Centre for Agricultural Research in Budapest based on the expected knowledge of the target age group to compile the school aid. It was important during the preparation of the experiments to find material, tools and contaminators are available in a general household. In addition to presenting the physical, chemical and biological properties of the soil, soil degradation and soil pollution processes that destroy soil health were also examined. For the experiments, we used 3 soil types, which were

chernozem loam soil, clay loam soil and sandy soil. The properties of the soils used are shown in Table 1, which data are from the database of the Institute for Soil Sciences Centre for Agricultural Research.

Table 1: Properties of the soils used for the experiments

Name of soil	Soil type	Soil level, humus (%)	pH value	Lime content (%)
chernozem soil form Nagyhörcsök	loam	level A, arable layer, humus 3%;	7,3	3-5 %
sandy soil from Őrbottyán	sand	level A, humus 0,9-1,1%;	7,5-8	3%
Clay loam soil from Tagyon	clay loam	level A, humus 2,16%	8,3	8,47%

Experiments showing the physical properties of the soil were carried out by examining the physical soil type with a so-called “kneading test”. The soil fractions were examined by sieving. Also, we examined the water permeability of the soils in the case of air-dry soils and the water storage function and water binding capacity of the soils. [4]

During the experiments showing the chemical properties of the soils, the lime content and organic matter content of the soil were determined. The lime content was determined with a 10% hydrochloric acid solution. The organic matter content was determined by examining the filtration capacity of quartz sands and sand with high humus content samples. A 20% solution of bio-fermented household vinegar is also suitable for the detection of lime content.

The observation of the biological properties of the soils was intended to show the visible and invisible soil life to the naked eye. To present the visible soil life, we demonstrated the activity of earthworms belonging to the annelid strain by constructing a “earthworm farm”. Earthworms mixed the layers of the already mentioned soil samples, so it provided a good mapping opportunity to observe the earthworm passages in a 10-liter vessel made of glass. Authors used 5 earthworms for the experiment, which were released after the end of the experiment. To illustrate the microscopic soil bacteria and fungi, we used chopped apples in 3 glass jars, two of which placed chernozem loam soil samples. The decomposition process of apple pieces placed on soil samples was illustrated under different conditions. Comparing the decomposition process of apple pieces stored on dry soil and wet soil sample showed that certain conditions are necessary for the operation of soil bacteria. On the wet soil sample the decomposition of fruit pieces took place partially, while in the other two cases it lagged and only shrunk, decomposition didn’t start.

We also, illustrated the degradation of the soil by water erosion modeling and demonstration of the deflation effects. Irrigation of vegetated and uncovered soils was used to demonstrate the erosion effects of water. The covered soil sample was captured by the roots and leaves of the vegetation, while the uncovered soil sample was largely washed out of the holding vessel. we used a 10-liter aquarium to illustrate the erosion effects of wind, where we also examined vegetation-covered and uncovered soil samples with a household hair dryer used to simulate wind movements. The granules of the covered soil did not move under the effect of the wind force, while the grains of the uncovered soil stirred up and mostly moved away.

Soil pollution and deterioration were illustrated by two series of 14-days experiments using materials also used in households. The first series of experiments was performed in Petri dishes using 5-5 seeds placed on 5 mg chernozem clay soil samples. Petri dishes could be replaced with small plastic or glass containers.

The seeds placed on the air-dry soil samples were contaminated with 7 ml of an aqueous solution of the materials generally found in any household, and then kept them moist by adding 2 ml of tap water every 3 days. For the entire duration of the experiment, a temperature of 22–25ºC was maintained in a place protected from daylight. In addition to the contaminated soil samples, a control group grown on a cotton wool basis and a not contaminated soil basis group was also observed. The type and percentage composition of the solutions are given in Table 2. The seeds used in the experiments were monocotyledonous cucumber and dicotyledon corn.

Table 2: Concentration and pH of contaminants used in the germination experiment

Contaminant	Solvent	Solution (%)
2 ml 20% Lidl biologically fermented vinegar (acetic acid, tap water)	5 ml H_2O (tap water)	6 % (V/V %) pH 2,6
2 ml 100% rapeseed oil	5 ml H_2O (tap water)	40 % (V/V %)
5 g Lidl iodized vacuum salt (NaCl, KI, E535)	50 ml H_2O (tap water)	10 % (m/V %) pH 6,5
0,5 g Baba soap (Sodium tallow, sodium palm kernel, water, Glycerin, Parfum, Sodium chloride, Tetrasodium EDTA, Tetrasodium etidronate, BHT, Geraniol, Hexyl cinnamon)	30 ml H_2O (tap water)	1,7 % (m/V%) pH10

As a result of the observation, there was no sign of germination in the case of seeds grown on saline-contaminated soil. In the case of seeds grown on soil contaminated with vinegar solution, the cucumber started to germinate on the tenth day, but significant deformation was observed on its cotyledons. In the case of soil sprinkled with soapy solution, the seeds began to germinate with a delay. In the oil-contaminated group, a seed germ was observed on a single seed, but all groups began to mold and by the end of the observation, the cucumber seeds began to decay. In the case of the soil-grown control group, the seeds began to germinate within a short time; however, several seeds began to mold. This is presumably due to the degrading function of the soil. In the cotton wool-grown control group, each seed grew strong cotyledons and roots.

The aim of the second 14-day experiment was to observe the most typical soil contamination effects, the consequences of inland water and soil dehydration on the soil and the development of plants growing in the soil. The experiment was carried out in transparent pots on 1-1 kg of soil below 2 mm grain size in a plant growth room at 22-24ºC. For soil contamination we used Chernozem soil from Nagyhörcsök, and we used 3 types of soil to monitor the effects of dehydration and inland water. The characteristics of each soil type are shown in Table 1. The corn and cucumber seeds were pre-germinated in Petri dishes, and after the appearance of the root and buds, we planted them in the prepared pots filled up with soil close to the edges of the transparent pots. After placing the seeds in the soil, we watered the soils individually with 100 ml of tap water every three days for one week, when cotyledons developed in the case of cucumbers and leaves appeared in case of the corn seeds. As well as the development of the roots was clearly visible. The plants thus developed received contaminants that were the same as in the first 14-days germination experiment. The concentration was determined by the pH value and the estimated amount of substances used in the household. Compared to the experiment in the Petri dish, we reduced the concentration of soap and vinegar. We watered the plants once with 100 ml of the contaminating solutions as the initial step of the experiment. We examined the developmental differences of the groups contaminated with soap, vinegar, brine and oil solution compared to the growth of control plants irrigated only with tap water. Data on contaminants and the concentration used are given in Table 3.

Table 3: Concentration and pH of contaminants used in the pot experiment

Contaminant	Solvent	Solution (%)
10 ml 20% Lidl biologically fermented vinegar (acetic acid, tap water)	100 ml H_2O (tap water)	1,81 % (V/V %) pH 2,8
40 ml 100% rapeseed oil	100 ml H_2O (tap water)	28,6 % (V/V %)
10 g Lidl iodized vacuum salt (NaCl, KI, E535)	100 ml H_2O (tap water)	10 % (m/V %) pH 6,5
1 g Baba soap (Sodium tallow, sodium palm kernel, water, Glycerin, Parfum, Sodium chloride, Tetrasodium EDTA, Tetrasodium etidronate, BHT, Geraniol, Hexyl cinnamon)	100 ml H_2O (tap water)	1 % (m/V%) pH 9,8

After sprinkling with the contaminating solution, a spectacular plant stress response was observed at the sixtieth minute in the groups sprinkled with saline and vinegar solution. The plants drooped, slumped. On the seventh day of observation, in addition to the strengthening shoots and roots of the plants in the control group, the plants watered with vinegar and saline dried out and their roots thinned. The soil of the plants watered with the soap solution became lighter, the development of the plants was slower and the leaves turned yellow. The leaves of the plants watered with the oily solution turned brown in places, their development was delayed, and their roots thinned.
The harmful effects of inland water were studied with cucumbers on three types of soil. We placed the pots in which the plants grew on a larger, high-walled tray, which we then poured with 3 liters of tap water, and also sprinkled the plants with 100 ml of water each. Every three days, we watered the plants with 100 ml of water and made up the evaporated water from the tray. On the seventh day of the experiment, the cotyledons of the plants were yellowish and lagged behind in development compared to the plants in the control group.
In the study of dehydration, we also used three types of soil and examined the growth of cucumber in each case. The plants from the seventh day did not receive water supply. By the end of the experiment, their cotyledons began to sag and their development was slower than in the control group.

RESULTS AND DISCUSSION

The aim of the performed experiments was to compile the worksheets written in Hungarian in addition to gaining experience. In addition to the worksheets, students are also given an illustrative guide as a second page next to each worksheet to check each step of the experiments performed.

Authors divided the colourful, eye-catching experimental worksheets in the following topics:

1. Soil Physical Properties, Soil Particle Size Worksheet and Guide
2. Physical properties of soil, Determination of physical soil types I. worksheet and guide
3. Physical properties of soil, Determination of physical soil types II. worksheet and help
4. The Soil Drainage worksheet and guide
5. The Inland Water Worksheet and Guide
6. The Workshop and Guide to Soil Erosion
7. Worksheet and Guide to Soil Filtering
8. The Germination and Soil Contamination worksheet and guide based on your own illustration and source material used
9. Worksheet and guide on Basic (Alkaline) pH and Soil Pollution
10. Worksheet and guide on Soil Acidity and Soil Pollution
11. The Salination worksheet and guide
12. The Oil Pollution Worksheet and Guide
13. Worksheet and Guide to Soil Biological Properties, Soil Creatures

Each worksheet contains sequential knowledge, but can also be used individually and also, contains at least one of the performed experiments. The proposed experimental procedures list ordinary tools used in everyday life, so they can be easily performed in the students' homes without the need for a laboratory or school environment. Topics suggested for class 5-6 are included in the worksheets on soil physical properties, and topics suggested for class 7 are included in worksheets on soil chemical and biological properties. As a demonstration of the result, we represent the Salination worksheet and guide out of the 13 prepared teaching aids in Figure 2.



Figure 2: Salination worksheet and guide, own illustration [5], [6], [7], [8], [9]

The presentation of saline soil with a photo illustration taken in the Hortobágy National Park by Attila Szilágyi helps to understand the topic [6]. The natural and anthropogenic causes of saline soils are presented in the description. In the Soil Smarty section, the most commonly found salt and sodium is listed and detailed. The Try the experiment section, invites students to observe the plant irrigated with saline and its consequences based the experiments that have already been performed. The illustration and explanation in the guide help to follow up and understand the experimental steps. In the Did you know? Paragraph students can get familiar with the typically saline areas of Hungary with the help of a blind map of Hungary depicting saline soils. The questions at the end of the worksheet serve to deepen the curriculum.

In terms of future usage of the teaching aid package authors plan to offer it to primary school teachers as a trial version of soil protection teaching material. Therefore, actively working teachers can get involved into the final piece of this study. Furthermore, future plans include the compilation of a video material on the same topics, which will help with further illustration, support the development of digital competencies, and promote a better understanding of the topics. The ready worksheets and video package then will be available for free to use for students and teachers to support and understand soil, soil protection, consequences of soil degradation and its connection with healthy life.

CONCLUSIONS AND RECOMMENDATIONS

Experiments have revealed that soil, as a primary resource, forms an indispensable unit with the spheres surrounding it. The complex functioning of the soil is fragile and even the slightest intervention can destroy decades of soil-building work, which can cause invaluable damage to the functioning of nature as well as to future generations. During the preparation of my study, we were fortunate to study in more depth the versatility and importance of soil for terrestrial life forms. Authors have personally experienced the detrimental consequences of adverse anthropogenic influences.

Furthermore, authors understood that soil protection has become extremely important these days. It is not enough to publish the importance of this in the form of scientific dissertations, but to illustrate and show useful practical steps that can be taken to protect it in an interesting and comprehensible way for as many age groups as possible. This requires an initial step that provides direction for dedicated professionals who can be involved in putting the idea into practice. The main goal with the worksheets is for the growing generations to understand the importance of preserving natural values, including the protection of soils, and to treat their environment responsibly. In this study, the target age group is 10-14 years old, primary school student class 5-7. However, knowledge of the soil and soil protection demonstration material can be extended to other age groups, adapted to the expectations of the age group. As a result, it can be incorporated into the playful basics of pre-school education in the same way as it can be integrated into secondary school curricula or higher education units. Furthermore, it can be prepared in the same way as an understandable learning opportunity for adults. These goals are opportunities for future soil protection efforts. The tools and materials suggested for use in the experiment sections are necessity of everyday life, so they are not tied to space, time, or expensive equipment. Based on the worksheets and aids, most people can try out the experiments on display. In addition to a vision based on accuracy, technical knowledge, and prepared professional foundations. Becoming an Environmental engineer how to represent solutions based on logical reasoning on a simple cost-effective way. This study contains a realization of a vision for a healthier future that holds many new opportunities for the future.

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