

Tools in Ecological Education from the Education Section of the Spanish Society of Soil Science Soil Vermicomposting Practical Booklet

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Abstract

The Soil Education and Public Awareness Section of the Spanish Society of Soil Science (SEPAS-SECS) aims to make known the essential role of soils for life and raise awareness of the need to ensure their sustainable development, especially among schoolchildren and university students. To protect the soil, spreading the knowledge of Soil Science is essential. Among the activities carried out by SEPAS-SECS were workshops with primary and secondary school children.

Among the activities carried out by SEPAS-SECS participates in the IUSS educational project "THE IUSS GOES TO THE SCHOOL" preparing educational materials for young people, and in the book contest for children organized by the IUSS and FAO on the occasion of the WSD. Special attention is deserved by the creation of these brochures, among which is the practical case of vermicomposting for children. These materials are very useful for schoolchildren and institutions to prepare practical cases in their classrooms such as: creating gardens, vermicompost, soil and water contamination, etc. This paper lists some of the materials created and activities carried out by the Soil Science Education Section in recent years.

Keywords: Soil Science Education, Soil Knowledge, School Students, Teaching, Soil Vermicomposting.

Introduction

Education and public awareness of soils and soil science is one of the objectives of the Soil Science Societies (SSS). One of the goals of the SSS is to enhance education, awareness and outreach at all levels. In addition, among the missions of the International Union of Soil Sciences (IUSS) is to support soil and soil science education and literacy at all levels (IUSS Strategic Plan 2021-2030). The IUSS identified education and public awareness of soils and soil science as one of the most important objectives of the International Soil Decade 2015-2024.

A well informed public is needed so that the importance of soils is understood by all. Soil education is vital for kids and young people as it helps them understand the role of soil in supporting life through plant growth, water filtration, recycling of nutrients, carbon storage, foundation for agriculture and infrastructure, climate regulation, etc. Children and young people can marvel at the incredible life thriving within the soil, from tiny microorganisms to intricate networks of fungi and plant roots. Exploring the hidden microorganisms beneath their feet opens their eyes to the vital role that soil organisms play in supporting plants and human life. This sense of wonder fosters curiosity, respect for soils,

and a deeper connection to the environment, inspiring them to protect and nurture the soils.

Actions are needed to make students aware of soils and their importance. The SSS play an important role in ensuring that soil science is not underrepresented in the teaching National Curriculum. Different Soil Science Societies have prepared educational materials and resources suitable for a range of ages and interests on soils, and have made them available to teachers and students on their websites (Table 1). Soil experiments, stories, soil games, colouring books, soil songs, paint with soil, soil videos, lessons and hands-on activities, readings have been published to make

soil knowledge more attractive to young people. The book "Soil Sciences Education: Global Concepts and Teaching" collects good practices of soil sciences education currently used for promoting soil and soil sciences to children and students (Kosaki et al., 2020).

It is worth noting the number of organizations that have made a great effort to provide educational material related to soil science. For example, a UK government-funded initiative led to Soil-Net, an open, innovative online soil educational Web site resource to support school curricula (Hallett and Caird, 2017).

Table 1: Web Links of Soil Science Societies to websites with Educational Resources

Soil Science Societies	Websites
British Society of Soil Science (BSSS)	https://soils.org.uk/education/
Soil Science Society of America (SSSA)	https://www.soils4teachers.org/
Canadian Society of Soil Science (CSSS)	https://csss.ca/education-committee/
Spanish Society of Soil Science (SECS)	https://edafoeduca.es
International Union of Soil Sciences (IUSS)	https://www.iuss-goes-to-school.org.mx/

The following sections present activities carried out by the SEPAS-SECS and collaborators.

Practical Soil Science Workshops in Schools

The people in charge of the SEPAS-SECS visited schools with the aim of bringing soil science closer to schoolchildren. In the workshops the experiments carried out were very carefully chosen so that young students learn about soils and soil properties according to their age. A set of driving questions to answer with the experiments were: what is the soil made up of?, how is a sandy soil different from a clay soil?, how does soil hold water?, can soil be a filter?, what types of organisms live in the soil?, what do soil organisms feed upon?, does the soil breathe?, why is the soil so important to us?, how can students help the soil?.

Schoolchildren could touch soil particles of different sizes to understand the importance of the range of particle sizes in the transfer of water through the soil, in the support of plants, in soil aeration, etc. They also observed the soil's ability to act as a filter and the decomposition of soil organic matter when hydrogen peroxide is used. The schoolchildren had fun when they measured with a CO₂ sensor their respiration and subsequently the respiration of soil microorganisms.

Conferences and Other Activities

The Soil Teaching and Public Safety Section has set out to collect and provide educational material for teachers and school students to be used both in the classroom and outside of it. Educational resources are being compiled on the website edafoeduca.es. To celebrate World Soil Day 2020-2025, various activities have been carried out, including a day titled 'Let's keep the soil alive: protect soil biodiversity'. The Soil Biology and Soil Teaching and Public Safety Sections of the Spanish Society of Soil Science (SECS) organized an online international day aimed at raising awareness about the importance of preserving soil biodiversity. This event, 'Soil Biodiversity: Source of Life for Planet Earth', which is also part of the activities organized by the Latin American Society of Soil Science (SLCS)-UNIDA, took place on December 4. Presided over by Dr. Jorge Mataix Solera, president of SECS, who presented the new editions of the comic 'Living in the Soil' in Polish (Chrońmy Gleby) and

in Chinese (生活在土壤里) promoted by our colleague Dr. Montserrat Diaz Raviña (IIAG-CSIC), coordinator of these projects.

La Jornada featured the CEBAS-CSIC research professor Dr. Carlos García Izquierdo with the lecture 'Caring for the soil is caring for life.' He discussed the key role of soil for life and, therefore, for the environment, as well as concerns about soil health, the complexity of defining soil quality, biological and biochemical parameters as indicators of soil quality, and various techniques for studying microbial biodiversity such as measuring PLFAs, metagenomics, metatranscriptomics, metaproteomics, and meta-metabolomics. He also mentioned the need to understand the effects of climate change on soils and the significant role of soils in achieving the Sustainable Development Goals. He addressed the European Commission's roadmap for the new EU strategy for soil protection and the importance of soil for the European Green Deal. He indicated instruments in the EU related to soil protection such as 'Caring'. "for Soil is Caring for Life," the Green Deal Call (part of Horizon 2020) and the new EJP SOIL tool to create an enabling environment to improve the contribution of agricultural soils to key societal challenges, such as climate change adaptation and mitigation, sustainable agricultural production, etc. Finally, he emphasized the need to promote the importance of soil at all levels.

The second conference, "Land Uses and Microbial Communities in the Carchi Province (Ecuador)," was given by Professor Dr. Luis Roca Pérez from the University of Valencia. He explained how the composition of soil microbial communities is affected by various factors, including those resulting from human activity, changes in land use, and crops, which can lead to a loss of biodiversity caused by the alteration of some soil properties.

The third conference was delivered by biology professor Dr. Nicolás Lucas Domínguez, who shared reflections on the genesis and evolution of the interdisciplinary environmental education project "After the Fire," carried out with secondary edu-

cation students (IES A Pontepedriña, Santiago de Compostela). Finally, Dr. Montserrat Diaz Raviña, Scientific Researcher at the Institute of Agrobiological Research of Galicia of CSIC (IIAG-CSIC) and president of the Biology Section of the SECS, gave the talk "Innovation of teaching resources in the education of soil as a living system." In 2000, the Consello da Cultura Galega published, in Galician, the comic "Vivir no solo," aimed at informing young people in an attractive and novel way about the importance of soil and the need to protect it. The protagonists of the comic (the snail, the mole, and the worm living in the soil, along with a group of young people) show us all aspects (concept, training, components, functions, threats, degradation, and recovery of its quality), in order to resolve a conflict that arose in a village related to land management. During the last decade 2015-2020, it was adapted and edited in several languages for dissemination at national and international levels.

In this line, the work of other teachers involved in this educational motivation for soil science was made known, which is reflected on the edafoeduca website. Among them are the comic Biodiversity (C. Llull), the Service Learning projects, and laboratory practices related to soil analysis from IES Miguel Catalán (Coslada), the soil and ecology fair promoted by Dr. Josep Llinares of the Higher Polytechnic School of Gandía at the Polytechnic University of Valencia, and the informative brochure on Vermicomposting promoted by members of the Soil Science Society (C. Lull and MD. Soriano) in collaboration with IES Bernat de Sarria in Benidorm (Laura García-España). And in the international arena, the activities related to soil profiles carried

out by Carlos Ivan Bonilla Pascuas, a natural sciences teacher from Fómeque in the department of Cundinamarca, Colombia, with his 2nd-year high school students, and with children aged between 11 and 13 years. In this line, the work of other teachers involved in this educational motivation for soil science was made known, which can be found on the edafoeduca website, including the comic Biodiversity (C. Llull), the Service Learning projects, and laboratory practices related to soil analysis from IES Miguel Catalán (Coslada), and the soil and ecology market led by Dr. Josep Llinares from the Higher Polytechnic School of Gandía at the Polytechnic University of Valencia. the promotional brochure on Vermicomposting driven by members of the Soil Science Society (C. Lull and MD. Soriano) in collaboration with the IES Bernat de Sarria de Benidorm (Laura García-España). And at the international level, the soil profile activities conducted by Carlos Ivan Bonilla Pascuas, a natural science teacher from Fómeque in the Cundinamarca department of Colombia, with his 2nd year high school students and with children aged between 11 and 13 years.

Additionally, within the application workshops, a vermicomposting workshop was conducted at IES Bernat de Sarria in Benidorm with ESO students. In this workshop, children are taught the importance of recycling waste through vermicomposting, in collaboration with the vermicomposting group from the Universitat Politècnica de Valencia. During this activity, the students learned how to prepare beds for worms using suitable mixtures for their development while monitoring soil variables such as water content and substrate temperature. The vermicom-



Figure 1: Vermicomposting experience with schoolchildren

The pandemic filtered numerous activities, including the visit to the vineyards in the province of Valencia, which could only be carried out with a small number of attendees. In 2022, a field day was organized on infiltration measures, using disc infiltrometers on different surfaces and treatments; measures of humidity and CO₂ using moisture sensors and CO₂ analyzers under different conditions and rain simulation. It was organized for students of the Forestry and Rural Environment degree at the Polytechnic University of Valencia. Held at the facilities of this university, it had a large number of attendees, both students and professors from this university and the Universitat de Valencia Estudi General, including the professor of edaphology Dr. Rafael Boluda.

Sciencelab Workshop at University

The Universitat Politècnica de València (Spain) organizes each year the ScienceLab workshop (CienciaLab in Spanish), aimed at secondary school students (3rd and 4th course of the compulsory secondary education and vocational training). The objective of CienciaLab is to awaken scientific vocations through the realization of scientific, technological and artistic workshops taught by university professors in the facilities of the University. In 2023-2024 school year, 73 young people from four schools participated in the workshop "Soil, the great unknown" in separate sessions. This workshop was prepared by associate professors who are members of the SECS.

A questionnaire named How much do you know about soils? was prepared for the students. Before starting the experiments, they were asked four questions. The objective of the first question was to know if the Spanish students knew the difference between land, sand and soil. In Spain, the terms land (tierra) and soil (suelo) are often used interchangeably but refer to distinct concepts. The Dictionary of the Spanish language facilitates confusion by indicating that one of the meanings of the word "tierra" is "crumbly material of which the natural soil is mainly composed". Land comprises the physical environment, including climate, relief, soils, hydrology and vegetation, to the extent that these influence potential for land use (FAO, 1976). However, soil refers specifically to the upper layer of the Earth's crust, composed of organic and inorganic matter, minerals, water, and air, which is vital for plant growth. Soil is integrated in this broad natural system that is defined as land. To the question what do you see in the picture, 89% of the students answered "land-tierra" instead of "soil".

The objective of the second question was to make students aware of the importance of soils for human life. Healthy soils are the foundation of 95% of the food we eat. The correct answer was given by 37% of the schoolchildren, which indicates the effort that still needs to be made to make them aware that a very large part of our food comes from the soil. In the framework of World Soil Day 2022, the Food and Agriculture Organization of the United Nations (FAO), the International Union of Soil Sciences (IUSS), and the Global Soil Partnership (GSP) launched a children's book contest on soils for nutrition with the motto "Soils: Where food begins". Teachers can use the booklets submitted as teaching material (FAO and IUSS, 2022).

The third question sought to make the students realize that soil is a living system, full of microorganisms with very important functions for ecosystems. There is a lack of knowledge about this topic, 47% answered correctly (Image 5). In the framework of World Soil Day 2020, the FAO-IUSS-GPS launched a children's book contest on Soil Biodiversity with the motto "Keep soil alive, protect soil biodiversity". The result was a published collection of 10 stories that give visibility to the importance of soil organisms and raised awareness on the urgency of protecting soil biodiversity among a young audience (children aged 6-11 years) (FAO and IUSS, 2021). A very good didactic material to use in the classroom with the youngest students.

The fourth question was about the location of organic matter in the soil. The aim of this question was to make the students aware of the importance of taking care of the most fertile surface layers of the soil. 34.2% of the students answered that most of the organic matter is located in top soil. It is crucial for children to understand the importance of conserving organic matter in topsoil because it plays a vital role in supporting plant life and maintaining ecosystems. Healthy topsoil, rich in organic matter, ensures nutrient availability, water retention, and prevents soil erosion, all of which are essential for sustainable food production and environmental conservation. By learning the value of preserving topsoil, children can become responsible stewards of the soil, helping to protect natural resources for future generations.

After the students answered the four questions above, the teachers explained the difference between land and soil, discussed

what the components of soil are, and the students determined the texture to the touch of a sandy and a loamy soil. The formation of soil organic matter was then explained to them and the existence of organic matter was tested using hydrogen peroxide. Subsequently, they were asked if the soils breathe and the respiration of several samples of pre-incubated soil in closed flasks was measured. The flocculation and dispersion of clays and their role in the formation of soil aggregates was then explained, and an experiment was conducted to visualize this phenomenon. Then they observed the cation exchange by adding a KCl solution to one soil sample and water to the other sample, and then performing a test for calcium by adding saturated ammonium oxalate to the filtrates. And finally, they studied the infiltration of nutrient solution in a sandy and loam soil.

After the experiments, the students answered three questions related to the flocculation and dispersion of clays, another about nutrient adsorption on the surface of some soil particles, and one on soil cation exchange. These questions were intended to help students understand how nutrients adsorb to some soil particles and are a reservoir of nutrients for plants, and that different ions have a different effect on soils, so the chemicals that reach them must be taken into account for the functioning of the soil. A large proportion of the students answered the correct answer to each of the three questions demonstrating that they understood the experiments performed.

Soil Drawing Contest and Booklets for Teachers and Kids

The SEPAS-SECS has been organizing a school drawing competition since 2018 as part of the celebration on December 5 of World Soil Day. Drawing contest for students allow children to express their creativity and expression, and can encourage learning in students. At the launch of each drawing contest, teachers are encouraged to explain to students the importance of soils.

The objective of the different activities carried out by the Soil Teaching Section and Public Safety of the SECS at various educational levels was to raise awareness of the role of soils, designing activities to broaden students' knowledge of soils and instilling the idea of conserving and protecting soils. Among the activities carried out, workshops were held that included a soil breakout and Who's Who in minerals?, activities developed with first-year students of the Bachelor's Degree in Agro-Food Engineering and Rural Environment, and the Bachelor's Degree in Forest Engineering and Natural Environment at the Polytechnic University of Valencia (UPV).

The traditional drawing contest for students, and this past year to celebrate World Soil Day, in 2020, 'Soil Salinization', the Soil Teaching and Public Safety Section of the Spanish Society of Soil Science (SECS) organized an international event to raise awareness about the importance of preserving soils from salts. This event, 'Soil Salinity', took place on December 2 at the ETSIAMN. Universitat Politècnica de València. The conference was led by Dr. Jorge Batlle, a professor at the University of Valencia and President of the International Society of Saline Soils. In his lecture, the expert discussed the causes and issues of salinity in soils. The event was attended by students of the Agronomy degree, highlighting the issue of soil salinization as one of the priority research avenues in soil science. Another of the classic contests in this section has been the school drawing

contest for primary and secondary students "Challenge against soil salinity," organized in the framework of the celebration of World Soil Day. In 2021, the theme of this day was "Let's keep soils suitable for plant development." Like in previous years,

many schools participated nationwide, awarding numerous prizes among the contestants from different levels of primary and secondary education.

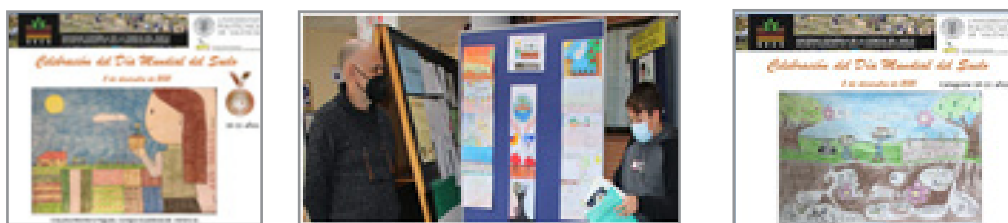


Figure 2: School drawing contest

In recent years, this competition has been institutionalized with the participation of more than 20 national centers with students of all ages (Figure 2).

Teaching Materias (Booklets). Vermicomposting Booklet for Teachers and Kids

Each year, the SEPAS-SECS prepares a booklet to help teachers introduce students to the theme of the competition. Some of these booklets have been submitted to the booklet contests launched by FAO in recent years on the occasion of World Soil Day (Figure 3). In addition, some are integrated in the IUSS educational project "THE IUSS GOES TO THE SCHOOL".



Figure 3: Booklets prepared by SEPAS-SECS.

On the website of the SEPAS-SECS (<http://edafoeduca.es/>) school teachers have information related to the minimum teachings for Primary Education regarding soil (Royal Decree 157/2022). Among this information was that primary school students need to know how to identify the relationship between people's lives and their actions on environmental elements and resources such as soil and water, and also consolidate healthy and sustainable lifestyles, such as those aimed at a responsible management of soil, air, water.

We have set out to facilitate the work of teachers and students by providing material to be used both in the classroom and at home. Some of these materials can be found on the website of the IUSS GOES TO SCHOOL Project in English, German and Spanish.

The vermicompost brochure includes a theoretical section that

introduces students to the concept of vermicomposting. The booklet written for schoolchildren tells the story of a worm, and the narrator is the worm itself, whose name is Galeriana.

Vermicompost, or worm compost, is a product generated by worms as they feed on food, manure, plant parts, and other organic materials, producing a rich material widely used in agriculture. The word "vermes" comes from the Latin word "worm." Therefore, vermicompost can be considered the product of a process of stabilizing organic materials through the action of worms. Vermicompost is made from worm detritus and is a granular, brownish-black, odorless material. It is a rich source of slow-release nutrients in the soil. It acts as a soil fertilizer, improving its physical and chemical properties and preventing soil compaction.



Figure 4: Booklet The vermicomposting prepared by SEPAS-SECS.

Characters (Table 2)

Galeriana, the composting worm, communicates with children with questions and answers like:

Do you know how big I am?. There are about 100 worms in this glass.

Do you know where I live?. The ground is my home. I like it cool and humid. I live in galleries that I walk through often. When it's very cold or very hot, I go up or down to get food.

Table 2: Information about earthworm companions in the soil

Acarina	
Escarabajin	
Krac	

It provides information about earthworms such as:

Earthworms perform vertical movements that are responsible for transporting organic matter from the surface to deeper levels and mineral material from depth to the surface. They are responsible for water percolation through the soil profile due to their burrowing activity, increasing bacterial activity on organic matter, and mobilizing nutrients. These activities have a direct influence on infiltration, the grinding of organic matter, the organo-mineral aggregation of the soil, and the structure and stability of the aggregates.

Their Lifestyle and Habits are Further Explained

Worms mix waste, promoting a large growth of bacteria, absorbing digestive enzymes from certain organisms that develop in the intestine, and excrete the remaining material with a highly transformed mix of organic matter, fungi, bacteria, protozoa, and nematodes. The brochure also introduces the worms' collaborators.

1. Acarina recommends transforming waste into resources in your home, your institution, or your workplace.
2. Escarabajin proposes holding an explanatory workshop for lower-level students.
3. Krac believes it would be interesting to introduce the vermicomposting process by creating posters or panels explaining how vermicomposting is done and its advantages.
4. If this premise is included in education, children will learn from a young age about the importance of waste treatment and the problem of its disposal.

Finally, we encourage everyone to try vermicomposting and thank you for your cooperation.

Encourage Everyone and Thank You for Your Effort

On the website of the SEPAS-SECS school teachers have information related to the minimum teachings for Primary Education regarding soil (Royal Decree 157/2022). Among this information was that primary school students need to know how to identify the relationship between people's lives and their actions on

environmental elements and resources such as soil and water, and also consolidate healthy and sustainable lifestyles, such as those aimed at a responsible management of soil, air, water.

Conclusion or Final Considerations

In order to conserve and respect soils, it is necessary that young people know the functions of soils as well as their properties. Soil Science Societies play a key role in the dissemination of soil knowledge among young people. The SEPAS-SECS holds workshops for young people to get to know the soil by touching it and doing experiments in an entertaining way and prepares educational material for teachers and students as well as school drawing competitions. It has also participated in the discussion of the teaching National primary and secondary Curriculum.

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