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Editorial: Teaching and researching in soil science

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Editorial on the Special Issue
Teaching and researching in soil science

Introduction

Soils are considered one of the fundamental natural resources for the development and sustenance of life on Earth. Soils are essential for the production of a wide variety of goods and services and for human wellbeing (FAO, 2015). It is essential that the study of soil – as the foundation of food production, a component of ecosystems, a habitat for diverse living organisms, a regulator of water resources, and a carbon sink – along with its conservation and degradation, be included in all levels of education. In this regard, the European Soil Charter of 1972 reminds that "Soil conservation principles must be fully included in teaching programs at all levels as an element of environmental education as such: at primary, secondary and university levels".

It is essential to introduce soils early in school curricula, underscoring their importance and raising awareness (Margenot et al., 2016; Črnec and Vrščaj, 2026). As Margenot et al. (2016) stated: *Curricula standards are a potential constraint and entry point for soil science*. However, the study of soils in compulsory education remains marginal in many regions (Tseng and Lai, 2025; Margenot et al., 2016; Virto et al., 2019), despite their central role in terrestrial systems. In primary and secondary education, students should understand and value the many functions of soil. A major challenge in teaching about soil is ensuring that young people understand the degradation processes that affect soil and learn about soil conservation measures. Moreover, young students should acquire not only knowledge but also skills and attitudes relating to caring for and respecting the environment in which they live, including the soil. In the field of soil science education, the book *Soil Sciences Education: Global Concepts and Teaching* (Kosaki et al., 2020) is particularly noteworthy, as it outlines the concepts, philosophy, and key principles for designing soil science education curricula across all levels, from preschool to adult learning.

In the article "The joy of teaching soil science" (Hartemink et al., 2014), Megan Balks mentions "The joy (and serious responsibility) of teaching soil science is to see some

students awaken to the fascination, intrinsic beauty, and importance of our soil resource, . . .". To promote and teach soil science, we need teachers who possess the necessary knowledge, confidence, and motivation (Brevik et al., 2022). The teacher's job is to provide a solid foundation, spark curiosity, and equip students with conceptual and methodological tools that enable them to delve deeper on their own, ask questions, analyse data, and apply soil science to real agricultural and environmental problems. Therefore, a key point in teaching soil science is training teachers responsible for imparting knowledge about soil, mainly at the primary and secondary levels. Not all teachers at these educational levels have in-depth knowledge of soil.

Aran from the University of Lorraine points out that soil is virtually absent from school curricula and from the training of future schoolteachers. Therefore, to raise schoolchildren's knowledge and awareness of soil, their teachers should receive training. Aran has written an article describing the use of project-based learning to help future primary school teachers explore soil science and learn how to teach it. These teachers are enrolled in a multidisciplinary bachelor's degree in education. As part of this approach, the author explains how students design and implement an educational activity on soil in an elementary school classroom.

Turning now to the teaching and learning of soil science at the university level, for a soil scientist, teaching this subject involves some challenges. Among them, align soil science with sustainability. Al-Ismaily et al. argue that soil science curricula at university level should be redesigned from a sustainability perspective. This implies fostering in students a holistic understanding of soil systems as integral components of socio-ecological landscapes, and preparing them to contribute to interdisciplinary research, community action, and policy engagement. They address the urgent need to transform soil science education to ensure its alignment with the United Nations Sustainable Development Goals (SDGs). Soils contribute directly to at least 14 of the 17 SDGs, including those relating to food security (SDG 2, SDG 15 and SDG 13), water purification (SDG 6) and climate regulation (SDG 13). Their article provides guidance for educators who wish to prepare students to tackle the challenges of global sustainability through soil science. This study proposes a shift from viewing soil merely as a technical physical medium to understanding it as 'natural capital' and as a dynamic agent of sustainable transformation. The authors, drawing on case studies from the Bachelor of Science in Soil Sciences at Sultan Qaboos University (Oman) and Moscow State University (Russia), propose a forward-looking soil science curriculum focused on sustainability, systems thinking and real-world engagement. They also consider global stakeholder insights and integrative frameworks, such as One Health, Soil Security and the Pedometrics Challenges. Furthermore, the article highlights pedagogical innovations such as inquiry-based learning, debates and community projects. These tools aim to foster students' interdisciplinary and systems thinking skills. Moreover, the authors call for a comprehensive curriculum reform that positions soil science not as a technical sub-discipline, but as a strategic catalyst for a sustainable planet.

Why is it important to understand soil? It is an essential resource for life on Earth and, moreover, is directly linked to global issues such as food security, access to water, biodiversity, and climate change. This is the perspective from which Reyes-Sánchez, in her article "An Educational Gaze From the International Union of Soil Sciences", argues that the deterioration of soil resources generates environmental, social, and economic problems, leading to poverty, inequality, and resource conflicts. Therefore, in this situation, state soil science societies and, more specifically, the International Union of Soil Sciences (IUSS) have a moral obligation to promote soil protection through education and public awareness, as these are key tools to achieve the SDGs. However, although soil is essential to almost all the SDGs, the author emphasises that its importance is not explicitly recognised, reinforcing the need for transformative education worldwide that focuses on soil as a resource. It is not enough to transmit technical knowledge; it is necessary to cultivate values, attitudes, and environmental awareness about soil from an early age, thereby proposing a methodological shift beyond traditional teaching. More specifically, she speaks of a systemic approach in which soil acts as an integrating element for different disciplines. The IUSS presents two main priorities as its specific objectives: (1) halting soil degradation and (2) focusing educational efforts on children and young people, who will be the future stewards of this resource. To achieve these objectives, it proposes training students, scientists, and teachers to foster the ability to communicate science in an accessible way. It also raises the need to professionalise the teaching of soil science, integrating digital technologies and promoting the participation of governments, educational institutions, and civil society. A prime example is the "The IUSS Goes to School" project (Reyes-Sánchez, 2019), launched in 2019, whose main objective was to bring soil science to children and young people through educational materials, activities, and digital resources. Children's stories, cultivation fact sheets developed by scientists, the publication of educational books in several languages, the organisation of competitions, and collaboration with international organisations such as the FAO were the main avenues of dissemination in this project, which aimed to promote practical application. As a main conclusion, Reyes-Sánchez calls on scientists and educators to move from words to action, actively engaging in the education of new generations.

Final remarks

Although a considerable body of literature has been developed on soil science education, much remains to be done to further raise awareness of soil science and its teaching across all sectors of society. It is necessary to promote and reinforce sustainable lifestyles among young people, which entails responsible and sustainable soil management. This will help ensure that future generations are aware of the need to take care of soil. Soil science education is evolving alongside new teaching methodologies, recent advances in soil science, and the integration of artificial intelligence in schools and universities. This requires rigorous educational research. Thanks to the International Decade of Soils (2015–2024), proclaimed by the IUSS, there has been a significant rise in awareness of soil health. During this period, various educational and outreach projects aimed at improving 'soil literacy' have been funded, such as LOESS, CURIOSOIL, etc. Other projects, such as PREPSOIL, aim to encourage teachers to incorporate soil-related topics into their teaching; to this end, the project identifies and

promotes innovative examples of soil education. We would like to express our gratitude to all the authors who have contributed to this Special Issue, as well as to the reviewers and the editorial team for their dedication to upholding the scientific quality of the published works.

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