



A persuasive concept of research-oriented teaching in Soil Biochemistry

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One of the main problems of existing bachelor programs is disconnection of basic and experimental education: even during practical training the methods learned are not related to characterization of soil field experiments and observed soil processes. We introduce a multi-level research-oriented teaching system involving Bachelor students in four-semester active study by integration of the basic knowledge, experimental techniques, statistical approaches, project design and its realization. The novelty of the research-oriented teaching system is based 1) on linkage of ongoing experiment to the study of statistical methods and 2) on self-responsibility of students for interpretation of soil chemical and biochemical characteristics obtained in the very beginning of their study by analysing the set of soil samples allowing full-factorial data treatment. This experimental data set is related to a specific soil stand and is used as a backbone of the teaching system accelerating the student's interest to soil studies and motivating them for application of basic knowledge from lecture courses. The multi-level system includes: 1) basic lecture course on soil biochemistry with analysis of research questions, 2) practical training course on laboratory analytics where small groups of students are responsible for analysis of soil samples related to the specific land-use/forest type/forest age; 3) training course on biotic (e.g. respiration) - abiotic (e.g. temperature, moisture, fire etc.) interactions in the same soil samples; 4) theoretical seminars where students present and make a first attempt to explain soil characteristics of various soil stands as affected by abiotic factors (first semester); 5) lecture and seminar course on soil statistics where students apply newly learned statistical methods to prove their conclusions and to find relationships between soil characteristics obtained during the first semester; 6) seminar course on project design where students develop their scientific projects to study the uncertainties revealed in soil responses to abiotic factors (second and third semesters); 7) Lecture, seminar and training courses on estimation of active microbial biomass in soil where students realize their projects applying a new knowledge to the soils from the stands they are responsible for (fourth semester). Thus, during four semesters the students continuously combine the theoretical knowledge from the lectures with their own experimental experience, compare and discuss results of various groups during seminars and obtain the skills in project design.

The successful application of the research-oriented teaching system in the University of Göttingen allowed each student to reveal knowledge gaps early, accelerated their involvement in ongoing research projects, and motivated them to begin their own scientific career.