

# **Pre-Lecture Material for Equalizing Student Background Knowledge**

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## **Introduction**

Background knowledge can vary substantially among Danish students, depending on which elective they have chosen in high-school. Traditionally, students that have followed an A level in chemistry (advanced – 3 years study in the Danish system in upper secondary education) or B level in chemistry (intermediate – 2 years study) are likely to study a Bachelor (BSc) in chemistry, biochemistry, molecular biology, medicine, pharmacy, environmental science, or chemical engineering (<https://ufsn.dk/>; <https://www.ku.dk/studier/bachelor>). Although the prerequisite levels in chemistry for such specific science topics are well-defined, the expected level that is required for other educations is less clear-cut. This is particularly the case for the BSc in Geography and Geoinformatics at the University of Copenhagen (KU), where students that enroll in this education have a wide range of interests and personal motivations. Depending on the student, study objectives can be oriented towards applied science (physical geography which for example include climate change, geomorphology, landscape development, soil mapping, hydrology, and environmental processes) or towards social sciences (human geography which for example include the urban and regional development, globalization, sustainability, resource management, and the social dimensions of environmental change). Considering this variation in study objectives, the admission into the BSc in Geography and Geoinformatics does not require any course in chemistry at the high-school level. Usually, most of the students have a chemistry C-level (basic – 1 year study).

For the topic of soil science, no chemistry background or a C-level in chemistry presents a challenge for course and lecture design, because it tends to result in cohorts of students with unequal, and in many cases insufficient background knowledge. To address this challenge, I implemented and evaluated the use of pre-lecture material as part of the soil chemistry lecture in the course Kultur- og Naturgeografi (KNG - part of the BSc in Geography and Geoinformatics). Here, I outline observations and perspectives about both student backgrounds and the implementation of pre-lecture materials.

### **Course Background and Justification**

The KNG course ([kurser.ku.dk/course/NIGB14031U/2024-2025](https://kurser.ku.dk/course/NIGB14031U/2024-2025)) is the first course that first-year BSc students take when beginning their Geography and Geoinformatics studies at KU. Spanning two teaching blocks (Block 1 and Block 2 – 15 ECTS), the course introduces students to how societal and natural conditions shape geographical processes, both independently and in interaction. It covers fundamental theoretical concepts in both cultural geography and physical geography, emphasizing how geography works through time, space and processes, as well as the connections between local, regional, and global scales.

Within this course, I teach the Soil Science module (physical geography), which takes place in Block 1. The module aims to equip students with knowledge about soil composition, soil processes, and soil classification. By the end of the module, students should be able to explain essential soil processes. The Soil Science module includes various teaching formats including auditorium lectures (8 lectures, each lasting 45 minutes), hands-on exercises (3 hours), and a week-long excursion (mix between the various geography disciplines).

In previous years, while teaching the soil science module of the course, several students approached me and expressed that they struggled with some of the basic chemistry concepts in the “soil chemistry” lecture. Many students felt underprepared, and seemingly particularly those who only had not followed any chemistry lecture during their high-school education. Some students even suggested it would be helpful to have a dedicated lecture and exercises focused on chemistry fundamentals.

However, time constraint within the course schedule means we cannot include a separate lecture on basic chemistry. Considering this time constraint, as well as the different interests and motivations among individual students (physical vs human geography), I have designed optional pre-lecture material to support students who feel their chemistry knowledge is insufficient to follow the soil science module.

## **Objectives of the Pre-Lecture Material**

The KNG course encompasses students from a wide range of educational backgrounds and disciplinary interests. This heterogeneity presents a pedagogical challenge, as lecturers must accommodate varying levels of prior knowledge while introducing fundamental concepts from chemistry, physics, and biology within limited instructional time. Ensuring that students remain engaged and motivated, without being overwhelmed by the complexity of topics such as chemical reactions, is a central concern. This issue is particularly significant for first-year students, many of whom are still in the process of determining their academic trajectory, for instance, whether they wish to specialize in physical or human geography. My objective was to enhance students' confidence in their scientific foundation, by supplementing the course with a short, recorded lecture that reviews basic chemistry concepts relevant to soil science.

The recorded lecture is provided as optional preparatory material and was designed primarily for students who may feel less secure in their understanding of chemistry. At the same time, it serves as a useful refresher for all students, offering additional insights into chemical processes relevant to soil science.

By engaging with this resource, students are expected to approach the subsequent soil chemistry lecture with greater preparedness, thereby reducing the risk that gaps in prior knowledge will impede their learning. The broader pedagogical objective is to foster inclusivity and support diverse student backgrounds, while maintaining the intellectual rigor of the course content.

## Implementation of the Pre-Lecture Material

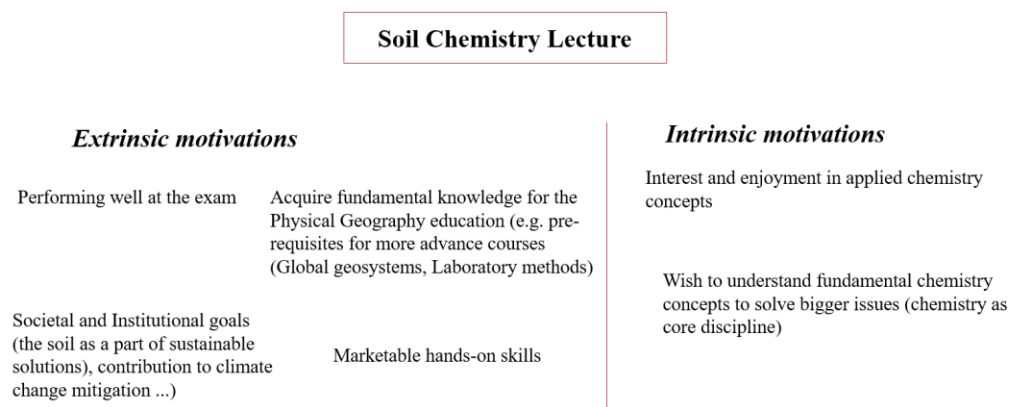
The design and implementation of the pre-lecture video began with a systematic investigation of students' educational backgrounds. This process drew on informal feedback collected in previous years, as well as on a review of the formal admission requirements for the BSc in Geography and Geoinformatics at the University of Copenhagen (Københavns & Universitet, 2025). According to the official curriculum, no previous chemistry background is required for entry into the program. Only Danish language at A-level, English language at B-level and Mathematics at A-level are required. Based on previous cohorts, most students have completed Chemistry at the C-level. However, depending on their high-school study line (social science versus natural science), students' interest and teaching context in chemistry tend to vary considerably. To clarify the scope of a basic chemistry level, I examined the national curriculum for Chemistry C as defined by the Ministry of Children and Education (Undervisningsministeriet, 2025). Specifically, the curriculum specifies that students should acquire:

- An introduction to basic chemical language, including formulas and reactions
- Experience with simple laboratory experiments and laboratory safety
- Knowledge of the periodic table and atomic structure
- Familiarity with chemical bond types, states of matter, and miscibility
- Skills in mass quantity calculations related to reaction schemes, including mass concentration
- Understanding of precipitation, simple redox reactions, and acid–base reactions, including the pH concept

Given that many soil processes are governed by redox and acid–base processes, this background is highly relevant. However, the official curriculum emphasizes only simple redox reactions, meaning that students are expected to recognize electron transfer but are not required to master oxidation numbers or systematic balancing. Similarly, acid–base reactions are introduced at a basic level, with the pH concept framed as a correlation between hydrogen ion concentration and acidity. This

indicates that although students with a C-level in chemistry should possess some familiarity with these processes, their exposure remains limited.

Additionally, I examined the potential extrinsic and intrinsic motivations of the students, using Ryan and Deci (2000) framework, in order to better tailor the video content (Figure 1).



**Fig. 1.** Synthesis of the potential extrinsic and intrinsic motivation of the 1<sup>st</sup> year students in the BSc in Geography and Geoinformatics at the University of Copenhagen (KU) for the Soil Chemistry lecture.

To bridge this gap and contextualize these concepts within soil science, I developed a preparatory lecture that reintroduces the principal chemical reactions occurring in soils from a theoretical perspective. The lecture emphasizes the underlying chemical principles and mechanisms, while only briefly illustrating soil-specific applications, which are addressed in greater depth during the main soil chemistry lecture. The overarching objective of the video was to establish a robust theoretical foundation in chemistry that supports students' engagement with soil systems, regardless of their diverse academic backgrounds.

The video was uploaded to the Absalon teaching platform one week prior to the scheduled soil chemistry lecture. Students were instructed to view the material in advance, with the explicit purpose of reinforcing their understanding of basic chemical principles relevant to soil science.

## Evaluation of the Pre-Lecture Material

The evaluation of the pre-lecture video was conducted during the final five minutes of the lecture. Students were asked directly whether the chemistry lecture was easy to follow when the pre-lecture video was watched, to which the auditorium responded with a resounding “yes.” They were also invited to provide additional feedback individually if desired. The primary points of student feedback included:

- The video length was appropriate.
- The video format was engaging and well-received.
- Students expressed interest in having similar videos accompanying each lecture.
- A quiz at the end of the lecture would be a valuable addition.

In addition to student feedback, the video was reviewed by two experienced teachers. Overall, they agreed that the incorporation of a video prior to the soil chemistry lecture was a valuable pedagogical strategy. It provided prerequisite knowledge and enriched the learning experience during the in-person session. They suggested that to maximize student engagement and ensure meaningful interaction with the content, the inclusion of a follow-up exercise is recommended. Such an exercise could take the form of a short quiz, a discussion, or an application task designed to reinforce key concepts and assess comprehension.

Furthermore, the two experienced teachers emphasized that it is essential to clearly communicate the purpose of the video, such as explaining why it is shown and how it connects to the lecture’s objectives. This framing helps students attend to relevant details and perceive the video as an integral component of the learning process (this contextualization was only provided through Absalon).

Finally, while the content level was generally appropriate, reviewers noted that certain sections contained excessive detail, which may have hindered clarity.

## Own Reflections and Future Perspectives

This experiment highlighted that effective lecture preparation extends beyond the development of content alone. A crucial dimension of teaching lies in understanding the audience (in this case, the students and

their educational background) to deliver information that is both accessible and appropriately targeted (Yeo & Ting, 2012).

Another important insight concerns the role of evaluation. Incorporating systematic tools for assessment would be valuable for both the teacher and the students, as it would enable a more rigorous appraisal of the video's impact on learning outcomes. Such tools could include short quizzes, or structured feedback mechanisms. Additionally, examining the video's utilization patterns would provide valuable insight into how many students actually watch it. This could also shed light on how student characteristics influence (i.e. interest and background) their engagement with pre-lecture materials (Cerbin, 2018; O'Brien & Verma, 2019).

Student feedback also pointed to the potential of integrating pre-lecture videos before each in-person session. This approach may provide a more accessible alternative to extensive compendia and could foster continuity across the course. However, this suggestion raises broader questions about the scope of university teaching. Specifically, it prompts reflection on whether it is the responsibility of university teachers to reintroduce foundational knowledge typically acquired at the secondary level. In some educational systems, such as in France, introductory courses in basic scientific skills are offered prior to specialized courses. Adopting a similar model would require reconsideration of the pedagogical program at the university level. From this perspective, the creation of a dedicated course could serve as a structured means of equipping students with the necessary foundational competencies. This would parallel existing practices in subjects such as statistics, where preparatory courses are often provided to ensure that students are adequately prepared for advanced study. While these reflections are influenced by my own educational background, they underscore the importance of aligning pedagogical strategies with student needs and institutional objectives.

## References

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