Two Aspects of the Teaching Quality of Soil Science in Land Remediation Engineering - Preparation Before Class and Solutions of Homework after Class

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Abstract: Against the backdrop of "New Agricultural Science", land remediation engineering education and talent development demand a higher level of proficiency. Helping students to promptly integrate into their professional studies, effective teaching of fundamental courses holds tremendous importance. This paper discusses the two aspects of blended teaching of Soil Science, preparation before class and solutions of homework afterclass. In the process of preparation before class, especially in the pre-study material selection and reading processing, teachers try to guide students to think more problem about soil, combined with the discipline's research hotspots, expedite students' progress towards the forefront of the discipline. In the process of answering the homework after class, on the basis of the classroom teaching content, it is useful to inspire and guide students to think about the role of soil in land remediation engineering across disciplines and sectors, so that students will have acquired a comprehensive understanding of soil with the land remediation practice organically integrated. Through guiding students in preparation before class, offline lectures, and solutions of homework after class, the objective of constructing soil science courses that are centred on competency cultivation has been fulfilled. This has enabled the cultivation of highly-skilled professionals with practical proficiency and innovative aptitude for the advancement of ecological civilization construction.

Keywords: preparation before class, solutions after-class homework, teaching, inspire and guide, Soil Science

1 Introduction

With the rapid development of science and technology, multidisciplinary comprehensive research and application are receiving more and more attention from scientific researchers, resulting in the emergence of some composite specialties[1]. Based on this, Ministry of Education of the People's Republic of China added a new major in land remediation engineering(LRE) in 2016. Yunnan Agricultural University opened this major in 2018, which is the second batch of LREs approved by the Ministry of Education, and is currently the only institution in Yunnan Province to open this major. As a national emerging profession, LRE is based on the strictest arable land protection system and economical and intensive land use system in China. LRE serves the national strategy of food security, socio-economic development

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and ecological civilization construction, which adopts the concept of mountains-rivers-forests-farmlands-lakes-grasslands life community. The aim of LRE is to improve the quality of the land and the conditions of production and living in the countryside, to optimise the ecological environment, and to resolve the contradiction of supply and demand between the land and the people.

LRE encompass physical, chemical, and biological engineering measures to halt further degradation of land and enhance its quality to render it usable, following previous deterioration. The specific six categories of degraded land comprise of soil erosion, soil sanding, soil salinisation, soil pollution, deterioration of soil properties and non-agricultural occupation of arable land. All of these categories have a strong connection to knowledge associated with the field of soil science. As one of the basic courses, Soil Science is only set up for 32 theoretical hours, so if we want to complete the teaching tasks in the limited classroom time, the content needs to be screened in accordance with the objectives of LRE. At the same time, taking a blended approach to teaching, preparation before class and solutions of homework after class are organically combined as an important part of the study of the basic course.

The course of Soil Science is offered in the first semester of the freshman year in LRE. It is a challenge for us to teach students well alongside many other basic courses such as advanced mathematics, English, and pictorial geometry. There is a need to integrate soil science with other disciplines in the classroom, and to find applications of Soil Science to practical problems in order to stimulate students' interest in learning[2]. It is also useful to extend the knowledge and conclusions already available in soil science at the right time, and introduce the research frontiers of the corresponding problems as well as the context in which they are applied[3]. As a result, it will make students see the future of studying soil science, and thus motivate them to learn.

In terms of pedagogical methodology, the heuristic approach to education, which emphasises students' subjective initiative, has proved effective in practice and is generally recognised by educators[4-7]. Learning is always the students’ own business, so a successful course does not depend entirely or even not mainly on how advanced the textbook is and how skilful the teacher is at lecturing, but mainly on the students' interest and enthusiasm for learning the subject[8-10]. Preparation before class and solutions after-class homework are the basic link of Soil Science teaching, which are helpful to stimulate the subjective initiative of students' learning[9-12]. This paper discusses the significance of preparation before class and solutions after-class homework based on the teaching experience of soil science teaching team of LRE in the passed three years.

This paper is divided into four sections. The first section describes the whole idea of teaching soil science; the second section discusses the teaching link of Preparation before class in Soil Science with examples; the third section discusses the setting of answers to homework at the end of the class; and the fourth section discusses how to guide students to think about problems in an interdisciplinary way with examples.

2 Ideas for course instructional design

The content of the course consists of an introduction and eight modules, which are broken down into independent knowledge points, but at the same time are interconnected and linked into an

organic whole[13,14]. In accordance with the concept of CDIO engineering education, with "soil fertility" as the core, the teaching work focuses on soil moisture, soil organic matter and nutrients, soil air and heat, soil physical structure, soil biology, soil classification and investigation, soil degradation and ecological remediation, as well as soil quality and management of the use of the reconstructed teaching content[15-17]. With the main objective of understanding the physical, chemical and biological properties and applications of soil, the students are allowed to learn about the project and achieve the learning tasks in an active, practical and organically linked way between the courses, mainly through the organic combination of online learning and offline classroom teaching, and the organisation of the flipped classroom teaching method to make the teaching and learning process more vivid, intuitive and easy to understand. Making full use of the practical aspects of the course content, which will stimulate and maintain students' interest and active participation in their learning. According to the cognitive law and acceptance characteristics of students, adopting the mode of "teaching and learning" to "learning and teaching", the teaching effect is remarkable by cultivating students' concept of "new engineering" and "Internet +" innovation ability, which promote communication and interaction between teachers and students, students and resource sharing, timely teaching feedback. The idea of teaching the Soil Science course is shown in Fig 1 below.

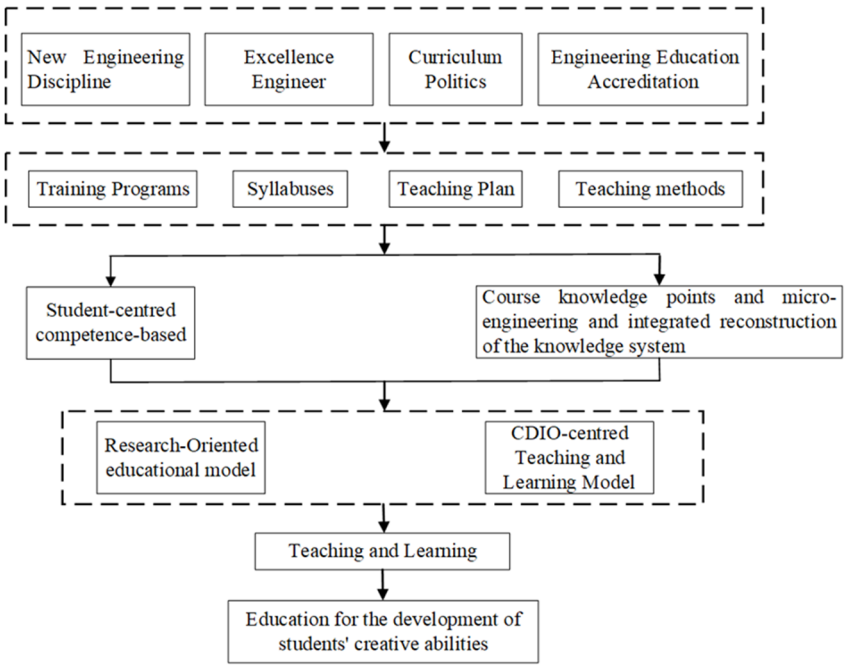

Fig. 1 Idea map for the teaching design of Soil Science

2.1 Preparation before class

The preparation of the course is supposed to be a clichéd topic, but it has to be adapted to the specific setting of the soil science course. A soil science teacher who wants to train land remediation engineering students to become real engineers or disciplinary talents must first let

students feel the important role that soil plays in land remediation engineering, rather than just lecturing on soil knowledge or even isolating soil science knowledge. Proper pre-course preparation is very important to stimulate students' enthusiasm for learning, to clarify the purpose of learning and to understand the boundaries of the subject.

Prior to the official start of classes, a mass notification will be sent to the classes by teachers in which they are teaching via the school's attendance system integrated with WeChat: ①It is suggested that the whole class is first divided into study groups of no more than 6 students and that the list of groups is reported by the members of the study committee or pre-selected class representatives before the first lesson; ②Recommending students to pay attention to official accounts such as "Soil Watch", "Soil Home", "Soil Time", "China Land Rectification", "Ministry of Natural Resources" and "Yunnan Provincial Department of Natural Resources", which are influential in the field of soil science or land rectification, and to watch the popularised content on them in their spare time, especially the video; ③Informing students to register their accounts and log in to the "China University MOOC (Mucue)_National Excellence Courses Online Learning Platform" (https://www.icourse163org/), search for the Soil Science course on it, and choose to take the online materials from Zhejiang University or Zhejiang Agriculture and Forestry University (either is premium, decided by the members of the study group).

During the official lesson, before each lesson, the students are informed in advance about the content of the next lesson and are asked to study the video material on the Catechism platform on their own. As the online materials from Zhejiang University or Zhejiang Agriculture and Forestry University are always open and each video is about 10 minutes long, they are particularly suitable for viewing before class. Students can get a rough idea and impression of what is being taught before the formal class. Meanwhile, students are also encouraged to try and complete some of the above practice questions in the online materials and bring them to class which can also be assessed as part of the preparation before class.

On the other hand, students are also given some written preview assignments for certain chapters in advance. For example, Before teaching of the content of "soil moisture" , teachers first let the students in study groups as a unit search for China's "water resources bulletin" in the past ten years in the internet. Students organise the data on total water supply and consumption, agricultural water consumption, actual irrigation water consumption per mu of arable land, and the effective use coefficient of irrigation water for farmland into charts, tables, etc., so that they have an overall concept and understanding of the national water use situation, understand the importance of water use in land reclamation projects, which promotes their interest in studying soil water and increase their attention. Before teaching the chapter on "Soil Degradation and Ecological Restoration", the students were also allowed to search the relevant data of the previous six national desertification and desertification monitoring in the form of study groups, and to express the serious situation of desertification and desertification in China and the management of the situation in the form of graphs, diagrams and a suitable amount of text, so that they would be full of confidence in the current challenges facing the land remediation project and its future development. This will help the students to develop the belief that they need to study soil science as a serious subject and as a major subject through these preparation.

2.2 Solutions after-class homework

Solutions after-class homework is not only useful for students to learn from the past and consolidate what they have learnt, but also very effective for them to familiarise themselves with and integrate into the language environment of soil learning as soon as possible. At the same time, it is also a way for teachers to self-test the effectiveness of their teaching, so that they can adjust their lecturing style and progress later in the teaching process.

Soil science is one of the fundamental disciplines of agricultural science, and as a multidisciplinary integration, it is a science that focuses on the laws of movement of substances in the soil and their relationship with the environment, as well as a course that is relatively close to our daily lives. The course aims to enhance students' grasp of the specific terminologies and scientific jargon required for effective communication within the field of soil science. As some students may have prior non-professional knowledge, the lectures concentrate on bolstering their competence in the language and terminology of the subject. Moreover, the practical exercises conducted at the end of the sessions serve to reinforce the memorization of the technical terms and to hone their comprehension skills with respect to certain queries. For instance, a query posed in the preliminary section of the post-course material was "What distinguishes soil fertility from land productivity?" The majority of students answered the assignment by directly addressing the distinction between soil and land. However, in terms of of the answer way, these approach was characterized by the description of scientific definitions of soil fertility and land productivity individually firstly. They then established a connection between the two concepts in line with their definitions before providing an answer to the difference question. This answer template applies to most comparisons between two proper nouns, such as soil and land, or soil fertility and soil organic matter.

3 Guiding students to think across disciplines

After covering some of the content, it is necessary to include 1-2 additional reflection questions related to land remediation projects. During the process, teachers encourage cooperation between students to find appropriate solutions beyond the scope of the textbook. This approach guides students to apply theoretical knowledge from the classroom and textbooks to real-world situations. Additionally, it tests their ability to apply required knowledge and encourages proactive engagement with cutting-edge research in soils or land remediation engineering. This aids in developing a deeper understanding of how to apply soils knowledge to land remediation engineering. Additionally, students are encouraged to proactively seek current information on topics such as the integrated protection and restoration of mountains, water, forests, lakes, grasses and sands. This will enhance their comprehension that soil science is not purely theoretical and that it is closely connected to the establishment of the country's ecological civilization. It is vital for students to recognise that soil science is a fundamental course in the land remediation engineering curriculum.

For instance, what is the reason for stating that sandy soils are fast in fertilisation but weak in subsequent strength, with a poor ability to retain water and resist drought, while clay soils are slow in fertilisation but sturdy in subsequent strength, with a robust ability to retain water and resist drought? In the mountainous regions of Yunnan Province, what measures can be taken to improve the state of cold flooded fields? To provide a comprehensive answer, students must

consider the physical characteristics of sandy and clay soils, as well as previous knowledge of soil moisture, nutrients, organic matter, and temperature. In addition, it is advisable for students to conduct independent searches and downloads for the most recent national, local and industry guidelines related to the evaluation of soil quality. Examples of such guidelines include "Agricultural Land Quality Grading Procedures" (GBT 28407-2012) and "Cultivated Land Quality Levels" (GBT 33469-2016). "Cultivated Land Strength Survey and Quality Evaluation Technical Procedures" (NYT 1634-2008), "Soil Environmental Quality Soil Pollution Risk Control Standards for Construction Land (Trial)" (GB36600-2018), "Soil Environmental Quality Soil Pollution Risk Control Standards for Agricultural Land (Trial)" (GB15618-2018), and "Soil Erosion Classification and Grading Standards" (SL190-2007) are important guidelines for assessing the quality of soil for different land use purposes. These technical documents provide standardized procedures for investigating soil strength and pollution risks, as well as erosion levels, to support informed decision-making on land use. This approach serves two purposes: first, to enhance students' ability to search and filter information, and second, to provide clear insight into how their acquired knowledge from Soil Science can be applied in land remediation engineering. This aims to expedite students' transition into the realm of land remediation engineering to achieve optimal learning outcomes.

The above process has resulted in a teaching process for the course Soil Science, as shown in Figure 2.

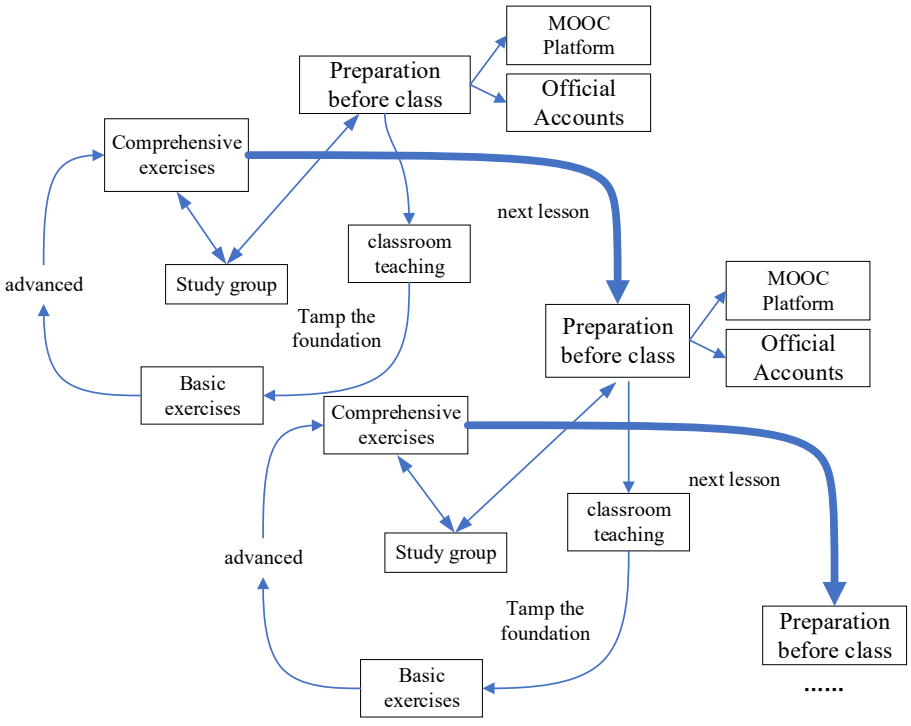

Fig. 2 Teaching flow of Soil Science

4 Promoting the reform of blended teaching methods

The objective of the teaching reform is to develop students' innovative capacity, enhance the pedagogical techniques of the courses, investigate a blended approach to teaching, which can effectively activate students' enthusiasm and foster their innovation, and offer guidance and insight for the teaching reform initiatives in higher education institutions. To enhance the implementation of the reform, a survey was conducted to assess the students' level of contentment with the advancements in their abilities and competencies achieved via their active engagement in pre-class preparation and post-class assignments. The outcomes of this research are illustrated in the table 1 and table 2.

Table 1 Questionnaire on Blended Learning's Change in Some of the Students' Skills and Abilities （n=25）(%)

skills and abilities	significant improvement	improvement	no change	lower
motivation	5	95	0	0
self-directed learning ability	30	70	0	0
ability to access literature	42	56	2	0
Practical problem-solving skills	13	87	0	0
Teamwork ability	82	18	0	0
awareness and capacity for innovation	11	85	4	0

The survey revealed that the students acquired fundamental knowledge of soil science, enhanced their analytical and problem-solving skills and, crucially, developed broader scientific thinking and teamwork abilities.

Table 2 Questionnaire on Students' Satisfaction with the Pre-Course Preparation and Post-Course Homework Answering Sessions

project	yes	general	no
satisfaction with pre-course preparation	95	5	
satisfaction with content selection	100	0	
satisfaction with basic post-course exercises	100	0	
satisfaction with comprehensive exercises	92	8	
satisfaction with appraisal methods	90	10	

To ensure an effective classroom implementation, teachers should pre-design suitable coursework that matches their students' proficiency levels. Additionally, requiring students to complete assigned pre-classwork before attending the next session can provide helpful guidance towards a smooth teaching process. Moreover, teachers' guidance on post-schoolwork solutions assists in directing students through the entire process of independent learning, correcting their errors promptly while also enhancing their own teaching capacity and professional level.

5 Conclusion

To excel as a land remediation practitioner or researcher in soil science, it is essential to possess the ability to contemplate novel challenges, apply findings beyond one's own domain to their area of expertise, and possess an in-depth knowledge of the cutting-edge research in the discipline. In essence, it is highly significant to integrate the knowledge acquired during the learning process, endeavour to expand and link the gained insight, and unify it with practical application, other fields of study, and the leading research perspectives within the disciplines. As a soil science instructor for land remediation engineering, it is essential to conduct thorough research to guide students in critical thinking and practical application. Students should combine their acquired knowledge to make horizontal links among diverse topics, thereby expanding their learning. It is vital to connect with real-life situations, encourage objective analysis, and maintain factual accuracy to promote a comprehensive understanding of the subject. Teachers aim to support students in consolidating and expanding their knowledge, delving deeper into their chosen fields of study, and exploring the frontiers of research, which is to foster a passion for learning, whilst preparing students to be versatile and skilled resources for the global workforce.

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