

Teaching Reform and Practice of "Low Carbon Technology and Management" in the Context of Dual-Carbon

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Abstract: In order to cope with the challenges and opportunities brought about by the intensification of global environmental problems and the realization of the "two-carbon" goal, higher education institutions are facing the pressure of reform of teaching content and curriculum systems. This study focuses on how to train talents who meet the needs of the future society by integrating low-carbon technology and management knowledge and designing the professional extension module of low-carbon Technology and Management. On the basis of analyzing the background, purpose and significance of curriculum construction, this paper puts forward a clear teaching goal, and constructs a comprehensive curriculum structure including "three and four steps" curriculum model system and five sections. The curriculum model aims to impart knowledge of key low-carbon technologies while developing students' ability to think systemically and innovatively. The article also emphasizes the importance of diversified teaching methods such as case studies, hands-on operations, and innovative projects to enhance students' hands-on skills. In addition, the multi-dimensional course evaluation method can fully reflect the learning outcomes of students and ensure the cultivation of high-quality talents.

The curriculum construction and teaching model proposed in this study is of great significance for cultivating high-quality talents who can play a key role in the global low-carbon economy, and is expected to have a far-reaching impact on the reform of higher education and contribute to global sustainable development.

Keywords: Double Carbon; Low-Carbon Technology; Low-Carbon Management;

Curricula Construction; Talent Cultivation

1. Introduction

"Global Carbon Plan" displayed globally during 2011-2020. The average annual person emissions are about 38.9 billion tons. Because of Carbon2, the cumulative emissions are closely related to the highest increase in global surface temperature, through "double carbon" action to control carbon emissions has become not only a national choice but also a social choice as well as an individual choice.

In recent years, for the irreversible destruction of state balance, China has proposed a series of related policies [1]. In July 2021 and April 2022, the Ministry of Education successively issued the Carbon Neutral Science and Technology Innovation Action Plan for Colleges and the Work Plan for Strengthening the Construction of Carbon-Neutral Higher Education Talent Training System[2]. Higher education system should follow it as a base for talent training "1+N". The policy system carries out corresponding teaching reform to ensure the development of high-quality, high-integration and high-quality talents, in order to ensure "Double carbon". The successful implementation of the provision of reserve talent guarantees and the establishment of a highland for the export of talents from colleges and universities.

Therefore, "double carbon" is driven by policies and needs in both directions, in the process of teaching reform in colleges and universities. The advancement of teaching reform is not limited to "double carbon" related disciplines of basic technology training. Management, as a discipline involving many fields such as enterprise management, organizational behavior, strategic management, etc., cultivates both management and "Double carbon".

2. Teaching Objectives are Set by the

Significance of "Double Carbon"

High-quality talents of knowledge are the prospect of integrated development between disciplines, the desire of enterprises and society for talents in carbon emission reduction and carbon trading, the need of the national and international environment for sustainable green development, and the vision of man and nature to build a better home together. Therefore, those who export comprehensive low-carbon knowledge have the significance that cannot be ignored. In the training process, it is necessary to focus on cultivating students' high-level, innovative and challenging skills.

2.1 Teaching Objectives

According to the Bloom teaching goal system, the teaching objectives of the low-carbon technology and management course are divided into three aspects: knowledge objectives, ability objectives and quality objectives. The three objectives complement each other cultivate students' ability to think at higher levels and solve complex problems. From the perspective of knowledge goals, memorizing carbon-related basic knowledge and explaining the principles of carbon confirmation. Apart from that, from the perspective of ability goals, students can apply carbon emission reduction related knowledge to analyze the carbon trading market. Furthermore, from the perspective of quality goals, cultivating students' high-level thinking and creating methods of carbon incentives, as Figure 1 shows.

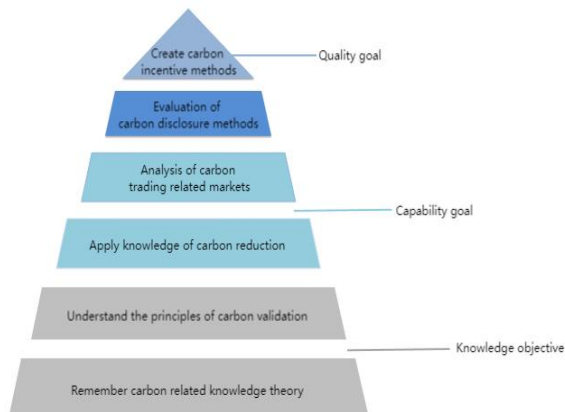


Figure 1. Teaching Objectives of Low Carbon Technology and Management

2.2 Overall Target Effect

Many universities focus on "double carbon" in

China. In the construction of related technical majors, there are several problems such as comprehensive discipline development and lack of talent, and less information on integrated discipline construction. Low-carbon Technology and Management conducts teaching curriculum construction through teaching objectives, and conducts curriculum construction and reform from the curriculum knowledge system, curriculum model system and curriculum evaluation system to provide support for the ultimate achievement of the overall goal effect as Figure 2. shows.

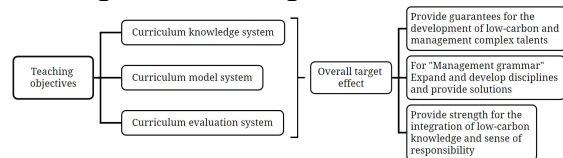


Figure 2. The Overall Target Effect of Low Carbon Technology and Management

3. Provide Guarantees for the Development of Low-Carbon and Management Complex Talents

In the process of carbon neutrality, technology reduces reliance on energy and improves energy utilization through technical means. Management is to encourage carbon emitters to participate in and practice carbon reduction through guidance, reward and punishment, etc. in order to move towards carbon neutrality[3]. Actively carry out "double carbon" education, building a carbon-neutral expansion module course. The "Low-carbon Technology and Management" course integrates and other environmentally advantageous disciplines such as economics, management, metallography, and resources, provides high-level low-carbon-related professionals for the country, trains talents with both management and low-carbon knowledge, and provides strong support for the construction of carbon-neutral major.

4. For "Management Grammar" Expand and Develop Disciplines and Provide Solutions

In the process of implementing the goal of carbon neutrality, it is difficult to ensure the achievement of the goal without the support of technology. As above, if incentives cannot be formed through management means, carbon emitters do not participate in the enthusiasm of carbon neutrality. Therefore, the addition of

the expansion module of Low-Carbon Technology and Management can effectively promote the effective integration of engineering disciplines such as economy, management, literature, law, and continue to make efforts in the low-carbon field to provide talent support and intellectual guarantee for low-carbon transformation.

5. Providing Strength for the Integration of Low-Carbon Knowledge and Sense of Responsibility

In contemporary society, the cultivation of college students' sense of social responsibility has become one of the important contents of college education, and having a certain low-carbon knowledge can help enhance their own civic awareness. Realizing that social issues and taking responsibility for improving society. Building a sense of responsibility will help them "double carbon" knowledge is transformed from textbooks to practical actions, guiding students to follow national policies and understand "double carbon" knowledge, and then transfer it. Implementing "double carbon" achievements, students are in the digital age and have a strong ability to access new things. It is easier to combine low-carbon knowledge with network trends through digital feedback, transmit new policies, new ideas and new methods, make rational use of resources in daily life, disseminate and share low-carbon life skills, and build a green and sustainable home together.

6. Sort out the Content Module and Clarify the Teaching Content Curriculum Knowledge System

In the context of sustainable development, the main goal of the management teaching construction reform is to cultivate a certain "double carbon" knowledge, management talent with a sense of environmental protection and sustainable development. In addition, it is also necessary to focus on cultivating students' innovative ability, strategic thinking and communication skills to adapt to the needs of the future working environment. Low Carbon Technology and Management focuses on starting from the perspective of enterprise carbon and management and incentives, focusing on the whole process of carbon neutrality. It can break it down into five

modules: carbon confirmation, carbon reduction, carbon exchange, carbon disclosure and carbon stimulation as Figure 3 shows. Build the knowledge system of this course, improving carbon neutral professional expansion, and phase, step by step and clarify the course knowledge system.

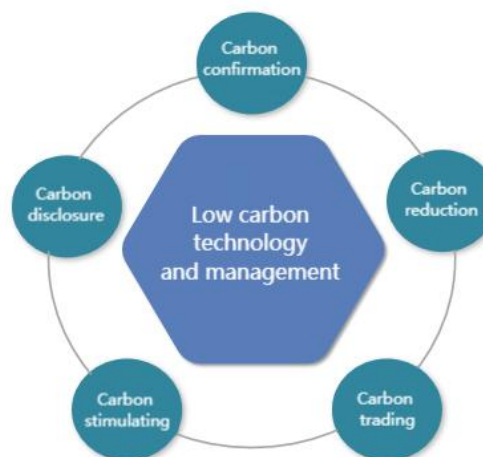


Figure 3. Five Modules of Low Carbon Technology and Management

6.1 Carbon Confirmation

Carbon confirmation means the relevant knowledge of carbon responsibility confirmation. The main steps of carbon confirmation are divided into three stages: visualization, segmentation and accountability. In the visualization phase, students are required to be clear on the basis of how enterprises can achieve zero carbon emission implementation goals, and students are required to be able to define quantitative standards for the carbon footprint. According to quantitative data analysis, the segmentation stage divides the responsibilities and scopes of enterprises in the carbon neutrality process, and decomposes carbon neutrality responsibilities into individual enterprises in the supply chain. Within the enterprise, carbon neutrality responsibilities are implemented to departments and even individuals. In the final stage of accountability, enterprises are required to claim responsibility based on the results of subdivision. Because the five modules of carbon neutrality are interlinked, the primary task in the course of Low Carbon Technology and Management is to identify carbon accurately and effectively, which is the primary management problem of promoting

carbon neutrality and the basis for establishing an effective carbon neutral responsibility and management system.

6.2 Carbon Reduction

That is knowledge about carbon emission reduction incentives. Carbon emission reduction should start from both technical and management aspects at the same time to support the training of management professionals "ecological civilization" achievement of class goals. Technically, it relies on interdisciplinary integration and uses metallurgy and other professional knowledge to solve problems such as optimizing energy structures, implementing low-carbon technologies, achieving carbon separation and carbon capture. In terms of management, it systematically combs out the key factors that restrict carbon neutrality of enterprises, so as to effectively ensure the implementation of the concept of carbon neutrality[4]. Dual insurance based on technology and management, adopting clean energy, improving production processes, optimizing transportation methods, and jointly promoting the implementation of carbon emission reduction goals from governments to enterprises to individuals. Therefore, this part of the course is to explore key ways to motivate enterprises and employees to actively practice carbon neutrality and promote carbon emission reduction, so as to establish an effective incentive mechanism for corporate carbon emission reduction and provide a path basis for corporate carbon emission reduction incentives.

6.3 Carbon Trading

That is, the relevant knowledge of carbon trading management. This module combines theory and practice to help students clarify carbon trading usually includes tax emission rights trading and carbon offset two mechanisms. Through carbon trading, enterprises evaluate and predict the output and profits of carbon dioxide emission reduction by combining big data, artificial intelligence technology, green tree planting and other means according to their own characteristics. By establishing a carbon market, enterprises can be encouraged to actively reduce emissions and promote technological innovation and the application of clean energy,

and finally reached reduce greenhouse gas emissions and promote the development of a low-carbon economy.[5]In this course, Low Carbon Technology and Management, through the setting of the content section, we focus on how to guide enterprises to use carbon trading methods reasonably, establishing decision-making and incentive mechanisms for carbon trading behavior, and provide guidance for enterprises to conduct carbon trading reasonably.

6.4 Carbon Disclosure

That is, the knowledge of carbon information disclosure. At present, there are still fewer disclosure enterprises in carbon disclosure, and some enterprises have active or passive "Green bleaching behavior" And other problems. This section provides an in-depth introduction to the choice of information disclosure, the motivation for disclosure and the method of disclosure in the process of carbon neutrality. Therefore, this part focuses on systematically exploring the factors and internal mechanisms affecting enterprise carbon neutral information disclosure, so as to provide theoretical support for the construction of enterprise carbon neutral information disclosure systems.

6.5 Carbon Stimulating

That is, the relevant knowledge of carbon effect incentives. Participation and achieving carbon neutrality are of great significance to enterprises, but few enterprises are aware of this problem. It is very important to guide enterprises to participate in carbon neutrality and how to avoid the abuse of carbon neutral public welfare characteristics in the process of carbon incentives. The key point of this section is to identify the results of carbon neutrality of enterprises reflected through direct economic benefits. Therefore, by establishing a long-term incentive mechanism to clarify the path of long-term benefits from carbon and behavior, it provides a basis for enterprises and their employees to take on more carbon-neutral responsibilities.[6] Finally, through the teaching of the five modules of Low-Carbon Technology and Management, as well as the integration of relevant professional and technical knowledge such as metallurgy, energy and environmental engineering, we will achieve the organic integration of low-carbon technology and

management and build a sound knowledge system.

7. Course Model System

The curriculum improves the traditional "indoctrination" teaching, adopting a diversified teaching model, using "three transformations and four steps." The teaching model is reflected throughout the learning

process "Sanhua" Learning is autonomous, methods are diversified, and knowledge is fruitful." Four steps "Gradually advance the course content from penetration, internalization, consolidation and expansion, Pre-class penetration, in-class internalization, after-class consolidation and expansion, strengthening "double carbon" knowledge as shown by Figure 4.

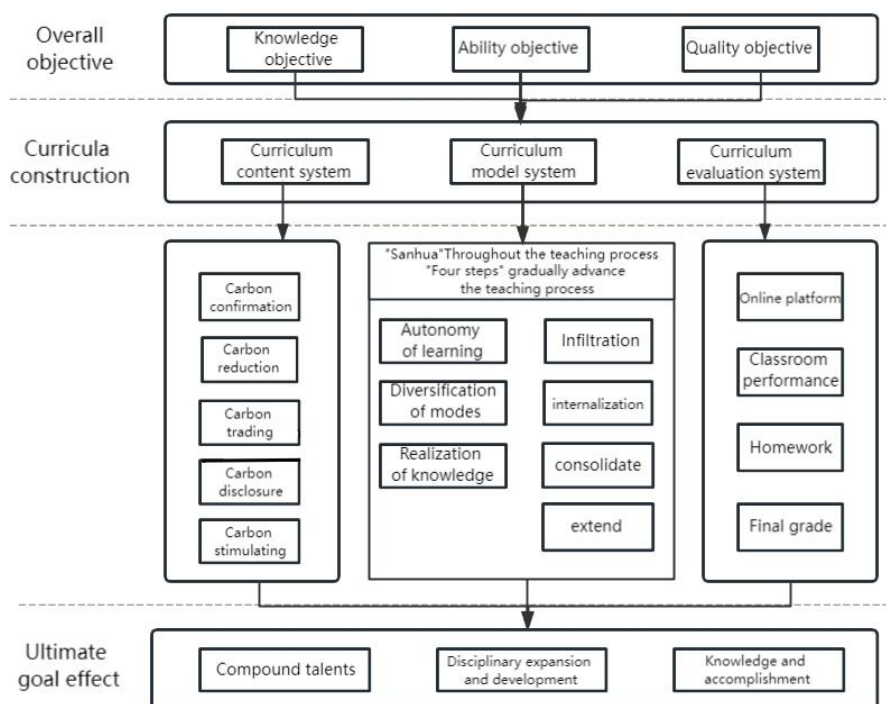


Figure 4. "Low Carbon Technology and Management" Course Construction Map

7.1 "Sanhua" Stages throughout the Teaching Process

In terms of teaching and learning, students are inspired to learn consciously and autonomously through changes in the learning process, curriculum process, teacher-student role, and other aspects. [7] In the learning process, students can first ask questions to induce interest in learning; in terms of course flow, cases can be introduced first, and then knowledge points can be taught; in terms of the role of teachers and students, teachers guide the learners to guide students to discuss and study independently, so that teaching achieves the purpose of long-term.

In terms of online and offline, offline teaching combines online digital courses, case videos, simulation experiments and other digital means to break through a single teaching method and promote diversified knowledge access. At the same time, for students with

different needs and characteristics, using differentiated teaching methods to help each student develop their full potential. Combine the knowledge of different disciplines to cultivate students' comprehensive literacy and interdisciplinary thinking ability, and broaden students' academic horizons.

Achievement of knowledge. In terms of theory and practice, help students fully understand and master theoretical knowledge points and applications through the introduction and analysis of practical application scenarios, case libraries, field research, engineers into the classroom, etc. Understanding the actual needs and motivations of enterprises will help cultivate students' enthusiasm for learning and interest in learning, break down the bottlenecks of students' discord between theory and practice, and improve the quality of low-carbon technology and management talent training.

7.2 "Four Steps" Gradually Advance the Teaching Process

Table 1. Low-Carbon Technology and Management "Four Steps" Teaching Link

Before class	In class	After class	
Osmosis	Internalization	Consolidate	Expand
Course introduction and preview Online discussion and Q&A	Case analysis Group discussion Classroom testing	Homework design Practical tasks	Advanced reading. Competition and project expansion

As mentioned in Table 1., for pre-class penetration, the main tasks are "Draw a bow" and "Guide" Two aspects. Before the class starts, students can warm-up before the course by reading materials, case studies, video lectures, etc., and introduce relevant theories, practices and cases such as environmental management, sustainable development and carbon emission reduction. Through these infiltrations, students can be awakened to understand carbon emission reduction tax importance. Or use Superstar Learning to publish carbon emissions and management problems generated in enterprises in advance as an example, and use progressive questions to induce students to think deeply and generate interest in the course.[8]

Internalization in class. In the course teaching, in addition to basic knowledge transfer, Case teaching, group discussions, classroom testing, flipping the classroom. And other ways to help students deeply understand the principles and strategies of low-carbon environmental protection and carbon emission reduction. Through examples and analysis, students learn to apply carbon emission reduction concepts in practical management scenarios to improve student' green competitiveness, further to cultivate students' low-carbon technology and management ability.

After class consolidation and expanding. At the end of the course, assign assignments and practical tasks related to the course content to help students consolidate what they have learned and allow students to practice consolidate theoretical knowledge. At same time, provide advanced reading materials, online resources or recommended books to encourage students to study more deeply after class and explore more dimensions of the course content. Organize students to participate in course extensions in the form of

research, field visits, project practice, etc., such as conducting corporate environmental management practices, participating in green innovation projects organized by related industries, etc. Students are encouraged to explore research topics, write papers or participate in related competitions to consolidate course knowledge and expand practical applications.[9]

Create efficient courses with autonomous learning, diversified methods, and achievement-based knowledge through pre-class penetration, in-class internalization, and post-class consolidation and expansion. Deepen students' understanding and practice of low-carbon environmental protection and carbon emission reduction strategies, transforming passive learning to be proactive and further implement knowledge outcomes, so as to promote "Double carbon" Comprehensive talent training in technology and management, and stimulate a deep understanding of sustainable enterprise sustainability and environmental protection. And stimulate their practical actions to actively participate in low-carbon environmental protection and carbon emission reduction actions.

7.3 Curriculum Evaluation System

Science and technology low-carbon and management courses are innovative and practical. Traditional assessment forms are difficult to meet the evaluation criteria of the curriculum. To achieve a comprehensive and accurate grasp of students' knowledge and practical application ability, the construction of a multi-dimensional curriculum evaluation system is required. The curriculum evaluation system is built through online and offline, individuals and groups, process and the final comprehensive form. The online platform scoring mainly focuses on teaching video viewing, class check-in, in-class testing, problem discussion, etc.; in class performance, it is scored according to the student's due situation, in-class testing, and comprehensive classroom performance; after-class results are based on group assignments, individual assignments and practical assignments; and final exams are evaluated according to paper scores.

Through a multi-dimensional curriculum evaluation system, we strive to realize the

transformation from traditional to intelligent classrooms, theoretical to ability classrooms, and from closed to open classrooms. In a diversified teaching process, low-carbon technology and management courses will continue to improve teaching content, update typical cases of management, continuously optimize low-carbon related technologies, and better integrate courses into students.

8. Conclusion

Low-carbon technology and management curriculum construction is committed to "Double carbon" Knowledge is integrated into teaching routine, and the teaching plan is based on national policies; the teaching content focuses on students' learning; teaching results focus on social needs. In the curriculum, balance knowledge transmission and value shaping and independent learning, overall layout and fine management, while making it clear that curriculum construction and reform is a long-term and scientific work that requires gradual exploration, understanding, practice and improvement, and continuous optimization of the curriculum, and finally reach a blueprint for teachers and students to promote the training of high-quality talents.

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References

[1] Li Xiujun, Peng Bin, Song Mingyang. Teaching Reform of Civil Engineering Materials Curriculum under the Background of "Double Carbon" in the New Era. Higher Education Journal,

2023,9(33):12-15.DOI:10.19980/j.CN23-1593/G4.2023.33.003.

- [2] Liao Ping, GUO Baowei, Dai Qigen. The significance and reform of agricultural curriculum teaching under the background of "double carbon". Education and teaching forum, 2023, (52):66-69.
- [3] Jia Ming, Yang Qian, research Group of New Era Enterprise High-quality Development Research Center. Carbon neutrality Strategy for Chinese Enterprises: Theory and Practice. Foreign Economics and Management, 2022, 44(02):3-20.DOI:10.16538/j.cnki.fem.20211215.101.
- [4] Huang Zhen, Jia Ming, Liu Hui. Exploration of Constructing "Low-carbon Technology and Management" major in colleges and universities under the dual-carbon goal. Research on new Liberal Arts education, 2021, (04):60-73+142-143.
- [5] Fan Zhenjia, Yang Lijuan, Zhang Wenyan. Future Learning Center: Concepts, Elements, and System Construction. Library and Information Work, 2024, 68 (06): 3-11. DOI: 10.13266/j.issn.0252-3116.2024.06.01.
- [6] Sun Wenxuan The improvement path of green education under the "dual carbon" goal. Forestry Teaching, 2024, (03): 1-4.
- [7] Liu Zhihua, Yuan Qinglu, Li Cui, The synergistic effect of low-carbon economy and high-quality development under the "dual carbon" strategy: Taking the Beijing Tianjin Hebei urban agglomeration as an example. Environmental Science, 1-20 [2024-04-07] <https://doi.org/10.13227/j.hjlx.20231201>.
- [8] Xiong Linbo, Chen Wenjun. Research on the Impact and Mechanism of Carbon Trading on the Development of Low Carbon Economy. Enterprise Economics, 2024, 43 (02): 66-78. DOI: 10.13529/j.cnki. enterprise Economy, 2024.02.006
- [9] Sun Quansheng. Research on the Motivation Mechanism and Implementation Path of Digital Economy Empowering Low Carbon Development. Journal of Lanzhou University of Finance and Economics, 1-18 [2024-04-07] <http://kns.cnki.net/kcms/detail/62.1213.F.20240316.1811.008.html>.