

Construction of a New Engineering of Marine Technology based on the Approach of "Morality, Teaching, Learning, Research and Industry"

-- Taking Oceanography Course as an Example

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Abstract: The construction of new engineering disciplines has put forward higher requirements for the teaching of related courses and the cultivation of students. This paper takes the basic course of oceanography in Harbin Institute of Technology at Weihai as an example, and carries out teaching reforms from the objectives of course construction, teaching contents and methods, assessment methods, etc. In the course of construction, we integrate "morality, teaching, Learning, research and Industry", and achieves remarkable effects in the construction of teaching team and optimization of teaching contents, the improvement of teaching methods and means, and the enhancement of the comprehensive quality and ability of students, which provides a reference for the teaching reform of related new engineering courses.

Keywords: Integration of Morality; Teaching; Learning; Research and Industry; New Engineering in Marine Technology; Curriculum Construction.

1. Introduction

Under the background of the new round of technological and industrial revolution, the Education Ministry of China put forward the "new engineering concept" in February 2017 in order to cope with the new opportunities and challenges. The aim is to cultivate students' innovation ability and engineering practice ability, and to make them become innovative engineering talents, with the ability to lead the development of new science and technology and new industries [1]. How to effectively establish the curriculum system and course content for the cultivation of new engineering talents has become a difficult point of reform. The reform of curriculum system for new engineering disciplines is an important, global and systematic work that must be accomplished for the construction of new engineering disciplines [2,3]. Therefore, the new engineering course of marine technology was born based on the professional and disciplinary characteristics of Harbin Institute of Technology at Weihai. As the basic course, the teaching of marine fundamentals course also faces new requirements and challenges.

The reform and construction of the curriculum system and course content is the most difficult in teaching [4]. Oceanography is the basic course and compulsory course for the marine technology major of new engineering department in our university. This course takes the marine science system as the main line, and systematically expounds the basic concepts, basic theories and main achievements of marine science. In the cultivation program of this course, the cultivation objectives of this course are clearly stated: through the study of this course, students can understand and know the main phenomena and processes of the ocean and its development and change rules, so that students can master the basic knowledge of physical oceanography, marine chemistry, marine geology and marine biology in a more systematic way, and understand the important role of the ocean in the fields of

national economy, national defensive construction, disaster prevention and mitigation. The course will raise students' awareness of marine resources, environmental protection and sustainable development, and lay a foundation for the subsequent development and utilization of marine observation and monitoring technology.

In oceanography teaching, the traditional mode is still based on the teacher's lecture around a certain textbook, focusing on the learning of theoretical knowledge and neglecting the enhancement of engineering ability. Dull theoretical content often leads to low interest in learning and poor learning results. And it is difficult to combine theoretical knowledge with practical problems in engineering, textbook knowledge with cutting-edge knowledge, unable to cultivate students' abilities of dispersive thinking, independent learning, engineering practice and innovation, which is contrary to the concept of new engineering education [5-8].

In order to achieve the above cultivation purposes, this course takes students as the centre and teachers as the leading, and implements the cultivation mode of "morality, teaching, learning, research and Industry". It is conducive to the cultivation of innovative and applied talents needed by enterprises under the concept of new engineering education. Through this mode, students can improve their practical and innovative ability, deep learning and independent learning ability, become new era engineering college students with the quality requirements of engineering talents and all-round development of morality, intelligence and physical fitness in the new era.

2. Main Elements of Curriculum Development

2.1. Objectives of Construction

The construction objective is to set up advanced teaching concepts, introduce the concept of "morality, teaching,

learning, research and Industry" into the teaching construction, reform the teaching mode, and drive the modernization of teaching. The course is strengthened in terms of teaching content, teaching methods, assessment forms, teacher training, teaching management, teaching materials construction, scientific research, teaching practice and other aspects. Taking this as an opportunity, we will improve the system of the course and students' ability of

engineering practice, independent learning, problem solving and solidarity, by which to achieve the purpose of teaching and educating people. The measures will provide reference and basis for the construction of the new engineering discipline of marine technology.

2.2. Main Construction Content

Table 1. The teaching content and courses integration

Chapters	Morality integration	Science integration	Industry integration
Chapter 1 Introduction	By the explanation of marine culture, analyses the shortcomings in the contemporary marine research; stimulate students' patriotism enthusiasm and mission sense.	Use the top 10 ocean science questions for 2022 as a tie to introduce the science questions.	-
Chapter 2 Earth system and seabed science	Review polar scientific research experience and achievements of China, to make students feel that under the guidance of the Party's policy of reform and opening up and the strategy of developing the country through science and education, the great motherland's sustained economic development, rapid improvement in scientific and technological level, and greatly enhance the comprehensive national strength of the ever-changing face. It also fosters the enthusiasm of students to learn about the polar regions, recognize the polar regions, and better support and participate in polar expeditions.	Taking the current great power tool of the deep submersible as an example, to present the ideas and methods of solving these problems integrating the seabed characteristics of high pressure and low light; additionally, let students to know how to carry out scientific research from the discovery of the problem to the solution.	-
Chapter 3 Physical and chemical properties of seawater	By the explanation of sea water temperature and salinity, to stimulate students' patriotism, pride and sense of mission by the introduction of China's contribution to the marine exploration.	Utilizing the difference in temperature and salinity in seawater, to introduce how to utilize and develop new energy sources and so on.	Environmental Monitoring Station: Determination of seawater properties.
Chapter 4 Chemical composition and properties of seawater	Based on understanding of the current situation on seawater characteristics at home and abroad, to enhance the students' exploration spirits of marine knowledge, to learn our marine scientists' spirits of facing hardship, innovating, and working in unity and cooperation. To cultivate students' patriotism, national pride and self-confidence, and to take the initiative to participate in the practice of building a strong marine country.	Large amount of trace rare metal elements in seawater, to induce students how to enrich metal elements at low concentrations to solve practical difficulties in seawater utilization.	Environmental Monitoring Station: Determination of chemical composition of seawater.
Chapter 5 Movement forms of seawater	Based on the understanding of common wave tidal energy, to introduce students in the process of scientific research to believe in ourselves, start from minor matter and accumulation to get more harvests.	Based on the Lens Tidal Power Station in France, to consider the theoretical knowledge applied to the establishment of a tidal power station.	Modelling of seawater movement patterns
Chapter 6 Seawater-atmosphere interaction	To Learn from the "ocean spirit" and philosophy of life of our predecessors who dared to compete with the ocean and vowed to dedicate their youth to science, the youth will take the initiative to devote themselves to the construction of a strong oceanic country and the realization of the great Chinese dream.	Using the familiar El Niño and La Niña climate phenomena, to introduce students to explore the emergence factors of this weather phenomenon and model its development.	-
Chapter 7 Marine life and ecosystems	To guide students to understand the marine ecological and environmental problems caused by marine organisms, and to analyze and summarize the impact on the marine industry and possible solutions. To help students to further understand the concept of "green mountains are golden mountains" and to establish an awareness of environmental protection.	Taking the construction of "national marine pastures", to propose the main contents of marine ecosystem testing and to discuss its testing principles and methods.	Visiting Xunshan and Haodangjia sea pastures and simulating their designs
Chapter 8 Marine pollution and ecological problems	To analyses the form causes of red tide, low oxygen, chemical pollution problems, combining with the construction of China's sea pastures.	To know about the microplastic of large surface area and adsorptive properties, and to analyses its influence to the spread of organic pollutants.	Measurement, modelling and traceability of microplastic in seawater
Chapter 9 Marine resources development technologies	Based on the idea of "the benefits of fish and salt, and the convenience of oars", to learn the marine history of our ancestors' earliest understanding and utilization. Also, to know about the development and utilization states of modern marine drugs in China.	To state the current shortage of freshwater resources, to guide students to think about the kinds and principles of seawater desalination technologies.	Seawater reverse osmosis desalination technology
Chapter 10 Regional Oceanography of China	To explain of the state of China Sea and the knowledge of Convention on the Law of the Sea of UN; students will be inspired with patriotism, pride and sense of mission, and the establishment of the maritime rights awareness.	To discuss the advantages and characteristics of China's ocean development through the understanding resources.	-

The content of course construction involves 2 aspects: one is the research and reform of course teaching team and system, which mainly includes the construction of course systematization, the establishment of the system of science-education fusion, the design and incorporation of course ideology and politics cases, optimization of teaching content, strengthening of knowledge system, and injection of frontier advances of disciplines, etc.; the other one is the innovation of course teaching methodology and means, the adoption of a diversified teaching mode, and the matching and positioning of appropriate teaching methodology to specific teaching content. The other is the innovation of course teaching methods and means, adopting diversified teaching modes, matching and positioning appropriate teaching methods to specific teaching contents, such as multimedia-assisted teaching, case teaching method, project-oriented extracurricular experiments, etc. The ways can stimulate students' interest in learning and improve students' comprehensive ability in scientific research.

1) Optimization of course content and system

The course content adopts the classic textbooks "Introduction to Marine Science" edited by Feng Shizuo, which can not only lay a good theoretical foundation but also reflect the advanced technology level at home and abroad. Besides, the contents of the course's ideology and politics refer to the author's textbook "Ideological and Political Education Cases of Marine Science and Engineering", which is conducive to the continuous improvement of the quality of teaching and guarantees the ideology, scientificity and contemporaneity of the course contents.

On the basis of the original system, the curriculum has added elements of ideology and politics, scientific frontiers and industrialized contents, thus realizing the teaching characteristics and contents of the integration of the five aspects of "morality, teaching, learning, research and Industry". The detailed course arrangement is shown in Table 1.

2) Teaching Method Construction

Based on the fundamental goal of cultivating first-class students and new engineering talents, we carry out the integrated teaching reform at the three levels of classroom teaching, experimental teaching and practical teaching.

Improve the quality of classroom teaching by adopting informatization and integration of science and education.

How to visualize and concretize the theoretical knowledge in the classroom is the key to improve the quality of classroom teaching and give full play to students' subjective initiative. In order to solve this problem, we integrate the teaching team and a variety of teaching resources and teaching methods, and use information technology means (multimedia, rain classroom, simulation, etc.) to play the animation of instrument principle and structure, to enhance the construction of the knowledge system of the students. The participation and pride sense of students are enhanced by carrying out the "fusion of motility and education". By the "integration of science and education", the teachers bring models of the latest scientific research achievements into the classroom, to promote the students' participation and subjective initiative.

Strengthen the integration of theory and extracurricular practice through the integration of industry and education to cultivate future talents.

It is the key to the utilization of the theoretical system of

oceanography for students to strengthen the integration of theoretical knowledge and practice. In order to solve this problem, in the course teaching we integrates scientific research resources, construct courses with scientific research teams, campus ecological bases, institutes, and enterprises. In the research laboratory, by the multi-level integration of "innovative experiment + project + competition", the students' abilities are strengthened in design, teamwork, data acquisition and analysis, etc. Through the four-step integration of "team, campus, institutes and enterprises", the students' personalized training is achieved and the ability to analyze and solve problems is improved.

2.3. Construction of Assessment Methods

Based on the guiding principle of "Diversification - Emphasize the process - Examine the ability", the grades are assessed by a cumulative assessment method of "formative" and "summative" evaluation. Additionally, the learning attitude, autonomy sense and innovation and practice sense are included in the assessment. By this way, a diversified, whole-process assessment method is formed.

The form of course assessment is as follows: classroom performance (5%) + homework (5%) + inquiry-based learning (20%) + academic report (20%) + practical operation (20%) + final examination (30%). Finally, we utilize questionnaires and messages to collect students' feedback and provide references to the course reform, so that the teaching and learning can grow together and run in a closed loop.

3. Results Achieved in Curriculum Development

After more than 2 years of construction, the course has achieved remarkable results in terms of teaching team, teaching content, teaching methods and means.

3.1. Optimization of Teaching Team and Teaching Content

1) Establishment and improvement of teaching team

Teaching team construction is the fundamental element of the course construction. In the course construction, we further strengthen the construction of the teaching team, and gradually build up a teaching team with high academic level, good at innovation, high education, high title, reasonable age structure, high teaching level and research ability. Teachers are encouraged to carry out scientific research activities to improve the teaching quality. The course team currently includes 2 associate professors, 2 lecturers, 1 engineer. In addition, the project team also has 2 doctoral students and 4 master students. The composition and knowledge structure of the personnel is reasonable, and the experimental skills are skillful in operation. The project team has participated in 6 marine-related teaching and reform projects, among which "Practice and Exploration of Marine Science Discipline Construction under the Background of Double First-class" won the second prize of the university teaching, and 2 people were awarded the title of "Outstanding Ideological and Political Worker of Harbin Institute of Technology". We have accumulated rich experience in teaching and research experience.

2) Systematization of teaching content

In the setting of course content, we track the new progress and organically combine the cutting-edge knowledge with the

course teaching. At the same time, the new achievements of the discipline development are introduced into the classroom teaching appropriately, and the relationship between the basic knowledge and the cutting-edge research content are handled. The establishment of science and education system and the integrating into the course of the ideological cases make that the course achieves the unity of modernity and fundamentals, and science and systematicity.

In addition, the contents of isolated chapters are linked through comparison and synthesis. Students are actively guided to take the initiative to summarize and find out the common rule, so that the knowledge can be systematized and pulsed.

3) Establishment of research, industry and education fusion system

At present, the Modern Instrumental Analysis Research Laboratory where the course group is located, has undertaken a number of scientific research projects, such as National Key Research and Development Program, National Science and Technology Support Program, National Natural Science Foundation of China, Natural Science Foundation of Shandong Province, and Key Research and Development Program of Shandong Province. In addition to basic teaching content, the increase of experimental results analysis, data processing and case study improves students' ability to analyze and solve problems. At the same time, teachers expand the relevant contents around the frontier areas of scientific research, and integrate the latest research results into the teaching contents. In laboratory, about 50 students annually are admitted and more than 10 innovative projects are prescribed, which has accumulated rich experience for the completion of the course construction. It is important that college has established a good cooperative relationship with Weihai Marine Environment Testing Center, Haodangjia Group and Xunshan Group, laying a foundation for the integration of industry and education.

4) Design and integration of the ideological cases

We tap the unique materials contained in the course and integrate them into teaching. In the process of course teaching, we inherited the relevant materials in the field of marine science and engineering, and prepared the "Ideological and Political Education Cases of Marine Science and Engineering". In the book, we introduce the application examples in the fields of marine biology, marine chemistry, physical ocean, ocean exploration, marine space resources and so on, as well as the scientific research and the spirit of scientists. Additionally, the difference between the international situation of scientific and technological innovation and the reality of our country is compared, which inspires the students' sentiment of strengthening the country in science and technology, scientific research ethics and discursive thinking. It improves students' political standpoint, cultivates students' sense of family and country and sentiment, and makes students combine character cultivation, personality development, academic ambition and professional theoretical knowledge, so as to be a qualified builder and creator in the new era.

3.2. Improvement of Teaching Methods and Means

In teaching methods and means, the organic combination of modern educational technology and heuristic teaching are further explored to formulate clear course objectives and scientific teaching planning, deepen the teaching reform, and

constantly explore new methods, approaches and measures to improve the teaching effect.

1) Multi-media-assisted teaching

The working principle of the instruments is shown through pictures and videos. The experimental procedures of instrumental analysis and software operation are simulated by flash or the instrument simulation software, so that students increase the perceptual understanding of the instruments and improve the success probability of the actual experimental operations.

2) Case teaching method

Typical examples containing the science essence and inspiration are selected from daily life, scientific history and research experiments, so that students can better grasp and understand the relevant knowledge points. In case teaching, modern teaching methods and inspirational teaching are fully applied to cultivate students' ability to connect theory with practice. Combined with the teachers' research work and the current development of cutting-edge technologies and topics, we focus on the introduction of problem-solving ideas and methods to consolidate the students' understanding of theoretical knowledge and increase their learning interest.

3) Flipped classroom and seminar teaching method

Focusing on the given topics in class, students voluntarily form a study group, conduct a literature review, summarize the progress of research in the field, and produce PowerPoint for classroom reporting. After the lecture, the teacher and students will ask questions and discuss the content of the report, so as to exercise the students' ability of literature review, promote their research thinking ability, and expand their disciplinary vision.

4) Project-oriented extracurricular experiments

Based on the theoretical learning in class, students choose one of the experimental projects, and through reviewing the literature, they formulate a feasible plan, including the pre-treatment of the samples, the conditions of sample testing, as well as possible problems and solutions, etc. And then complete the process of testing and analysis to form a research report with the assistance of the laboratory teachers or siblings. As a result, students can truly understand and master the principles and applications of the technology, laying a good foundation for future scientific research. In addition, the course group has established a course practice base in Weihai Xiaoshidao Marine Environmental Monitoring Station, which provides a good carrier for students' extracurricular practice.

3.3. All-round Improvement of Students' Comprehensive Quality Ability

1) Stimulate students' nation sentiment in science and technology and research ideology.

We tap the unique materials contained in the course, such as scientists and their spirits, and compare the international situation with the actual situation in China in scientific and technological innovation fields. Then, we integrate these materials into the teaching to stimulate the students' sentiment for a strong scientific and technological country, and the ability to link theory with practice. At the same time, students are guided to closely integrate what they have learned with their own practical research work, and gradually internalize it into their own work, so as to enhance their social adaptability and competitiveness. In recent years, the laboratory has accepted more than 200 students and nearly 100 postgraduates, and offered more than 100 innovation projects for undergraduates; carried out more than 10 times of

innovative experimental classes, totaling about 130 people.

2) Make students grasp the knowledge of oceanography systematically

Oceanography takes the system of marine science as the main line, and systematically expounds the basic concepts, theories and main achievements of marine science. Through this course, students can understand the marine phenomena and processes and its development and change rules, so that students can more systematically master the basic knowledge of physical oceanography, marine chemistry, marine geology and marine biology, *etc.*, and understand the important role of the ocean in the national economy, national defense construction and disaster prevention, *etc.* Also, the students' awareness of marine resources, environmental protection and sustainable development are improved to lay a good foundation for the subsequent marine technology development and utilization.

3) Improve students' ability to analyses and solve problems

In order to improve students' ability to analyze and solve problems, strengthen the cultivation of students' research ability and thinking, the integration of science and education is implemented. Based on the teaching of the basic principles, we expand the frontier areas of research literature, and integrate our latest research results into the course teaching. By this way, we can train the students' ability of literature review, research ideas, and expand their disciplinary horizons. In addition, we introduce students to summarize their research results and guide them to participate in scientific and technological competitions to enhance their thinking ability and communication ability. Until now, we have guided more than 20 student teams to win prizes in various levels of science and technology competitions, including the second prize of the National Ocean Vehicle Design and Production Competition, the second and third prizes of the National University Students' Energy Conservation and Emission Reduction Social Practice and Science and Technology Competition, and so on. By taking part in some competitions, kinds of abilities are cultivated including independent learning ability, thinking ability and innovation ability.

4. Conclusion and Prospective

After more than 2 years of course construction, enormous outcomes have been achieved in terms of teaching team, teaching content, teaching methods and teaching means. "Marine technology" is a multidisciplinary integration major, which integrates the basic theoretical knowledge system of different disciplines, research methodology, teaching methodology and teaching effect, *etc.* The teaching aim is to cultivate outstanding talents with creativity, composability and professional knowledge in line with the strategic needs of national and local development. The curriculum is strongly theoretical and practical, and the teaching is carried out by means of "morality, teaching, learning, research and Industry" to cultivate students' national sentiment, and to fully mobilize

students' enthusiasm, participation sense and subjective initiative. By multi-level integration and application of "team, campus, institutions, enterprises" resources, students' interest is stimulated, the application of theoretical knowledge is strengthened, and the program design, problem solving and other practical skills are improved.

This model and method of course construction can be firstly operated in several larger teaching and research teams in colleges and universities, and gradually improved to form a mature management system, which can provide reference for the construction of other courses.

Acknowledgments

This work was supported by Excellent Course Construction Project of Shandong Province (SDYKC21036) and Teaching Reform Project of Harbin Institute of Technology (XJG2022010, XJG2022005).

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