

STUDY ON DECISION FACTORS OF THE CULTIVATION STANDARDS OF UNDERGRADUATES OF ATMOSPHERIC SCIENCE MAJORS

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ABSTRACT

In order to promote the comprehensive development of China's the cultivation of undergraduates of atmospheric science in the new era, the cultivation standards should be strategically set up and kept pace with times. Therefore, the analysis on the macro and micro decision factors of cultivation standards need systematically be carried out according to CDIO education ideas. After study, four macro and four micro decision factors have been concluded. The important factors at the macro aspects are enrollment, personnel training model, teaching conditions, teaching teams respectively, while the ones at micro aspects are training schemes, information resources, the teaching quality monitoring mechanism, continuous improvement mechanism for majors respectively. China's cultivation standards of undergraduates of atmospheric science majors can be set up only by continuously constructing their decision factors. China's demands of qualified undergraduates of atmospheric science majors can be met by cultivating them according to the standards with evident advantages.

KEYWORDS

Atmospheric Science, Major Standards, Decision Factors, Standards: 3, 6,8,9,11,12

1 INTRODUCTION

Since 21st century, China's modernization process is developing rather quickly. Meanwhile, the development of China's meteorological service also accelerated. In this rapid social development and transition phase, our country should transform from a large meteorological country into a powerful one promptly. Through this transformation, we can ultimately solve major issues such as resources, environment, and natural disasters mainly by our own strength. We also should make a contribution to the world meteorology in areas such as scientific theory, research ideas, and scientific findings through hard work. In order to achieve this ambitious strategic target, one of the most critical factor is the need to train a large number of qualified graduates for China's meteorological service.

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However, how a major cultivate excellent talents that needed by the high developing society? This is a question to which all kinds of majors have to seek an answer. First of all, what good qualities should be attained by talents? In fact, these qualities include: moral, cultural and professional qualities and physical and mental qualities; secondly, how can the ordinary undergraduates possess these qualities, and to better serve the development of China's meteorological service and bring personnel training to a higher standard. Many scholars and researchers of higher education have done a lot of work in these aspects (Guosong Chen et al., 2012; Mingzhao Peng et al., 2007). How do we recognize the effect of all kinds of qualities in personnel training? The education circles have now reached a certain consensus (Lizhong Zhao, 1996), i. e., "comprehensive knowledge structure is the basis for the overall quality of talent, comprehensive creation ability is the core of an integrated comprehensive quality talent, ideological and moral, psychological quality is the guide of he overall quality of talent, scientific way of thinking and method is the mainline of the overall quality of talent mainline, comprehensive knowledge structure is the basis for the overall quality of talent". The consensus is the basic theoretical direction of the building of talent training standards under the new situation. With the development of China's meteorological service, the establishment of a farsighted personnel training standard is imperative, but in the process of the establishment, we must to take two important aspects", which are "the cultivation of comprehensive quality talents" and "the promotion the continuous development of meteorological science and technology" into account.

At present, the universities which cultivate atmospheric sciences undergraduates in China are: Nanjing University of Information and Science Technology, Chengdu University of Information Technology, Peking University, Nanjing University, Lanzhou University, University of Science and Technology of China, Ocean University of China, and Sun Yat-sen University, etc. And all universities have training standards according to their actual situations, for example: "Emphasis on basic knowledge, strengthening of practice, application oriented" of Nanjing University of Information and Science Technology, "Broaden the base, strengthening of practice, focusing on innovation" of Nanjing University, "Strengthening the basic, desalination the professional, individualized teaching, differentiated training " of Peking University, "The integration of Atmospheric Science and Physical Oceanography, emphasis of the cultivation of cross-field talents" of Ocean University of China. These universities have generally focus on the training of basic knowledge and ability of applications, which still has a large gap with the " The cultivation of comprehensive quality talents " and "The promotion the continuous development of meteorological science and technology". In addition, the universities still have no definition of the "knowledge, ability and quality" that undergraduate students of atmospheric sciences should achieved from the students' perspective.

While for the foreign universities, especially the Department of Atmospheric Science in Colorado State University and University of Washington, they have more emphasis on training of professional elite, focusing on research-guided teaching, advocating students' research and operational capacity, and students should be more independent in learning. American Meteorological Society defined the atmospheric sciences graduate defined "meteorologist", which means that they should be able to use basic scientific principles to explain, analyze, observe and forecast fundamental phenomena of Earth's atmosphere, and have a basic understanding of the impact of atmosphere for the Earth and its life.

Presently, our country is facing an important strategic opportunity time, all relevant colleges and universities must develop new talent training standards to meet the needs of development of China's meteorological undertakings in present stage and promote atmospheric science education into a new stage by CDIO (Conceive Design Implement Operate) education ideas. The paper will focus on a systematic sort of the macro and micro determinants of the establishment of professional training standards for atmospheric science undergraduates.

2 THE MAIN MACROSCOPIC DETERMINANTS

2.1 Research of the first macroscopic determinants "The enrollment mode"

The enrollment mode is the "entrance" of personnel training, flexible and reasonable enrollment mode is essential for the diversified development of talent, which can meet the requirements CDIO education idea.

At this stage, how to recruit potential atmospheric science undergraduate students to adapt to the new era of the development of China's meteorological undertakings and change the current situation, which is emphasizing knowledge and ignoring capacity, in college entrance examination in our country, must be answered in the enrollment.

The initial conditions or key internal factors for successful atmospheric science undergraduate student are ability of independent learning and flexible use of knowledge, while successful entrance examination is to try to test whether such ability which decide their own future development have been mastered by students at secondary school.

In terms of the entrance exam, we should focus on the evaluation of languages (Chinese and English), mathematics and comprehensive science knowledge. For language testing, in particular, we need to examine students' reading comprehension and writing skills particularly, and mathematics mainly test students' ability of calculation, drawing, spatial analysis and abstract thinking through algebra and geometry, integrated science is to test students' basic knowledge of physics, chemistry and biology. In addition to the exam, we should also fully assess students' comprehensive quality by reference to the courses students learned in high school, students' grades in high school rankings, as well as recommendations from their teachers and principals.

In addition to the independent admission examination, we can also solve the employment difficulties in remote areas by contractual training in enrollment and make sure the orderly and sustainable development of the sector.

We can be able to eventually form system and measures in atmospheric science that can attract the best students through proper planning and continuous adjustment.

2.2 Research of the second macroscopic determinants "The personnel training mode" (CDIO Standard 8 — Active Learning)

Researches on "the personnel training mode" are to solve the problems, what kind of talent

we should foster under current conditions. The talent demands of economic and social development are diverse, which requires the research of correspondingly diverse talent training mode and training direction. The classified cultivation is the inevitable choice for universities to adapt to the needs of diverse talents of economic and social development. The classified cultivation is the demand of individual differences in intelligence, the implementation of personalized training; the need of the promotion of quality education, while quality education is the strategic themes of education reform; in addition, classification training is the need of the development of colleges and universities, the need of the specialized occupations, but also the need for specialized teachers.

Based on the reform in enrollment mode and the full implementation of quality education, we should design student-centered training model to fully enhance the quality of teaching, give full play to the advantages of students and fully develop the students' ability according to the integration of teaching plan of CDIO.

2.2.1 The objective of talents training

According to professional characteristics and social demand for talent, we need to refine the connotation of talent training objectives, establish talent training objectives for secondary classification system. The first classification system divides talent training objectives into application type and academic type.

(1) The application type: applied talents who taking employment as objective, acquired strong practice ability delivered to the meteorological sector (Weather Bureau at all levels, the military, civil aviation and other sectors). Applied talents mainly focused on positions which demand high practical ability. We should focus on the cultivation of students' practical ability, knowledge application ability to meet the needs of first-line technical personnel posts after their graduation.

(2) The academic type: research-typed talents are cultivated to be able to undertake further advanced studies and engage in applied science and technology research and development work. Academic talents need to have a more profound theoretical knowledge and ability to engage in the application of science and technology. According to this social demand, we introduce research projects into the classroom, so that students can not only deepen their theoretical knowledge, but also participate in the projects, which have favorable influence on their further education and consciousness of scientific research.

The secondary classification system refined the first training objective, taken a rigorous classification of talents according to employment positions. For example, application-oriented talents can be subdivided into weather forecasters, atmospheric sounding workers, weather forecasting workers etc.; high-level researchers can be divided into academic personnel (Table 1). The establishment of talent classify training mode under the secondary classification system can ensure talent training's compliance with industry personnel training needs.

Table 1 The Secondary Classification System of Atmospheric Sciences Professional Training Objective

| | |
|------------------------------|-------------------------------|
| The first training objective | The second training objective |
| Application-oriented talents | Weather forecaster |
| | Atmospheric sounding worker |
| | Weather forecasting worker |
| | Anti-thunder worker |
| | Weather modification worker |
| Academic talents | High-level researcher |

2.2.2 Standard of talents cultivation

According to location of classified personnel training objectives, we should structure training standards with different emphasis.

(1) Application-oriented talents stress that solid, extensive, social demand-driven technical expertise should focus on the cultivation of operational capacity and ability of knowledge application.

(2) Academic talents emphasize that learning of basic knowledge, professional knowledge should be deepen, focus on cultivation of students' ability to master frontier of knowledge, advanced technology and ability of technological innovation, so that students can lay a solid foundation for their further studies and research work of applied science and technology.

2.3 Research of the third macroscopic determinants "Teaching condition and investment" (CDIO Standard 6 — Engineering Workspaces)

Another important macro determinant of cultivation of atmospheric sciences undergraduate is teaching conditions, which are required especially by CDIO education idea. These conditions are mainly refers to the laboratory and practice base. In these basic teaching conditions, experimental teaching center of atmospheric science comes to the first; it needs to meet the basic teaching needs of professional courses and basic courses such as Atmospheric Observation, Atmospheric Physics, Atmospheric Chemistry, Weather experiments, Weather Forecasting and Analysis etc. The second is high-performance computing center that meet the teaching requirements of numerical methods, numerical weather prediction, statistical weather forecasting, computer programming etc. The third is stable practice base, a distinctive practice teaching base that established through cooperation with the meteorological sectors, related companies and research institutes to effectively enhance students' practical ability. Finally the National Ministry of Education, provincial or municipal scientific research center or field comprehensive observation stations that meet teachers and students' basic research needs.

In terms of teaching investment funds ,it need to meet needs of personnel training better, the annual daily teaching expenditure for each student should not be less than 1000 yuan, which should also increase steadily with the growth of education funding.

2.4 Research of the fourth macroscopic determinants "Establishment of teaching team"(CDIO Standard 9 — Enhancement of Faculty Teaching Competence)

Teaching team is a group of teachers formed to complete the curriculum planning and teaching mission, it is the key link of the establishment of personnel training and realization of teaching purposes. We need to comprise respective and distinctive teaching team for different types of talents to truly accomplish talents training objectives, which also is very important in CDIO education idea. We should focus on the establishment of professional courses and practical training courses teaching team that corresponding with the cultivation of applied talents. We should establish basic courses, professional courses group, and comprehensive research capacity training teaching team for the cultivation of academic talents.

The establishment of teaching team should improve team members' research ability on the basis of rational planning of the number and structure of the team, focus on teaching led by research, inspire students with scientific ideas and promote the continuous improvement through scientific research.

Secondly, we should establish a "Leading Professor - Core Associate Professor - Young Lecturers" high level teacher team with reasonable layout taken the construction of top-quality course group as the carrier, based on actual courses situation and integration and systemization of the various courses; We can also constantly improve the overall level of teaching team through continuous concentration of teachers team spirit, strengthening of the exchange and cooperation with other universities and research institutes in domestic and overseas and "inviting" and "going out" strategy.

We should also encourage team members to promote the teaching by scientific research, improve their academic level through active participation in scientific research, grasp the latest development of atmospheric science, update course content constantly, and guide students in extracurricular academic and practical activities, cultivate students' ability of innovation and practice.

We should give full play to the positive role of team collaboration and complementary advantages, have organic combination of the knowledge, ability and resources of team members to ensure it worked smoothly and efficiently. Each teaching team need to form their own unique teaching philosophy and methods gradually, and have constant reform and improvement in practical teaching.

3 THE MAIN MICROSCOPIC DETERMINANTS

3.1 Research of the first microscopic determinants "Personnel training program"(CDIO Standard 3 -- Integrated Curriculum)

In accordance with the rule of the atmospheric sciences undergraduate training, the total credits is set to 160-170 credits, total courses period is set to 2560-2720 hours (1 credit equals 16 hours), which is the most important part of CDIO education idea, and can connect CD and IO. All types of personnel training courses would be composed of four course

systems which are general education, infrastructure, professional development and practice. In terms of cultivation of applied talents, curriculum and job tasks and responsibilities should be connected closely, the proportion of professional courses and practical courses in the relevant basic courses should be increased (Table 2). In addition, we should strengthen the practical teaching and focus on the cultivation of students' professional ability to enhance their operational capabilities. We should try to interface cultivation of applied talents with professional training (new forecaster job training, etc.) . In terms of cultivation of academic talents, we should strengthen the interface with graduate education , increase post-graduate courses or relevant seminars appropriately, focus on the cultivation of students' ability to master the frontier knowledge and advanced technology and ability to innovate based on the emphasis of deepening basic professional knowledge, which could lay a good foundation for students to pursue advanced studies and their further science and technology researches (Table 3).

Table 2 Curriculum Provision for Application-oriented talents

| Curriculum system | | Courses |
|------------------------------|-------------------------|--|
| General Education Curriculum | | Ideological and Moral Cultivation and Legal Basis, The Outline of Modern Chinese History, Basic Theory of Marxism, Introduction to MAO Zedong Thought and Socialist Theoretical System with Chinese Characteristics, Situation and Policy, College English, Physical Education (PE), Calculus, Linear algebra and Space Analytic Geometry, Probability Theory & Mathematical Statistics, College Physics, University Computer Foundation |
| Foundation Course | Discipline basic course | Methods of Mathematical Physics, Numerical Methods, Atmospheric Physics, Atmospheric Fluid Dynamics, Atmospheric Sounding Science, FORTRAN Programming, Dynamic Meteorology, Weather Theory, China Weather |
| | professional courses | Weather Analysis, Statistical Weather Forecasting, Satellite Imagery Application , Nowcasting and Doppler Radar Applications, Weather Diagnosis and Short-term Weather Forecasting, Medium-term Weather Forecasting, Numerical Weather Prediction, Real-time Short-term Weather Forecast |
| Professional development | | Radar Meteorology, Satellite Meteorology, |

| | |
|---|---|
| courses (can be freely selected according to needs) | Climatology, Introduction to Earth Science, Atmospheric Circulation, Tropical Weather, Meso and Micro-scale Weather , Weather Diagnostic analysis, Pollution Meteorology, GIS Applications, Aeronautical Meteorology, Military Meteorology, English for Meteorological Science and Technology, C Language and Program Design |
| Practical courses | Weather Comprehensive Analysis and Prediction experiment, China weather (practice), Weather Analysis (practice), Satellite Imagery Application (practice), Nowcasting and Doppler Radar Applications (practice), Weather Diagnosis and Short-term Weather Forecasting (practice), Numerical Weather Prediction (practice), Real-time Short-term Weather Forecast (practice), Meteorological Graphics Software Applications, Comprehensive Experiment of Meteorological Observations, Atmospheric Science Comprehensive Experiment, Military Theory and Training, Graduation Practice, Graduation Project. |

Table3 Curriculum Provision for AcademicTalents

| Curriculum system | Courses |
|------------------------------|--|
| General Education Curriculum | Ideological and Moral Cultivation and Legal Basis, The Outline of Modern Chinese History, Basic Theory of Marxism, Introduction to MAO Zedong Thought and Socialist Theoretical System with Chinese Characteristics, Situation and Policy, College English, Physical Education (PE), Calculus, Linear algebra and Space Analytic Geometry, Probability Theory & Mathematical Statistics, College Physics, University |
| | Methods of Mathematical Physics, Numerical |

| | | |
|--|--------------------------|---|
| Foundation Courses | Discipline basic courses | Methods, Atmospheric Physics, Atmospheric Fluid Dynamics, Atmospheric Sounding Science, FORTRAN Programming, Dynamic Meteorology, Weather Theory, China Weather |
| | Professional courses | Advanced Atmospheric Dynamics, Advanced Weather, Mathematics Method of Atmospheric Sciences, Modern Statistical Methods and Software Applications, Cutting-edge Lecture of Atmospheric Science, Climate Change and Numerical Simulation, Global Change, Modern Weather diagnostic analytical methods, Progress of the Tibetan Plateau Meteorology, Climate Dynamics, Weather Analysis, Statistical Weather Forecast |
| Professional development courses (can be freely selected according to needs) | | Radar Meteorology, Satellite Meteorology, Climatology, Introduction to Earth Science, Atmospheric Circulation, Tropical Weather, Meso and Micro-scale Weather , Pollution Meteorology, GIS Applications, Aeronautical Meteorology, Military Meteorology, English for Meteorological Science and Technology, C Language and Program Design |
| Practical courses | | Weather comprehensive Analysis and Prediction experiment, China weather (practice), Weather Analysis (practice), Modern Weather diagnostic analytical methods Numerical Weather Prediction (practice), Meteorological Graphics Software Applications, Comprehensive Experiment of Meteorological Observations, Atmospheric Science Comprehensive Experiment, Military Theory and Training, Graduation Practice, Graduation Project. |

3.2 Research of the second microscopic determinants “Information resource condition” (CDIO Standard 6 — Engineering Workspaces)

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In this age of information, the construction of information resource conditions is also an important microscopic condition for Atmospheric Sciences undergraduate personnel training and active learning conditions for students required by CDIO education idea.

Firstly, we need to build the appropriate Website and manuals in order to provide the basic requirements of the Atmospheric Sciences undergraduate training program, syllabus of each course, teaching and assessment, graduation requirements and other basic teaching information. We particularly need to focus on the construction of library and information resources of the atmospheric sciences and related disciplines, purchased professional book amount per student per year should not less than two. Secondly, we need to build digital resources and appropriate professional literature databases and exploit simple and practical search tools. Finally, we need to build Websites for various courses at all levels to provide the necessary teaching resources online.

3.3 Research of the third microscopic determinants “The construction of quality monitoring mechanism of teaching processes” (CDIO Standard 11 — Learning Assessment)

We must ensure the quality of the Atmospheric Sciences undergraduate training, which is required by the major evaluation of CDIO education idea. Firstly, it is needed to build a mechanism of undergraduate teaching of professors, while the rate should be required mandatorily to reach 90%. Secondly, quality standards and teaching requirements in each link of teaching should be constructed construction of teaching various aspects of quality standards and teaching requirements, the supervision and safeguard should be guaranteed. Thirdly, it is needed to construct the basic status data monitoring and evaluation system and regularly carry out professional assessment and certification. Besides, we also should build a professional learning situation investigation and analysis and evaluation mechanism to have an effective evaluation of students' learning process, results and overall development. Finally, it is needed to construct revision mechanism of personnel training programs participated by graduates, employers and outside experts.

3.4 Research of the fourth main microscopic determinants “The construction of continuous improvement mechanism of atmospheric sciences”(CDIO Standard 12 — Program Evaluation)

Major construction requires self-improvement mechanism, which is also the driver of CDIO development, so that we should regular contact with alumnus, alumna and employers; seek their opinions and recommendations of atmospheric science personnel training programs, curriculum provision and teaching content and methods effectively. Secondly, experts and students' teaching evaluation should be held regularly, so that problems in major development and construction can be known and solved in time. An effective mechanism that could

constantly improve cultivation of undergraduates of atmospheric science would be formed by analysis and summary of opinions from all aspects.

4 SUMMARY

In this paper, the analysis on the macro and micro determinants of cultivation standards need systematically be carried out according to CDIO education ideas. After study, the main conclusions of the analysis are obtained, the important factors at the macro aspects are enrollment, personnel training model, teaching conditions, teaching teams respectively, while the ones at micro aspects are training schemes, information resources, the teaching quality monitoring mechanism, continuous improvement mechanism for majors respectively. Methods with guiding significance and corresponding measures of China's cultivation standards of undergraduates of atmospheric science majors can be set up only by solid implement of these macro and micro determinants.

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REFERENCE

Guosong Chen, Xiaodong Xu. (2012). The standard of talents cultivation of undergraduate engineering education, *Research on Higher Engineering Education*, 2, 37-42.

Mingzhao Peng, Jusheng Shen. (2007). The standard of talents in Colleges and universities, *Pioneering with Science and Technology*, 1,154-155.

Lizhong Zhao. (1996). The connotation of comprehensive quality of talents, *Liaoning higher education research*, 4, 40- 42, 64.

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