

An Updated Educational System for Cultivating Talented Students in Hydraulic Engineering: Experiences from Chang'an University, China

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Abstract Some new situations in China due to student-expansion policy, lack of experienced teachers and inadequate financial support have urged a reform or an update to the old educational system so that talented students in various disciplines can be cultivated. This study reported an updated educational system for cultivating talented students in Hydraulic Engineering. This system was updated in three main parts: updating education concept, establishing integrated practical training system, and improving teaching approaches. After implementation of the updated system, fruitful achievements have been obtained in the university in the field of Hydraulic Engineering education. Experiences and practical applications proved that the updated system is more efficient and effective to cultivate talented students in Hydraulic Engineering. The system reported in this study may be adopted by other universities in China to cultivate talented students in Hydraulic Engineering and related disciplines.

Keywords: *educational system, talented student, Hydraulic Engineering, innovative approach, field teaching practices*

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1. Introduction

Higher education is critical and is the basis for the sustainable development of society and economy [1,2]. Hydraulic Engineering is a discipline where graduated students should acquire both theoretical knowledge and practical skills. In China, this discipline is developed quickly during the past several decades. However, some new situations have emerged recent years which may obstacle the development of higher education in this discipline [3,4,5]. These new situations include: (1) the students' number has increased rapidly since 1999 when the nation began the student-expansion policy; (2) in order to cope with this expansion, universities adopted a large number of young teachers who lack teaching experience; (3) a large number of enterprises and institutions are no longer willing to provide students with free practice places and guidance due to the development of the market; (4) the prices of food and accommodation increased a lot during the past years, which increased the cost of field teaching without corresponding increase of education investments; (5) the tendency of emphasizing scientific research but ignoring teaching in colleges and universities is widespread in Chinese universities, affecting the cultivation of innovation ability and practical ability of undergraduates [6,7,8]. At the meantime, China has vigorously promoted the construction of an innovation-oriented country and ecological civilization. The State Council and the relevant

ministries have also put forward the policies and/or action planning such as "Ecological Water Conservancy", "Digital Water Conservancy". Therefore, the cultivation of students in Hydraulic Engineering must adapt to the new situations and actively respond to the requirements of the national sustainable development strategy and the needs of the water industry by enhancing practical field teaching, improving teaching approaches, and promoting high quality teaching systems [9,10,11].

In view of the problems existing in the training of talents in Hydraulic Engineering under the new situations of China, Chang'an University of China took its advantages of scientific research in Hydraulic Engineering and Geological Resources and established a comprehensive education system for the cultivation of talented students in Hydraulic Engineering. This system was built up to meet the national and international requirements of sustainable water and ecological development. Based on national key discipline program and national outstanding engineer program, Chang'an University proposed an innovative talent cultivation concept which put great emphasis on theoretical basis, practice and innovation ability of students that are important for future development.

This paper introduced the establishment of the education system for cultivating talented students in Hydraulic Engineering at Chang'an University, and the application and achievements of this system were also interpreted. The experience from Chang'an University is believed useful for national and international education in Hydraulic Engineering and other related disciplines.

2. Establishment of the System

The cultivation system established by Chang'an University includes three main parts: updating education concept, establishing integrated practical training system, and improving teaching approaches. The four parts of the education system closely related with each other, making the system a comprehensive one.

2.1. Updating Education Concept

With the buildup of the national characteristic specialty and the national excellent engineer programs, a new education concept was proposed. This new education concept aimed at enhancing the ability of students in practical work and in scientific research. The new concept put great emphasis on the fundamental knowledge required for a talented student who should acquire strong practical skills and scientific research ability while graduating. To fulfill this aim, three different types of students will be cultivated: science-oriented students, technique-oriented students and application-oriented students. The science-oriented students are those who have solid theoretical basis that is critical for scientific research. These students will go even further with their studies as master students and even doctoral students. They will devote themselves to science after graduation. The technique-oriented students are those students who are trained as technical engineers. These students will get a lot of training during their college studies so that they will acquire enough knowledge of advanced techniques and after graduation they will become technical engineers. They, of course, may also go further with their studies to become technique-based researchers. The application-oriented students, on the contrary, may get enough education in technology. They will find a job after graduation and may not go even further with their graduate studies. These students are selected based on their interests and their abilities and levels of intelligence.

2.2. Establishing Integrated Practical Training System

Establishing integrated practical training system is the core of the innovative education system [12], as all three types of the students need adequate practical training so that they will acquire necessary experience and knowledge in research and technical activities. A multi-step 4S practical teaching system was constructed with innovation ability cultivation as the main aim. A comprehensive practical teaching platform which covers practice base, in-situ experimental field, demonstration center and professional key laboratories was constructed.

Practice teaching is of great importance to the improvement of undergraduate teaching quality and the cultivation of talents, and it is also an indispensable part in cultivating students' innovative consciousness, practical ability and engineering quality [13,14]. Through the integration of internal resources and cooperation with the relevant institutes, our university has built three experimental bases including a multi-functional rainfall hall, a hydraulic laboratory, and a water resources and

environmental experiment center. In addition, two in situ test fields, one in the Weishui Campus and another in Ordos city, and three practice teaching bases: Liangshan practice teaching base for geology and, Lantian practice teaching base for hydrology and hydrogeology. To render students enough practical opportunities, the university has also signed agreements with Jinghuiqu Irrigation Management Bureau, Xi'an Water Group, Qinghai Environmental Geological Exploration Bureau and other enterprises and institutes to establish out-campus practical training bases.

Based on above experimental and practical bases, a practice training system was established to keep pace with the theoretical teaching. In the theoretical teaching framework, 23% of the scores have to be obtained by taking the practical training courses. The practical training courses cover in-class experiment, preliminary introduction training to discipline, course practice, graduation design, innovation practice and others. This practical training system was set up to cover the four years of study so that the theoretical knowledge learnt from the classes can be readily transformed into technical skills.

2.3. Improving Teaching Approaches

During the practice teaching, advanced techniques are used instead of old techniques. For example, digital mapping, 3S techniques, Google Earth were all adopted in the practice teaching. The simulation education is greatly improved after some new devices and software are adopted. This enhances the understanding of students to hydrological processes, providing students with support for innovative ideas. The water resources system simulation laboratory is built, and is mainly used in the field of hydrological forecasting, reservoir regulation, water resources planning and risk management, groundwater pollution simulation, groundwater vulnerability management.

In addition, teachers are required to use more videos, physical models, Google Earth, and other auxiliary ways to directly guide students to understand the application of the professional knowledge in engineering practices. At the same time, more case studies are required for professional courses such as hydrological statistics, hydrology, groundwater dynamics, water resources investigation and evaluation, water resources planning, geotechnical investigation, water resources system analysis, economy of water resources engineering, water resources utilization to show students the application of book knowledge in actual cases. An easy way to comply with the journal paper formatting requirements is to use this document as a template and simply type your text into it.

3. Application and Achievements

The updated educational system has been applied in Chang'an University for over 4 years. Graduates in Hydraulic Engineering are becoming more capable of adapting to social needs with higher innovation and practical ability. The system or the theory have been adopted by over 30 Chinese colleges and universities, and are highly praised by experts [12]. After application of such an updated system in the university, the following achievements have been obtained.

3.1. The Quality of Student is Significantly Improved

Since 2004, 18 students in Hydraulic Engineering have received the reward for outstanding thesis of bachelor's degree [15]. Several student teams have won the National and Provincial "Challenge Cup" competition prizes. In addition, 7 National College Students Innovation Training Programs have been granted second prizes for the excellent achievements, and students have also published more than 20 research papers [15].

3.2. Maintain a High Employment Rate with Satisfying Qualification

Obtaining a high employment rate of graduates is sometime the biggest goal of many universities, and the students' employment expectations are considered a vary important factor in alleviating graduate unemployment in China [16]. With the updated educational system of Chang'an University, the employment rate of the graduates in Hydraulic Engineering remains at about 93% over the past 10 years, which is higher than the average rate of this discipline over China. According to the survey, the employers are satisfied with our students. They thought that the knowledge structure of our graduates was reasonable (33% very satisfied, 67% satisfied) with high practical ability (54% satisfied, 46% satisfied) and innovation ability (33% very satisfied, 67% satisfied) [12].

3.3. The Discipline was Further Promoted

Since the application of the system in Chang'an University, the discipline has been further developed. The major of Hydrology and Water Resources Engineering has been selected as a provincial level key major in Shaanxi Province. It is also selected as a national characteristic major. The major of Groundwater Science and Engineering is selected as an excellent engineer cultivation program which is the only one in this discipline over the whole country. This discipline has also been approved by the national education committee as the "111 Talent Introduction Base" [12].

3.4. Remarkable Achievements have Been Obtained in Curriculum and Text Books

Since the application of the system in our university, there have been many courses selected as national and provincial excellent courses [12]. For example, the course Water and Human has been selected as a national excellent course, and there still are 3 courses selected as provincial excellent courses including Hydrogeochemistry, General Hydrogeology and Introduction to Earth Sciences [12]. Besides, 4 courses are selected as university level excellent courses including Engineering Hydrology, Groundwater Dynamics, Hydraulics and Applied Hydrogeology. There are also one provincial teaching group, 2 in situ test sites, a talent training innovation experimental area and a provincial Experimental Teaching Demonstration Center in this discipline [12]. Text books authored or edited by the teachers have been widely adopted for teaching purposes in over 20 colleges and

universities, especially, the textbook "hydrogeochemistry" won the first prize in Shaanxi Province for its excellence [17].

3.5. Exchanges of the Experience

The experience was exchanged with experts three times in the Education Commission annual meetings from 2012 to 2015, and the experience and achievements are highly recognized by experts attending the meetings. Especially, in 2015 a national seminar of teaching in Groundwater Science and Engineering was held in our university, indicating the national recognition to our achievements. During that seminar, over 50 experts from more than 20 colleges and universities gave high marks on our achievements. In addition, experts from China University of Geosciences, Nanjing University, Jilin University, University of Toronto, University of Arizona and others visit our university each year to exchange the experience in teaching and researching.

3.6. The Improvement and Enhancement of the Teaching Team

For higher education, the improvement and enhancement of the teaching team is of great importance, because the shortage of qualified teachers will harm the educational system [18]. Since 2007, in order to comprehensively improve the undergraduate teaching level, more than 10 new teachers who have obtained Ph.D. in hydrology related disciplines have been introduced from the domestic and international famous universities. Furthermore, supported by the national talent introduction programs, a one-thousand-plan scientist and a Yangtze River Scholar professor have been introduced to the university [12,15]. Three professors have been awarded the one-hundred-plan professors, and another 2 have been awarded as the Youth Stars in Science and Technology of Shaanxi Province. Overall, a high level teaching team has been formed, which is critical for high standard teaching program.

4. Final Remarks

Facing some new situations, the cultivation of students in hydraulic engineering of China must adapt to the new situations and actively respond to the requirements of the national sustainable development strategy and the needs of the water industry by enhancing practical field teaching, improving teaching approaches, and promoting high quality teaching systems.

The updated educational system established at Chang'an University is much more comprehensive than the traditional ones. The updated system is advantageous in updated education concept, integrated practical training system, and improved teaching approaches. After implementation in the university, great achievements have been obtained. These achievements, such as higher quality of graduated students, further promoted discipline, wide exchanges of the experience and enhanced teaching team, have in turn improved the quality of education. This system can be helpful and referential for student education in other universities.

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