Investigation and Implementation of Practical Teaching in Higher Education Institutes

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CONTEXT
The development of effective teaching practices at the university level is important for cultivating an innovative spirit in the student body, for encouraging the development of practical skills in students, and for improving the overall quality of students.

PURPOSE
Due to the problems that exist with current teaching practices and the requirements of innovative talent training in institutions of higher education, this study will explore and discuss the basic concepts and approaches to reforming teaching practices at the university level.

APPROACH
In order to achieve this, a scientific experimental teaching system will be constructed, in which experimental teaching content will be integrated. Then, experimental teaching models will be designed to demonstrate how it may be possible to develop professionally qualified faculty and staff members. Next, the projected effects of the experimental teaching management system will be analysed.

RESULTS
We established an assurance system that would be used to scientifically assess the feasibility of the quality of teaching practices. An evaluation system would be developed to analyse the effects of improved teaching practices as it relates to the cultivation of talent.

CONCLUSIONS
Experimental teaching should be promoted. It is necessary to construct an innovative thinking model that combines theoretical knowledge and technical innovation with production, and which promotes the cultivation of innovative talents. An experimental teaching system can be formed from the exploration and implementation of an open-style talent cultivation system. Experimental teaching that is taught in a step-by-step manner, beginning with basic professional training, and followed by professional technical training, experimental production training, and the implementation of technological innovations should be promoted. Based on the cultivation model that is closely integrated at the industrial, academic, and research levels, it is necessary to construct an innovative thinking model that combines theoretical knowledge and technical innovation with production, and which promotes the cultivation of innovative talents.

KEYWORDS
experimental teaching, cultivating talent, evaluation methods.

Introduction

Experimental teaching plays an important role in the cultivation of talent in higher education. It plays a crucial part in improving the overall quality of students, and in cultivating awareness and innovative ability among students (Rong et al., 2011). China's Minister of Education, Ji Zhou, pointed out at the Second National Undergraduate Teaching Working Conference of higher education institutions that "Knowledge comes with practice. Abilities also come with practice, which is even more essential for cultivating quality (Deng & Chen, 2014). Every single aspect of experimental teaching is especially important for cultivating the practical and innovative abilities in students, especially in the growth of university students. In order to cultivate talents, we must pay attention to experimental teaching" (Jung, 2008).

Presently, the experimental teaching curriculum in higher education institutions is based upon a professional teaching plan that addresses the following three areas: experiment, course practice, and graduation practice. The experiment component of the plan is primarily developed in combination with theories. The experiment class itself is only conducted during a certain time period, which is specified in the teaching plan. In most cases, the experimental methods are introduced by teachers. Then, the students follow the plan provided by teachers and complete the experimental operation following a step-by-step procedure that starts with the same experiment content and ends with the same result. Although students are accustomed to participating in the experimental teaching activities, in practice, students learn in a passive state, where students who take initiative and demonstrate enthusiasm in learning are restricted, while students who do not take initiative to actively participate in experiments are rewarded. In this situation, although the cultivation of research skills is emphasized, these kinds of research skills can only be viewed in terms of the technical skills that are taught in the form of knowledge (Kang, 2009). In this case, the emphasis of research skills over creative thinking results in the lack of the cultivation of innovative-thinking skills among students.

Existing problems in experimental teaching

Outdated teaching methods

Although a series of reforms in teaching content, curriculums, and existing teaching methods has been introduced to schools, the implementation systems are still relatively simple. First, classroom management is very rigid and bureaucratic, which negatively affects the innovativeness, enthusiasm, and creativity of students. For instance, prior to the beginning of an experiment, teachers will review the details of the experiment, the operation methods to be followed, the report format, and the expected results (Zhang, 2005). Students will complete the content as required by the teaching syllabus and will master the basic principles and methods, but will do so all within the scope and plan as designed by the teachers. The whole process is completed in a robotic way that limits creative thinking in students. Once students no longer have access to their teachers' guidance, they often do not know how to proceed if further instructions are not provided. Such a system is not conducive to the cultivation of an innovative spirit in students (Hong, 2005).

Insufficient attention paid to experimental teaching

The low emphasis on experimental teaching is demonstrated primarily in two ways. First, the mindset of the traditional "exam-oriented" education has led to the concept of theoretical teaching, which suggests that academic, experimental teaching is only a component of theoretical teaching (Zhang, 2011). Experimental teaching can be considered as the verification of rational understanding that is attached to theoretical teaching. The quality of education in schools is assessed primarily according to how well students can master theories, but does not take into account the role of a student's practical abilities. Therefore,

less learning time is allocated to experimental courses. Second, experimental teaching is relatively more challenging than theoretical teaching. Experimental teaching not only necessitates that students have access to teaching materials, but also to tangible materials. In order to achieve this, internal communication with other departments is needed, as well as collaboration with other external units in experimental teaching. Furthermore, organizational tasks in experimental teaching are more complex. From the design and preparation of an experiment to the experiment's report approval, the complexity of the logistics involved in conducting experiments in field teaching requires a great amount of organization. Moreover, other challenges affect the implementation of experimental teaching, such as the trials involved in managing students, the difficulty in acquiring basic necessities, the need to ensure that safety precautions are taken, the arrangement of the practice guidance outline, and the establishment of a well-coordinated relationship with the practice unit. Therefore, some teachers are afraid of the possible troubles they will encounter, and will try to avoid engaging in experimental teaching or will simply opt out from doing so. As a result, certain teachers implement experimental teaching in a cursory manner, without taking initiative or thoroughly following through with any part of the process.

Lack of experimental teaching spirit in teachers and unreasonable team structure of full time experimental teachers

In recent years, due to an increase in enrollment, the workload of teachers has increased. As a result, many teachers have adopted the traditional teaching method in order to accomplish the teaching tasks handed to them by schools without devoting much effort to exploring the models and methods necessary to cultivate innovative talents. Lack of innovation awareness in teachers will be unlikely to lead to any results in innovative teaching or breakthroughs in scientific research. Full-time experimental teachers are the predominant implementers of experimental teaching. At present, schools focus more on the credentials, knowledge, and professional titles of teachers, and do not put much value on their experimental abilities. Compared to laboratory technicians, there are more training and development opportunities for teachers. The mindset that laboratory technician teams are "supplementary" is deeply rooted; many technicians with few credentials or who are not qualified for theoretical teaching are assigned laboratory work. Hence, an unreasonable credential structure is created, in which the overall quality is poor, and therefore, the quality of experimental teaching cannot be guaranteed.

Conflicts between graduation practice and employment, and the decline in the quality of graduation theses

Graduate work tests and expands upon the knowledge that has been acquired throughout four years of education at the undergraduate level, and is an integral part of experimental teaching (Ni & Liu, 2004). According to the educational structure at the graduate level, the graduation thesis is written during a student's eighth semester, when students are already busy with various kinds of employment-related activities, such as job seeking, and in participating in talent exchange workshops, supply and demand meetings, and in interviews. The high demand for talent in the job market results in lower standards when it comes to the establishment of minimum requirements for graduate theses. Consequently, a majority of students pass their graduation thesis defenses. The conflicts that exist between graduate work and employment have reduced the time needed for education at the graduate level and a lower quality of graduation theses.

Investigation of experimental teaching in Harbin Engineering University

Based on the feature of "three seas, one nuclear" strategy and its demand for expert talents in the related disciplines, Harbin Engineering University is committed to cultivating talent with

features specified in the “three seas, one nuclear” strategy while taking into account the needs of the regional economic development. This is accomplished by emphasizing basic theoretical studies, the development of practical skills, and the cultivation of an innovative spirit. To adapt to the need for talent in the twenty-first century, a talent cultivation model aimed at “achieving experimental teaching in a one-stop shop” has been formulated.

The Twelfth Five-Year Plan of Harbin Engineering University has proposed the construction of a professional system that offers specialized majors, which will be based upon the cultivation of innovative talents in order to develop a highly credentialed professional teaching team. The plan also calls for a breakthrough in high-level scientific research by following a basic path of connotation construction and development. Driven by system innovation that is based on creative thinking, research, and innovative development, the goal of constructing large-scale research-based universities that are aimed at training innovative-thinking professionals must be expedited.

Reform of experimental teaching

Change the concept of experimental teaching

Experimental teaching plays a crucial and unique role in cultivating innovative talents. Therefore, experimental teaching must be strengthened and improved to enhance practical skills in students and to foster their desire to create.

In the proposed teaching model, it is necessary to revolutionize the traditional concepts of teaching theories, teaching about how to make a living, and answering queries. Furthermore, the model sets out to expand experimental teaching with simple single-faceted theoretical verification and to cultivate practical skills in students in order to strengthen the innovative thinking skills. Moreover, the model aims to strike an appropriate point of equilibrium to bridge the relationship between theoretical and experimental teaching such that the functions of experimental teaching in the verification, supplementary, deepening. Considering the relationship between university requirements and personality development, the traditional teaching model of “prepare-explain-experiment-report” should be abandoned, and more attention should be paid to developing teaching activities that focus on cultivating students innovative-thinking skills.

Optimize the content of experimental teaching

In order to optimize the content of experimental teaching, the traditional empirical-type of experimental model should be reworked by introducing a variety of integrated experiments, substantially reducing empirical types of experiments, replacing basic measurement methods and formula verifications with demonstrative experiments, focusing on the establishment of the experiment outline and the planning of materials, and carefully deigning new integrated and designed types of experiments. It is necessary to ensure that advanced experiments accord with the most up-to-date research of each academic field. Furthermore, professional theories and skills should be consolidated, especially in terms of the sharing of teachers’ technological knowledge and the promotion of technical applications that may cultivate creativity among students.

Reform of experimental teaching methods

Next, it is necessary to replace rigid, procedural teaching methods with a heuristic, experimental teaching style so that students may be encouraged to engage in self-learning. As a result, students may be more inclined to design individual experiment projects using an independent experimental process, which may in turn foster academic discussions among their peers. At the same time, experiment evaluation methods should be revised so that experiments may be assessed separately in order to allow for various forms of examination and testing, with an emphasis placed on the development of practical skills, associative thinking, and a sense of creativity. Moreover, emphasis should be placed on the achievement of results throughout the course, rather than on results that are garnered

entirely from exams. Finally, full use should be made of the latest educational technologies, and multi-media teaching tools should be incorporated into experimental teaching.

Fully implement the open-style experimental management model

“Open-style” refers to the implementation of a 24-hour laboratory that will allow students to work on experiments anytime during normal work hours or in the evenings, which will in turn provide students with adequate time for conducting experiments. Practical problems are often produced in the specific situation, the problems in practice are often structured is poor, the need for information is not clear, the problem to solve the problem by the background of the restrictions, which requires good practice strategy. The practice of teaching in colleges at present, some student’s do things went above, is the lack of practical strategies of performance. Therefore, in the practice of teaching, to increase the time of independent practice, improve the ability of students. In order to ensure the safety of experimental students, there will be the teacher on duty before 0 o’clock, more than 0 o’clock after the experiment to apply to the teacher on duty, if the experiment used electricity, fire and dangerous chemical reagents, the experiment cannot complete at night. The laboratory teachers will regularly check the laboratory, on the one hand to guide students to work, On the other hand, teachers check laboratory security risks, to ensure the smooth progress of the experiment.

Open content encourages students to make use of their leisure so that they may perform experiments or create small electronic projects that are of interest to them. Scientific and technological innovation activities in the laboratory to establish a system of financial support and management system, regularly take out funds as college students for scientific research and development of science and technology funds. Support and encourage popular extracurricular science and technology activities, and focus on funding for students and potential projects; teacher allow the students' scientific and technological innovation activities for independent research projects, research teachers encourage college students to participate in; be awarded to students of scientific research, students' scientific research and the research and assessment of such hook. In order to stimulate technological innovation and enthusiasm of College Students.

An improvement in the management of the open-style experimental method will increase equipment and laboratory usage. Furthermore, it is important to introducing open-style training sites and design exercises for students to complete within a certain period of time after the completion of a course. This will promote independent practice and critical thinking skills in students. The ultimate goal of an experimental class is to discourage students from functioning in a “robotic manner”; in other words, to guard against the tendency for students to become strict rule-followers who complete their assigned tasks for the sake of getting the job done. Rather, the hope is that through experimental teaching, students will be trained to actively identify and resolve problems and ultimately, to develop their independent critical thinking skills, as well as their practical skills.

Build an innovative training room

In order to cultivate academic research and investigation habits and skills in students, innovation awareness in scientific research needs and innovative thinking skills need to be cultivated. Furthermore, in-class learning should be supplemented with extracurricular activities. Hence, students will play a major role in learning activities and practical skills will be improved, which will consequently foster the development of an organic combination of theoretical knowledge and innovative teaching that will enable teaching content to keep pace with developments in new theories, technologies, skills, and materials

Cultivation of innovative abilities

Next, the full utilization of the advantages of Control Science and Control Engineering should be promoted, which refers to the key disciplines specified in the 211 Project. Particularly

close attention should be paid to the important roles that scientific projects can play in the cultivation of innovative talents and scientific research skills in teachers. Moreover, there should be a focus on the cultivation of scientific research skills in students. All professional teachers should be required to participate in scientific research work and actively commit to national and provincial research projects. Furthermore, the achievement of advanced scientific research results should be encouraged, and academic collaboration with prestigious domestic and foreign prestigious institutions should be sought to foster a strong academic atmosphere.

Investments in laboratory construction should be increased to improve the experimental teaching environment. Additionally, existing platforms for basic experimental teaching and experimental management should be optimized. Furthermore, more laboratories should be constructed, and professional teachers should be encouraged and supported to make their own equipment. Finally, the research and develop of unique teaching software that suit their experiments should be encouraged. Without compromising the sequence of development in regular experimental teaching, the laboratory should be fully available for students so that they may pursue creative extracurricular activities.

We promote the full utilization of the practice centers that are located in the engineering training center, which have consolidated teaching, research, practice, production, and business into one system in order to satisfy the needs of professional experimental teaching in Harbin Engineering University. Furthermore, these practice centers aim to promote creativity in students, optimize talent cultivation, and improve the effectiveness and quality of teaching instruction. A practical path has been created that can promote the exploration of industry, academia, and research in the majors offered at Harbin Engineering University and other related professions.

It is necessary to construct innovative laboratories for university students, to create new practice designs, strengthen experimental teaching, improve practical skills in students, and to promote an organic combination of theoretical knowledge, practical skills, and innovation qualities so that the teaching content can keep pace with development in new theories, new technologies, and new skills. If this is achieved, student awareness of scientific research innovations, can be cultivated, as well as their innovative thinking skills. This will lead to an organic fusion between in-class learning and extracurricular practice. As a result, students will be trained to play a major role in teaching activities.

Next, the establishment of an innovative education system and a reform of training plans should be conducted. Moreover, special attention should be paid to how theory may be put into practice in real-life situations. Additionally, the long-term cooperative relationships between Harbin Engineering University and the No. 701 Research Institute of CISC, No. 702 Research Institute, No. 703 Research Institute, No. 707 Research Institute, No. 712 Research Institute, China Aerospace Science and Technology Corporation, and China's 368 factories should be promoted. Harbin Engineering University should be encouraged to sign into joint agreements with the aforementioned units in the professional talent training plans, and should be sure to adhere to the missive to be employment-oriented and service-focused while targeting social needs that are based on the theme of cultivating innovative skills. The cultivation of innovative skills and the collaboration of industry, academia, and research should be promoted, and a particular emphasis should be placed on industry participation. Furthermore, practice factories should be built in schools for students to use.

Special attention should be given to experimental training in order to foster cooperation between industry and academia. Through further strengthening cooperation with Hebei Hanguang Heavy Industry Co. Ltd., Dalian Shipbuilding Industry Co. Ltd., Dalian Locomotive & Rolling Stock Factory, Dahua Group Co. Ltd., FAW Diesel Group and other units, a solid foundation can be established in experimental teaching. Enterprise technicians should visit campus to conduct experimental lectures to students in engineering courses in order to discuss the professional application of academic knowledge. On-site practice can deepen

students' understanding in the automation profession and its practical applications in production, which may in turn inspire students' interests in the profession while cultivating their ability to integrate theory and practice.

Next, students should be encouraged to develop their individual and collaborative skills. In order to achieve this, the unique and individual aptitudes of students should be identified and encouraged. With regards to the implementation of educational instruction, teachers should be encouraged to maneuver around students as they conduct their experiments. In teaching design and testing, teachers should focus on both ensuring consistency in instruction, while also remaining flexible in the classroom. Furthermore, the teacher should take into account the differences in the students' backgrounds, abilities, interests, and strengths in order to provide the best possible environment for individualized development. At the same time, teachers should explore the commonalities of students to promote their collective development and to encourage collaboration and teamwork.

Reform of experimental teaching evaluation methods

Experimental courses are primarily intended for the development of experimental skills and the cultivation of scientific aptitudes in students. The course evaluation and testing scheme are completely different than those presented in theory courses. A diversified evaluation scheme should be developed, especially for experimental teaching, which focuses on testing the overall qualities in students rather than assessing acquired knowledge. Therefore, the following evaluation system has been constructed, which is based on teaching practices conducted in recent years:

- The final score of the course is calculated based on percentage;
- Preparation work should account for 10% of the overall score. Teachers need to set up the experimental task for the following class period by the end of the that day's class period, and should randomly critique students' preparation reports and score the reports according to percentage of completion;
- Attendance in the experimental class, as well as health and safety compliance should account for 10% of the overall grade;
- Operation of experiments should account for 30% of the overall grade, which is subdivided into a) student participation (30%); b) techniques and degree of mastery in methods (50%); accuracy and reliability of experimental results (20%). A grade of excellent, good, fair, pass or fail will be given accordingly, subsequent to a comprehensive exam.
- Exercises should account for 30% of the overall grade. These exercises will ask students to accurately describe the experimental process and results. Based on students' understanding of and responses to the questions and their application of technical methods, a grade of excellent, good, fair, pass, or fail will be given accordingly.
- An experimental exam will account for 20% of the overall grade, which will include an examination of the design report and will show all the steps involved in the process, the degree of mastery achieved in the methods, and the reliability of the results; the same 5-tier grading system applies here.
- An additional bonus of no more than 10 points may be awarded to students who demonstrate outstanding achievement, but the percentage of students who may achieve this bonus may not exceed 3% of the total class size.

Specific measures to be taken in forming the teaching team

Implement accountability and improve the incentive mechanism

A mechanism should be established that requires undergraduate classes to be taught by professors and other personnel with senior titles. At the same time, an accountability system of the chief instructor of experimental teaching should be established. The chief instructor will

be responsible for the design of the experimental course and will provide guidance to ensure not only continuity between theoretical and experimental teaching, but also that professors and senior research personnel directly participate in experimental teaching.

The chief instructor plays a primary role in an experimental course, and is often assigned lab technicians. These technicians may either be permanent, temporary, or there may be a combination of both. Other instructors are hired on an appointment basis as recommended by the chief instructor in accordance with the design and content of the experiment. In addition, graduate students are employed as teaching assistants. This structure constitutes a comprehensive hierarchy of staff members involved in process of experimental teaching. Lab technicians are evaluated based on performance, and their workload and salary is specified when they are hired.

Strengthen exchanges and improve qualifications of the teaching team

It is essential to strengthen international collaboration in order to provide a high-quality education and a variety of diverse scientific resources for research. Students may learn from foreign advanced teaching methods and research ideas, which may in turn increase the recruitment of talented individuals and expand exchange platforms. Therefore, international intercollegiate and academic exchange platforms with prestigious international schools should be created. Furthermore, international talent exchange platforms promoting exchanges between teachers and students should be established, as well as international platforms intended for exchanges between high-quality foreign resources in order to promote collaboration and standardization. Moreover, the recruitment of outstanding professional leaders and professionals who possess an international vision and overseas educational background should be sought. Moreover, a profession-based talent training and dispatch system should be developed to improve the public school model that is based on professional international collaboration and exchange. Opportunities for creativity training and the development of lab personnel should be provided, encouraged, and supported. In particular, the core group of lab technicians should be encouraged to take continuing education classes while working and participating in on-the-job training. Moreover, experimental teachers should be encouraged to participate in domestic and foreign academic exchange activities. Further optimization of the credential structure and an improvement in the professional standard of the experimental teaching team should be pursued in order to build an experimental teaching team consisting of teachers and staff who are pioneers in management concepts, and who are collaborative, passionate about teaching, experts in experimental techniques, and bold in innovation.

Professors and industry experts should be recruited who are highly experienced leaders in the disciplines they teach and who can advise students in experiments related to their fields of expertise, so that clear and detailed information regarding the specific characteristics and advantages of Control Science subjects can be taught in a thorough manner. Teachers should be encouraged to bring scientific research results into the context of experimental teaching in order to enhance research and consequently ensure that the university maintains its unique status in Atmospheric Science subjects. Finally, the university should continue to optimize and stabilize the experimental teaching team by means of supplying jobs titles, focusing on strategies that encourage remuneration, providing awards and promotions, etc.

Assurance policies for experimental teaching reform

Leadership should be strengthened, and the development environment should be optimized. First, there should be a focus on unifying thinking, strengthening leadership, and orchestrating coordination in the development environment. Second, the formulation of development plans and the implementation of details that emphasize the project's objective, particularly the aim to strengthen the system and improve departmental coordination should be pursued in order to develop a harmonious environment for policy implementation. Finally, there should be an increase in investment and the promotion of effective collaboration.

Renew the concept of experimental teaching management and strengthen the experimental teaching process management

To develop a management system with complementary evaluation methods that are conducive to supporting a comprehensive pilot reform, conducive to providing a tranquil teaching environment for the teaching team, and conducive to the personal and overall development in students, it is necessary to establish a functional and strict experimental teaching management system that can encourage participation in exploratory experiments in the important areas of professional construction.

Adopt advanced management methods and create a novel management model for experimental teaching

Establish sound rules and regulations, improve teachers' business profiles, accelerate the construction of an experimental curriculum, and implement incentive mechanisms to facilitate an advanced management model and a scientific management system for experimental teaching and become the teaching and management model for cultivating talents.

Strengthen experimental teaching process management and improve the quality of experimental teaching

In order to strengthen the experimental teaching process management and to improve the quality of experimental teaching, the following objectives should be sought. First, teaching situations should be monitored and assessed for feasibility in each experimental teaching course. Next, experimental teaching outlines, weekly calendars, and teaching plans should be formulated. Furthermore, the teaching process and the quality of experimental teaching should be monitored by assigned personnel. The quality of undergraduate students should be strictly monitored. This should consist of the re-construction of the entire graduation design, including the graduation thesis proposal process, the mid-term exam, and the filing of the defense. Finally, the design quality of the graduation thesis, which is to be trialed by random committee members to ensure fair and effective review, should also be strictly monitored.

Establish an experimental teaching system

Based on the overall plan of the school and the actual situation of the college, it is necessary to steadily push forward the reform of experimental teaching. Reform should be people-oriented and conducive to certain development principles, and in which topics may be combined and adjusted to serve as starting points for the development of an innovative teaching team.

The expected goal of practical teaching reform

Experimental course content is arranged from whole to part, from the shallower to the deeper. Each module is linked together, for beginners guide to lay a solid foundation for each experiment can be completed in a clear way, every experiment is very rewarding; also can attract students to continue in-depth study, completed the final design. The laboratory opening great convenience to the students, through the early to attract students, greatly enhance the students' interest, improve students' innovative experiment enthusiasm, cultivate students' practical ability; handwritten log, report and test method to ensure the validity of the experiment, students will play a major role in learning activities and practical skills will be improved, which will consequently foster the development of an organic combination of theoretical knowledge and innovative teaching that will enable teaching content to keep pace with developments in new theories, technologies, skills, and materials.

Conclusion

Based on the school philosophy characteristics in the types of research and industry featured in Harbin Engineering University, cultivating talent should be the key focus, the goal being an improvement in educational quality, the coordination of development, the transmission of knowledge, and the improvement in training skills. Furthermore, the improvement in the quality and coordination of the construction of an experimental teaching system that promotes the increase in knowledge and the improvement in teaching skills should be fostered throughout the entire implementation process. An experimental teaching system can be formed from the exploration and implementation of an open-style talent cultivation system. Experimental teaching that is taught in a step-by-step manner, beginning with basic professional training, and followed by professional technical training, experimental production training, and the implementation of technological innovations should be promoted. Based on the cultivation model that is closely integrated at the industrial, academic, and research levels, it is necessary to construct an innovative thinking model that combines theoretical knowledge and technical innovation with production, and which promotes the cultivation of innovative talents.

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