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The "Multidimensional" Teaching Reform of Technical Basic Courses of Mechanical Major under the Background of Emerging Engineering

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Abstract: In order to cope with the impact of economic globalization and technological modernization, it is necessary to train "great craftsmen" and high-level applied talents with strong practical ability, innovative consciousness and competitiveness. It is an inevitable choice to optimize the major structure, strengthen the major characteristics and promote the development of connotation in order to strengthen the construction of emerging engineering major in colleges and universities. As an important basic course for mechanical major, multi-dimensional teaching reform is imperative. In this paper, in view of the problems existing in the current basic courses of mechanical major, such as the traditional teaching mode, backward teaching content and students' lack of engineering innovation ability, the specific measures for the "multi-dimensional" reform of the basic courses of mechanical major and the key points of the reform have been formed, which have solved many problems and puzzles in the teaching of the basic courses of mechanical major in undergraduate colleges. In addition, great innovation has been made in the teaching content and teaching methods, which provides a reference for the teaching reform of the basic technical courses of the emerging engineering machinery major in colleges and universities, and plays a role of demonstration or reference.

1. Introduction

Higher education in China is making rapid progress towards popularization, and international development is imperative. The only way for the development of higher education is to stabilize the scale, optimize the structure, strengthen the characteristics, pay attention to innovation, and take the connotative development path with quality enhancement as the core. The four functions of modern emerging engineering universities include talent cultivation, scientific research, social service and cultural inheritance and innovation, of which talent cultivation is the core one. It is an inevitable choice to optimize the major structure, strengthen the major characteristics and promote the development of connotation in order to strengthen the construction of emerging engineering major in colleges and universities [1-2]. The impact of economic globalization, internationalization of higher education and modernization of technology has made it the focus of local emerging

engineering colleges in China to cultivate talents. The serious disconnection between talent cultivation in colleges and universities and industry needs is mainly caused by the disconnection between the professional talent cultivation system based on discipline system in China's higher education and the occupation and post needs in universities of applied sciences. Therefore, it has become the consensus of local emerging engineering colleges to cultivate emerging engineering applied talents who meet the needs of local economic development and construction, have strong practical ability, innovative consciousness and competitiveness. The technical basic courses of mechanical major in emerging engineering colleges and universities mainly include mechanical drawing, theoretical mechanics, mechanics of materials, mechanical principle, mechanical parts, mechanical manufacturing foundation, CAD technology, etc., which are not only basic and theoretical, but also professional and engineering technical. Besides, the coverage of technical basic courses is constantly expanding with the progress of science and technology. Thus, whether the system and content of basic technical courses are reasonable is very important for consolidating basic knowledge and learning professional courses well. However, the main problem of the basic courses of mechanical major in China is the serious disconnection between the knowledge system and the real application. As a result, it is of great significance to speed up the research and practice of the "multidimensional" teaching reform of "project-oriented, formalized, dynamic, applied, video-oriented, networked" professional and technical basic courses.

2. Problems Existing in Technical Basic Courses of Mechanical Major in Emerging Engineering Universities

2.1. The Incompatibility between the Closed and Outdated Teaching Content and the Development of Subject Technology

In practice, technical basic courses are mostly set according to the traditional curriculum system, with many courses and many class hours, but the new courses of modern engineering technology can't be supplemented. In addition, the technical basic courses still pursue the integrity of the subject knowledge system. Most of the teaching materials draw lessons from each other and have the same content. They lack new theories, new processes, new technologies and new methods of modern engineering technology. The content is obsolete and lacks the characteristics of the times. The outdated and repeated contents of the system cannot be removed in time, let alone the task-driven teaching content combining project with project [3].

2.2. The Incompatibility between the Continuing Education Centered on Imparting Knowledge and the Education of Applying Innovation Ability

In practice, the teaching method of most basic courses of professional technology is still limited to one-way inculcation. The classroom is still the main place for imparting knowledge and is still in the cage of examination-oriented education. Students' passive learning leads to the suppression of their initiative and creativity in learning, which is not conducive to cultivating senior professionals who can adapt to modern society. Moreover, the disconnection between teaching, learning and application of professional basic courses seriously affects the cultivation and subsequent development of innovative and applied talents.

2.3. The Incompatibility between Traditional Formalized Teaching Means and the Development of Modern Multi-Dimensional Educational Technology

In practice, on the one hand, the course teaching depends on the teaching courseware, and lacks the image and language of teachers themselves, especially the step-by-step deduction on the blackboard, such as formula deduction, theoretical analysis, philosophical exposition, etc. On the other hand, the lack of formalized and dynamic design in the teaching courseware, and the lack of intuitive physical objects, physical models and other formalization and evolution process, dynamic movement process and other dynamic connecting with the theory, make it difficult to improve the teaching effect with pure theoretical teaching and empty PPT [4].

2.4. The Incompatibility between the Teaching Mode of Separating Theory from Practice and the Requirement of Modern Industrial High Technology on the Comprehensive Application Quality of Talents

In practice, most of the teaching experiments are simple and confirmatory without comprehensiveness and innovation, which makes students' initiative and enthusiasm suppressed. Besides, the outdated experimental instruments and equipment can't meet the needs of modern industrial high-tech experimental teaching. Moreover, there is insufficient specialized practical training combined with engineering practice, and a lack of seamless connection between the knowledge and ability of course teaching and the practical application of production.

3. Path to the Reform of Basic Courses of Machinery Major in Emerging Engineering Universities

3.1. Building a New Teaching System and Optimizing the Teaching Content

In view of the demand for talents in the machinery industry and in combination with the school-running philosophy of teaching application-oriented universities, a comprehensive revision of the training plan for the machinery major should be made to form a new curriculum standard for the basic course of machinery. With "application and service" as the theme, occupation demand as the orientation and ability training as the goal, the teaching content should be optimized based on the course characteristics and learning situation analysis, the "projectized" teaching module should be constructed, and the teaching system of basic courses for machinery major should be reconstructed to integrate, coordinate and optimize the content, clarify the division and positioning of each course, and deal with the complementary relationship of the content. The obsolete and repetitive contents should be deleted, and the new theory and technology of modern machinery should be expanded. The content design of "project-based" teaching and design training should be carried out, and the training of course engineering practice and innovation ability should be strengthened.

3.2. Constructing Formalized, Dynamic and Video Teaching Resources and Courseware for Mechanical Courses

Through the actual machine parts as a case to guide the teaching, students can really combine theory with practice and improve their application ability. Students should go out of the classroom, into life, into the model room and into the training base. The existing teaching model of the college should be used as a case to inspire students' thinking, the actual parts of the factory (auto and motorcycle industry) as a case to improve students' application ability, and the actual machine parts of the training center as a case to enhance students' intuition. Besides, a series of "materialized

resources" should be formed based on the three-dimensional modeling of three-dimensional CAD software [4]. A series of dynamic courseware such as evolution process, working process and production process of basic courses of each major should be constructed according to the characteristics of basic courses of each major. The students' professional perceptual knowledge and the combination of static and dynamic should be strengthened to improve the teaching effect of the basic courses of professional technology. The course content should be "fragmented" and a video-based micro-video of knowledge points should be produced as a video resource of an online open course platform, and a mixed online and offline teaching mode should be adopted to realize "student-centered" personalized teaching [5-6].

3.3. Building a Seamless Connection between Knowledge Ability Points and Practical Application Problems

The improvement of course application ability should be strengthened through the seamless connection between the theoretical knowledge ability point and the ability point to solve application problems. The practical application ability of students should be improved through processing course practice teaching: comprehensive experiment, comprehensive training (engineering training, course design, innovative design) and other ways. Students' innovative application ability should be improved through professional associations, professional accreditation (CAD, general lathe work), comprehensive competitions (comprehensive ability of engineering training, challenge cup) and innovative projects.

3.4. Constructing a New Teaching Method —— Guided by Improving Students' Practical Ability, as Shown in Figure 1.

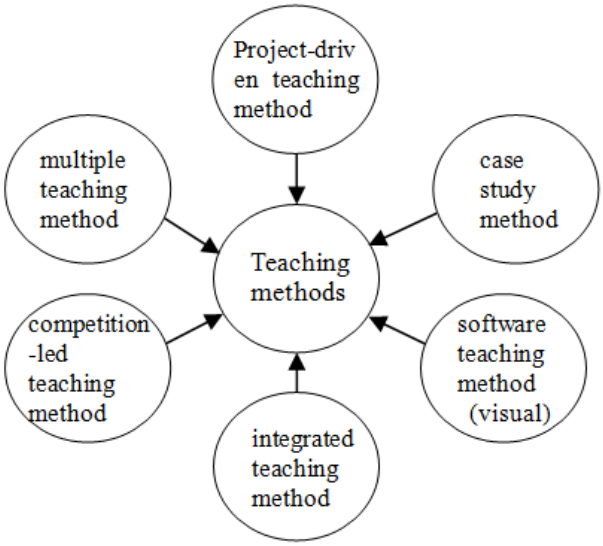

Figure 1: New teaching methods

3.4.1. Task-Driven Teaching Method

The setting of course content module is to construct the ask-driven "project-oriented" teaching masterstroke based on parts. The teaching process is: arranging tasks—analyzing tasks—completing tasks—mastering knowledge points.

3.4.2. Case Study Method

By integrating materialized resources, tapping "formalized" material resources, and taking actual machine parts as cases to guide teaching, students can truly combine theory with practice and improve their application ability.

3.4.3. Software Teaching Method (Visual)

Through the development of dynamic courseware, the creation of "visual" teaching resources, and the strengthening of "dynamic" teaching resources for the basic courses of mechanical technology, the students' professional perception will be enhanced, the combination of static and dynamic will be strengthened, and the teaching effect of the basic courses of professional technology will be improved.

3.4.4. Integrated Teaching Method

The integration of knowledge points in the same course-systematization of knowledge points. The integration of various courses-the cross integration of courses to achieve seamless connection. The integration of theoretical knowledge and practical application-the seamless connection between knowledge ability and application ability.

3.4.5. Competition-Led Teaching Method

By means of competition, learning and innovation can be promoted, advanced learning can be improved, and students' sense of competition and innovative application ability can be enhanced.

3.4.6. Multiple Teaching Method

In combination with the CAD Association, Invention Association, Mechanical and Electrical Engineering Application Technology Association in the college, and taking class instructors and project instructors as guide, a diversified teaching model of teaching and competition, project combination and online courses [7] is formed to strengthen the knowledge and ability after class.

4. Specific Measures for the "Multidimensional" Reform of the Technical Basic Courses of Mechanical major in Emerging Engineering Colleges

4.1. Optimizing the Teaching Content of the Basic Technology Course, Constructing the "Projectized" Teaching Thread of the Course and Reconstructing the Knowledge Points

According to the goal of applied talents, the adaptability between the knowledge ability of basic courses of machinery major and the knowledge ability requirements of applied talents should be deeply studied, the course teaching system and content should be adjusted and optimized, the content of modern engineering technology should be added, and the of task-driven "project-oriented" teaching masterstroke should be constructed, so that the teaching content can meet the development of modern industrial high-tech and the needs of applied talents.

4.2. Integrating the Materialized Resources of the Course of Technology Fundamentals and Exploiting the Formalized Resources of the Course ——Materialized Teaching Resources

In order to strengthen the perceptual knowledge of the course and improve the learning effect of the students, the materialized resources construction of the basic course of mechanical technology is

strengthened according to the professional knowledge and ability requirements of the mechanical application talents. First, a complete engineering training center has been established to strengthen the combination of classroom and on-site training. Second, a complete showroom has been set up to strengthen the integration of theory and practice. Third, by means of professional software, simulation technology and media technology, a three-dimensional model of the basic course of professional technology has been made to enhance the material intuition and perceptual knowledge of the teaching content and strive to ensure the teaching effect of the course. Through the actual machine parts as a case in the course of Mechanical Drawing and CAD to guide the teaching, students can really combine theory with practice and improve their application ability. Students should go out of the classroom, into life, into the model room and into the training base.

The existing teaching model of the college has been used as a case to inspire students' thinking, the actual parts of the factory (auto and motorcycle industry) as a case to improve students' application ability, and the actual machine parts of the training center as a case to enhance students' intuition. Besides, a series of "materialized resources" have been formed based on the three-dimensional modeling of three-dimensional CAD software.

4.3. Developing Dynamic Courseware for Basic Technology Courses and Creating Dynamic Teaching Resources-Simulated Resources

Through the development of a series of dynamic courseware such as the evolution process, working process and production process of the basic courses of professional technology, such as the dynamic combination and assembly in Mechanical Drawing, the dynamics of casting process, cutting process, welding process and pressure processing process in Fundamentals of Mechanical Manufacturing, motion process of four-bar mechanism and motion process of gear train in Mechanical Principle, gear forming principles of mechanical parts, etc., the "dynamic" teaching resources of basic courses of mechanical technology have been strengthened, students' professional perceptual knowledge has been enhanced, the combination of static and dynamic has been strengthened, and the teaching effect of basic courses of professional technology has been improved. For example, the mechanical drawing course is difficult to understand just by teaching due to the students' lack of three-dimensional space and limited teaching examples, the use of three-dimensional CAD software to complete the construction and modeling of three-dimensional models helps students understand graphics and cultivate students' thinking in three-dimensional space. Moreover, the assembly and explosion of animation are formed by using three-dimensional software to help students understand the relationship between parts and assemblies and the drawing method (software teaching method runs through the whole mechanical drawing teaching cycle).

4.4. Speeding up the Construction of Video Resources for Basic Technology Courses and Optimizing the "Video" Teaching Resources of Courses-Fragmented Resources

According to the personnel training plan and the teaching syllabus, the knowledge points of the course chapters are fragmented to gradually form the course design of the teaching objectives, teaching design and methods, teaching activities and evaluation of the course chapters, and to form the fragmented content of the "MOOC" teaching content of the mechanical major courses [6]. In addition, the number of micro videos recorded in the course is determined and optimized according to the nature and requirements of the course, high-quality micro videos corresponding to the course content are recorded by using the online course construction platform of video production, and the high-quality fragmented video teaching resources of the course are finally formed through continuous modification and production. The construction of video resources of basic courses has been accelerated, and multi-dimensional teaching resources have been used to implement online

and offline blended teaching, and the first-class courses and golden courses have been built continuously [8-9].

4.5. Strengthening the Combination of Theory and Practice in the Course of Basic Technology and Setting up "Applied" Teaching Scenarios of the Course —— Applying Seamless Connection Plan

Adhering to the combination of theory and practice, and through the seamless connection of theoretical knowledge and application problem solving ability, the course application ability has been strengthened. Through the practical teaching of processing courses: comprehensive experiment and comprehensive training (engineering training, curriculum design and innovative design), students' practical application ability has been improved [10]. Students' innovative application ability has been improved through professional associations, professional accreditation (CAD, general lathe work), comprehensive competitions (engineering training, finished drawing, challenge cup, Internet plus) and innovative projects.

5. The Key Points of "Multi-dimensional" Reform in the Technical Basic Course of Mechanical Major in Emerging Engineering Colleges

5.1. Connotative Development of Curriculum Reform

In the "multi-dimensional" reform of the curriculum system, the teaching content includes three systems: theory, practice and occupation; the connotation of teaching focuses on the synchronization of knowledge and ability, the integration of theory and practice, and the connection with application. The teaching process includes lectures, activities, and class production.

5.2. Diversified Combination of Teaching Resources

The "multi-dimensional" reform of the basic course system of mechanical technology mainly includes: "projectization"-task-driven teaching resources combined with production practice, "formalization"-teaching resources such as objects, models, three-dimensional graphics, pictures, intuitive language combined with teaching content, "dynamics"-teaching resources to simulate the evolution process of simulation or the working movement process, "application"-connecting knowledge ability with talent requirements, the combination of teaching content and project, classroom teaching and practical problems, experiment and innovative application simultaneously, the combination of training and production. "Videoization"-With students as the main body and teaching as the center, the "teaching" and "learning" are closely combined, and a "comprehensive three-dimensional" course sharing video resources with rich content, relatively complete, collection of text and pictures, two-dimensional and three-dimensional animation, video and other media materials as one, and illustrated with pictures, text, sound and images is constructed.

5.3. Integration of Theory and Practice in the Whole Process

Focusing on the whole process of teaching the basic course system of professional technology, the content is combined with the project, the theory is integrated with the practice, the classroom is integrated with the practice, the experiment and innovation are carried out simultaneously, and the training and production are integrated.

6. Conclusions

In this paper, starting from the cognitive theory and focusing on the cultivation of applied talents of machinery, the teaching content of the basic technical course system of mechanical major was optimized, the task-driven "project-based" teaching masterstroke was constructed, the "formalized" teaching resources of the course were excavated, the "dynamic" teaching courseware of the course was created, the "video" sharing resources of the course was optimized, and the "applied" teaching scene was set up. The "multi-dimensional" teaching reform of professional and technical basic course system has been realized, many problems and puzzles in the teaching of mechanical and technical basic courses in undergraduate colleges have been solved, and great innovations have been made in teaching contents and teaching methods, so as to maximize the teaching benefits. At the same time, it provides a reference for the teaching reform of the basic technical courses of the emerging engineering mechanical major and the creation of the gold courses, and also plays a demonstration or reference role.

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References

[1] Lin Jian. The Construction of China's Emerging Engineering Disciplines for the Future. Tsinghua Journal of Education, 2017, 38 (2): 26-35.
[2] Li Xiuhong, Li Wenhui. Reform of Basic Courses of Mechanical Majors under the Background of Emerging Engineering Education. Theory and Practice of Education, 2019 (3): 36-38.
[3] Bu Xiangfeng, Deng Jingquan. Exploration and Practice of Engineering Major Reform in Local Universities under the Background of "Emerging Engineering" Construction. Journal of Higher Education, 2018 (17): 136-141.
[4] Lin Lin. Research and Practice of Integrated Teaching ofmechanical drawing. Innovation of Mechanical and Electrical Education, 2019 (1): 103.
[5] Ding Qiao, Zhang Mengmei, Li Maosheng, Sun Yihong. Research and Practice on Student-Centered Mixed Teaching Mode in Mechanical Engineering Graphics. Journal of Graphics, 2018 (2): 362-366.
[6] Zhu Chaoying. Analysis of the Current Situation of Off-Line Teaching under the Background of "Suspension of Classes without Suspension of Learning" and Countermeasures. Vocational Education, 2020, 19 (11): 64-66.
[7] Tian Yu, Liu Yansong, Wang Na, Lu Lu. Research and Exploration on the Reform of Teaching Mode in Universities under the Internet plus Background. Higher Agricultural Education, 2021 (4): 92-98.
[8] Wang Ping, Shen Xiaoyang. Research on the Construction of "Mechanical Drawing and CAD" Course under the Background of First-Class Course Construction. Industry and Information Technology Education, 2021 (5): 28-32.
[9] Wu Yan. Building China's "Golden Course". China University Teaching, 2018 (12): 4-9.
[10] Chen Yue. Reflections of Engineering Practice Education under Background of Emerging Engineering Education: Challenges and Strategies. Journal of Nanjing University of Aeronautics and Astronautics (Social Science Edition), 2017, 19 (4): 89-91.