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Discussion on the Characteristics of Curriculum and Teaching Reform of Electromechanical Majors in Vocational College

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ABSTRACT. There are the following main characteristics of curriculum in electromechanical majors of vocational college: the more curricula with wide range scope and rapid change in their content, strong relevance of the knowledge points and strong requirements for experimental training. Based on the teaching reform practice of electromechanical majors in Wenzhou Vocational College of Science and Technology, the author puts out some proposals such as adjusting the training period, optimizing the curriculum system, innovating teaching methods and improving evaluation method to enhance and reinforce the teaching effectiveness.

KEYWORDS: Vocational college, Electromechanical majors, Characteristics of curriculum, Teaching reform

1. Introduction

The electromechanical majors are the traditional majors in the colleges and universities. They have always been known for their high employment rate and a strong social demand. Most of the vocational colleges in China have set up these majors for satisfying with the strong demand of the high-skilled talents for rapid development of the advanced manufacturing industry. However the history for most of the vocational colleges in China is not long, and it is using the curriculum and teaching method similar to undergraduate. Therefore it is important to carry out corresponding reforms of curriculum and teaching to build a new model of training electromechanical students [1-2].Combining with the teaching practice of electromechanical majors in Wenzhou Vocational College of Science and Technology, the author puts out some innovative proposals, which can be used as a reference for training highly skilled talents in higher vocational colleges.

2. The Characteristics of Curriculum and Students

2.1 Curriculum with a Wide Covering Range

The setting of electromechanical majors in vocational colleges in China is similar to undergraduate colleges, which can be summarized into three categories of mechanical engineering, electronic engineering and control technology[3]:mechanical specialty group includes mechanical design and manufacturing, mechanical design and automation, etc.; electronic specialty group includes electronic information engineering, communication engineering, applied electronics technology, etc.; control specialty group includes automation technology, material forming and control engineering, process equipment and control engineering. The most electromechanical majors are combined with both machinery and electricity, therefore their curriculum will involve multiple mechanical foundations, electronic and electrical, information technology courses, such as Engineering drawings, Mechanical foundations, Analog electronics, Digital electronics, Electrical control and PLC, Microcontroller technology, etc. And some integrate or highlight core courses are set up according to their respective professional characteristics. Because of wide coverage, much content and laying stress on the systematic and integrity in the curriculum of electromechanical in the vocational colleges, and too much basic theoretical content, it leads to theoretical overstatement and lack of practice. The academic system of higher vocational colleges in China is three years period that is shorter than that of undergraduate, and need to arrange more experimental training courses. Therefore, it is very important for training high-skilled mechanical and electrical talents by adjusting the curriculum content and reforming teaching methods for student to learn enough theoretical knowledge for their professional development in the limited theoretical classes.

2.2 The Content of Courses Rapidly Changing

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Electromechanical majors integrate with machine, electricity, light, liquid, computer and other technologies, which are rapidly developing. The content of various electromechanical courses is increasing and constantly updating, gradually develop towards intelligent, modular, networked, miniaturized, green and systematic. Taking traditional CNC machining technology as an example, more and more manufacturing-related courses are currently integrating with intelligent manufacture(rapid prototyping, additive manufacturing, etc.), automation manufacturing (industrial robotics, flexible manufacture systems, CAD/CAM integration technologies, etc.), special processing and micro-processing, and setting up independent courses to meet the continuous updating of advanced manufacture technology and equipment. Especially in the field of industrial robots, combined with the development requirements and trends of "Made in China 2025", some colleges are increasing their investment in curriculum construction and offer some new courses such as robotic mechanical systems, robot control technology, robot vision and sensing technology, industrial robot application and programming.

2.3 Strong Relevance of Knowledge Points

Taking the Mechanical Foundation (also called Mechanical Principle) course as an example, undergraduate colleges emphasize structural analysis and design, while higher vocational colleges focus on understanding various common institutions and mechanical parts. However, no matter what kind of vocational colleges and universities, the knowledge of the course generally begins with understanding the freedom of the plane mechanism, then conducts independent analysis on the linkage, cam, spiral, intermittent motion, gear and other institutions. Finally, the integration of various independent parts or components to form an operational machine. In this process, students need to understand the interrelationship of teaching content which is the weakest place for most students. At the same time, it is also found in the teaching that some basic knowledge has indeed been mentioned and mastered in the high school stage, but the in-depth learning of the subsequent derivative content is not good for most vocational students. Taking a typical gear as an example, the two gears meshing and its gear ratio calculation can have been mastered by most students, but there are fewer interested for students to study the subsequent gear shaping principle, manufacturing method and the meshing form change.

2.4 High Requirements for Experimental Training

The high-skilled training is highlighted in vocational colleges, which needs sufficient experimental training time and complete facilities and equipment. At present, the experimental conditions of electromechanical majors in vocational college are still backward. And the off-campus experimental training bases are not closely related to the course and cannot compensate for the lack of experimental conditions on campus. It affects students in the mastery of the essential skills. As the cross-integration of electromechanical majors is very strong, the requirements for teachers and students are very high. Teachers must teach both theory knowledge and practice skill. Students must learn electronics and electricity, as well as mechanics and control. At present, the most of full-time teachers of electromechanical majors in most higher vocational colleges specialize in theoretical teaching, but are not good at guiding practice, which affects the cultivation of students' high-tech application ability.

2.5 Characteristics of Students

Compared with students of undergraduate university, it is relatively low of the cultural basis of mechanical and electrical students in higher vocational college. According to the enrolment data of Wenzhou Vocational College of Science and Technology in 2018, the major with the highest score line is Software with 444 points ranking at 193648 and the major with the lowest score is Forestry with 364 points ranking at 219657 in Zhejiang province. The three professional majors of electro-mechanics, Motor and Electrical technology, Electrical Automation Technology, and Electronic Information Engineering have the score line with 400, 420, and 430 points, respectively, ranking at upper middle level of all 21 majors in the college (Table 1). Corresponding to the 261,000 candidates in Zhejiang province, those scores are lower. However, the student resources of higher vocational colleges not only recruited ordinary high school students through ordinary college entrance examinations, but also professional high school students recruited through counterpart examinations, as well as secondary or vocational secondary school students recruited through 3+2, 2+3 examinations, the knowledge structure of students is diversity. Therefore it is necessary to cultivate students through the education concept of "teaching according to aptitude of student" to promote the development of students' personality.

Table 1 Admission Scores Of Wenzhou Vocational College of Science and Technology in 2018

Name of major	Enrolments	Score line	Ranking

Seed Production and Management	35	401	217142
Facility Agriculture	30	295	219657
Horticulture	70	412	212092
Green Food Production and Inspection	100	405	215590
Animal Husbandry and Veterinary	72	422	207382
Garden Technology	45	410	213191
Forestry	20	364	229818
Animal Medicine	100	442	195568
Pet Care and Training	46	440	196498
Environmental Engineering Technology	50	418	209326
Landscape Engineering Technology	50	397	218871
Hydraulic Engineering	100	416	210325
Motor and Electrical Technology	74	400	217483
Electrical Automation Technology	50	420	208596
Food Processing Technology	35	404	215911
Food Quality and Safety	50	416	210492
Electronic Information Engineering	82	430	202771
Computer Network Technology	163	438	197747
Software Technology	90	444	193648
Digital Media Application Technology	84	433	200952
Financial Management	148	427	204249
Accounting	150	442	195478
International Business	70	423	206986
Chain Management	78	414	211353
Marketing	95	418	209290
E-commerce	86	435	199701

3. Some Proposals of Curriculum Optimization and Teaching Reform

3.1 Adjusting the Training Cycle of Talents

With the characteristics of higher vocational electromechanical major courses, adjusting the training period has become an important part of teaching reform. The author had surveyed the electromechanical majors of more than ten vocational colleges in Nanjing, Jiaxing, Lishui, Ningbo, Taizhou, Hangzhou, Shanghai, etc., and found that those colleges have developed the talent training program that places great emphasis on the cultivation and training of the practical ability of students. The main methods include conducting practice courses at the internal and external training bases during the training week, carrying out “order training” with the company jointly and completing the post-training internships in the counterpart enterprises. The course of training week is basically at the end of each semester. The order training and post-training internships are generally held in last year for a period of more than 3 months. The purpose is to allow students to have deeper understanding of the courses which have learned each semester, and on the other hand to allow students to adapt to the profession more quickly after graduated. However, when visited employment units and graduates, we found that it did not achieve the expected aims. Most graduates still need to work in the field for at least three months or more after they have taken up jobs. Therefore, we try to reform and arrange the enterprise time started from the second year. The time span can be 2 months or even the whole semester with follow-up by different teachers. Finally, corresponding course evaluation is completed with the comprehensive enterprise opinions. This approach will change the original 2+1 or 2+0.5+0.5 training period to 1+0.5+1+0.5 or a more flexible divergence mode. At the same time, the enterprise will hire the talented graduates with the higher salary by an audition and .The advantages of this mode is as follows: Firstly the students will get earlier and clearer contact with real experience, expand the knowledge space, and be able to understand the knowledge content of the subsequent courses according to their actual working experience feelings. Secondly, it will establish a “dual subject” mode of practical teaching with the joint efforts of colleges and enterprises. In this mode, enterprises not only provide advanced training equipment, but also participate in the process of the talent training, which can reduce the time and cost of staff training and improve their own benefits [4].Thirdly, it can enhance and stimulate learning the motivation and desire of students and let students be much clear the development direction and plan of career.

3.2 Optimizing the Curriculum System

Adapting to the above-mentioned adjustment of the talent training, as well as the characteristics of higher vocational electromechanical courses, it is necessary to adjust and optimize the curriculum system, and such adjustments mainly focus on curriculum integration and compress of teaching materials. Taking the motor technology major of my college as an example: integrating “Mechanical Drawing and AutoCAD” and “Three-dimensional Structural Design Technology” to enable the further study 3D drawing software on the basis of two-dimensional drawing; Integrating “Mechanical Design and Manufacturing” and “Electrical Manufacturing Process” to enable students to take typical electrical parts as an example to understand the complete process from design, manufacturing, craftwork to assembly; integrating “Tolerance and Measurement Technology” and “Mold Design and Manufacturing” to enable of grasping the essential role of precision requirements in the use of molds; integrating “Metal Technology” and “Electrical Materials” to enable of understanding the different roles of metal materials and electrical materials in machines and equipment. The benefits of curriculum integration are of course to strengthen the connection between different knowledge, avoid the frequent occurrence of duplicate content, and leave enough sap for students to develop practical skills. However, such a compression of course will inevitably affect the systematisms of knowledge. Therefore, there is the key point to precisely select teaching content and materials and use textbooks edited by teachers of college according to the characteristics of relevant majors. The streamlining of teaching materials is not an easy task. It requires a long period of experience accumulation and accurate grasping of teaching content. Based on principle of appropriateness, and the theoretical evidence should be relatively simple, practical and inspiring should be relatively more, and it should fully reflect the development situation of new technologies in the electromechanical industry.

3.3 Innovating the Teaching Methods

Innovation the teaching methods is crucial whether the reform achieve results [5-6]. Because the initial impression of students on traditional mechanical courses is boring, how to make them more vivid has always been the goal of educators. Traditional electrical courses (such as Analog Electronics, Digital Electronics, etc.) are generally based on formula derivation and calculation, most of the training courses involved in are the completion of demonstration experiments without innovation, so it is difficult to stimulate the interest of students. We had to try the following innovation of teaching methods: The first is to introduce the most up-to-date things that students are more interested in, such as drones, electric vehicle, 3D printing, virtual reality, artificial intelligence and other new technologies to stimulate attention and enthusiasm of student. The second is to try a variety of teaching modes, such as MOOC, WeChat, and non-training experiments. The third is to let the teachers of mechanical courses and electrical courses take a same course, and transform the “sub-disciplinary” into “integrated” course mode. This approach can not only pursue multidisciplinary integration and seek academic relevance, but also carry out a more comprehensive and multi-angle analysis around specific issues and applications. The fourth is to try to get students to “replace” the teacher, the so-called flip-classroom[7].This method also provides us with a new idea, that is, “encourage students to make mistakes”, and the teacher’s role has changed from “preachment” to “dissolvent”.it allows students to experience the process of producing mistakes, knowing mistakes and then correcting mistakes.

3.4 High-Skilled Training

The experiment and practice is the key link for training high-level skilled students in vocational college, which need to be matched with the high standards of the electromechanical experimental facilities and workshop, and jointly establish off-campus experimental bases with local well-known electromechanical enterprises. We should also pay attention to promote the construction of specialty through the development of skill competition and teaching resources, etc., and upgrade mutual use both the competition and teaching equipment, and design competition task as a teaching project, which can partially solve the shortage of resources in comprehensive training course teaching. It has been practiced the talent training mode,”instructor + project + team” for many years in Wenzhou Vocational College of Science and Technology. The projects consists of a student team, with full-time teachers as the instructors. The students try to apply the theoretical knowledge to the implementation i the project. It improves the ability to analyse and solve problems of students. The college also attaches great importance to the construction of the teaching staff by continuously improving the academic level and practical research ability in their professional fields, employing enterprise engineering and technical personnel with rich practical experience as part-time teachers, and building the training base of “double-qualified” teachers with local well-known enterprises such as Zhengtai Electric Group, encouraging the full-time teachers to exercise in the enterprise. There are attentions of the cultivation of humanities quality, professional ethics, psychological quality and educational quality of students as well.

4. Reform of Evaluation System

The theoretical examination is one of traditional and important way of assessment. Many colleges are actively promoting and implementing “procedural” assessment methods, which include the combination of open and closed

book, supplemented by process exams, practical exams, oral defences or paper work, etc. for comprehensively evaluating the learning effect [8]. However, those unified form of examination has certain drawbacks in considering of individuals. We try the assessment mainly based on the examination of skills certification, with the introduction of competition and contested mechanism for improving the entire evaluation system and taking the AutoCAD Drafter' Certification issued by the Ministry of Industry and Information Technology as an example. This is a "big test" with combination of two courses, engineering drawing and computer-aided design, which is not for all students. Some of The reserve players are only selected mainly based on the students' performance in the early and middle studying of the course. The reserve players aim in passing the draftsman assessment. The students finally obtained drafter certificate should be rated as excellent, others will be good or medium. On the surface, this approach may seem to be unfair because of not taking into account for the interests of all students. However, in terms of the author's observation, this practice had greatly improved the students' willingness to study newer and more knowledge, expand studying space. In addition, the above-mentioned class separation is a process that can be dynamically adjusted and it is also a process of survival of the fittest that can fully mobilize the enthusiasm of competition. The self-learning ability of some students is really stimulated in this process.

5. Conclusion

With very strong practicality and comprehensiveness, the electromechanical majors of higher vocational colleges are closely related to the innovation of the whole country and the development of the industry. It is an inevitable requirement to move to an innovative power from a manufacturing power for China by adapting the new situation and new requirements for the rapid development of China's modern manufacturing industry, cultivating innovative electromechanical technical and talents that meet the needs of the society. It is crucial to integrate the reform achievements of the electromechanical majors in various higher vocational colleges, focus on the needs of the employment market, improve the integration of "machinery" and "electricity" as much as possible, and effectively and appropriately adjust the talent training program. It has been proved that it is very effective to carry out reforms in terms of personnel training cycle, course materials, teaching methods, experimental training and evaluation system. And the relevant reform measures can be applied to the electromechanical majors in higher vocational colleges.

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