Reform of an *Automobile Electronic Control Technology* course based on a modern vocational education system

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ABSTRACT: At present, the *Automobile Electronic Control Technology* course delivered by higher vocational education (HVE) institutions in China has several problems, such as an unreasonable trainer structure, textbook content lagging behind new developments, weaknesses in practical training and unsystematic evaluation. These problems need to be addressed, as they have an impact on the extent of students' ability to master course content and their understanding of automobile fault occurrence and elimination. It also affects students' preparedness for employment, thus, indirectly affecting the automobile speciality's overall standing. In the context of these problems, which occur mainly in the teaching process, an industrial platform, training equipment and teaching standards were developed for students, and are presented in this article. A newly developed teaching system adequately meets the requirements of the three basic features of Modern Vocational Education System (MVES). The outcomes of the course reform demonstrate that it can enhance not only students' skills, but also the abilities of teachers.

INTRODUCTION

At present, automobile electronic devices account for over a quarter of the total cost of an automobile, and automobile electronic technology has reached the stage that optimises the overall human-automobile environment. There is a developing tendency towards ultra-miniature devices, ultra-high efficiency and ultra-low energy consumption [1].

With the applications of sensors and microcontrollers, the power, safety, comfort and the reliability of the automobile have been significantly improved. At the same time, automobile exhausts have come under scrutiny and have also been well controlled. The automobile has developed from the original pure mechanical product into a comprehensive product, one that is an integration of mechanical, electrical and hydraulic parts, thus, becoming an e-automobile.

Automobile Electronic Control Technology that builds on the basis of *Electrical and Electronic Technology*, *Automobile Structure, Automobile Electrical Equipment* and other courses, is a course taught in HVE colleges, and it combines traditional automobile structure principles and modern electronic technology.

This course covers modern automobile electronic control technology in regard to the structure, principles and fault diagnosis, and is a core course for capability training in the automobile speciality. As it is supposed to provide direct, practical techniques of enterprise production practice for HVE students when they graduate, it should be taught according to the actual demand for job capabilities by enterprises, and equip students with comprehensive skills for automobile fault diagnosis.

The graduates' occupational abilities should match the labour market demands and respond to the need for highly skilled personnel in the industry. The extent of students' mastery of course content, and their deep understanding of automobile fault formation and elimination, will directly affect their employability and employment outcomes and, thus, will indirectly affect the automobile speciality reputation [2].

CURRENT PROBLEMS

The rapid development of automobile electronic technology is not only bound to bring new challenges to automobile repair workers, but it also creates more substantial requirements and challenges for the students. Due to the dynamics and rapidity of this development, the traditional teaching mode, teaching textbooks, teaching system and teaching methods did not adapt well to the requirements of students' training.

Inadequate Teaching Team Structure

Because automobile technology began relatively late in China, speciality teachers with extensive experience were transferred from tractor speciality, machinery speciality or others. Those teachers, with tractor technology speciality and teaching ability, find it difficult to keep up with the developments in modern automobile electronic control technology and, therefore, are not able to pass on this knowledge to students. Also, as they are not fully conversant with new teaching methodologies, they do not teach modern automobile electric technology based on a sound pedagogical basis.

On the other hand, young HVE college teachers are mostly recruited from colleges and universities that practiced strictly disciplinary education and followed the traditional mode of education. As a result, these young teachers' abilities and perspectives tend to remain at the technical level acquired during their formal school education. They lack practical experience in enterprises, are not familiar with new technologies, do not possess new knowledge and skills required in the automobile industry and, thus, they cannot fully respond to the teaching pressures and demands of rapidly developing and changing automobile electronic control technology.

Outdated Textbook Content

Rapid changes in technology need to be reflected in textbook contents for college and university students. However, the process of publishing a textbook follows an established procedure that tends to be lengthy. The technology content compiled for textbooks by editors might be appropriate and up-to-date at the time of the compilation; however, parallel to proofreading, reviewing and publishing, the technology of automobile electronic control has been changing again, which makes it hard to incorporate the new content into an almost finished textbook, the content of which lags behind the latest, often crucial developments. This leads to the production of outdated textbooks, which do not reflect the latest achievements in automobile technology. There is anecdotal evidence that there is at least a five-year lag between textbook content and the current state of technology.

Weaknesses in Practical Teaching

The automobile speciality talent training scheme at HVE colleges specifies that students are required to have a strong practical ability for diagnosing actual automobile faults. It implies that automobile speciality classes should be equipped with adequate learning equipment for students to practice. As the cost of automobile speciality training equipment, training tools and other relevant facilities is relatively high, and the need to update faster than at other specialities, the financial requirements and pressures are much stronger than at other colleges. In addition, classes (i.e. training teams of students) are large and the number of teachers is inadequate, which has a negative impact on the current practical teaching approach, and intensifies other weaknesses, thereby, affecting the quality teaching/learning and the cultivation of talented graduates.

Unsystematic Evaluation System

Most Chinese HVE colleges have not yet adopted a three-combined evaluation (TCE) model, which creates a multifaceted structure for a project process evaluation combined with a final summative evaluation, a college evaluation combined with an enterprise evaluation, and a theoretical evaluation combined with a practical evaluation.

As a written (paper) examination is relatively simple and easy to execute, many courses use this form of examination, and do not embark on other tests that would identify students' practical abilities, which results in students focusing on learning the theory for the examination and ignoring the practical aspects of their studies. The pursuit of high marks for the examination does not have the effect of forming practical skills and, as such, does not benefit the students in the longer run. It may also hinder the development of students' personality and will not improve their employability.

In summary, teachers' professional standing may not be sufficient to arouse students' learning interest in automobile electronic control and textbooks do not keep up with modern, advanced technologies in the industry. What is more, students' preparedness for the course varies greatly, there are class time limitations, the evaluation system inadequate, all of which will affect graduates' ability for innovative thinking and problem-solving. They will not be able to meet the current requirements of enterprises.

AUTOMOBILE ELECTRONIC TECHNOLOGY REFORM STRATEGY BASED ON MVES

China's National Long-term Education Reform and Development Plan, 2010-2020 (the Plan) states that by 2020, China will form a Modern Vocational Education System (MVES) to adapt to the changing economic development mode and adjust to industrial restructuring, which reflects the concept of lifelong education, and a coordinated approach to the development of higher and secondary vocational education [3]. This indicates that China has

made a specific reference to the importance of MVES at the national level, and it requires that all vocational colleges must meet the MVES requirements and the expectation for renewed, higher quality vocational education.

Specifically, the MVES defined Plan needs to have three important features [4]. Firstly, it must have the capacity for external adaptability to the economic development pattern and industrial restructuring. The MVES must provide a talent base and intellectual support for local economic transformation and upgrading, and build the corresponding teaching standards so that enterprises can expect a certain standard of practice from an advanced, modern speciality, with graduates ready to work successfully in the industry.

The second feature is to have internal adaptability for lifelong education. The MVES must have a wide appeal, be people-oriented and promote lifelong development.

The third feature is to have an intrinsic coordination of the development of higher vocational colleges and secondary vocational schools. These are the means to realise the MVES. Vocational education needs space for development, and also has the right to do so. HVE should be based on secondary vocational education (SVE). They are two different vocational education levels within the same education type.

The reform of the automobile electronic control technology course based on the modern vocational education system also must abide by three important features. In regard to external adaptability, the course reform must place the student at the centre of the educational process, focus on a dynamic selection and editing of practice-oriented textbooks, which have to reflect the latest scientific and technological achievements in the automobile electronic technology.

The textbooks' content should be taught through practical projects or tasks based on enterprise's actual requirements. In regard to the internal adaptability, the course must have an inbuilt productive training base. The intrinsic coordination requires a reform of the current single teaching evaluation mechanism to allow for a systemic, multifaceted evaluation of students' learning outcomes.

Based on the above strategies, the automobile electronic control technology course teaching team at the Zhejiang Industry Polytechnic College conducted a reform of the course for student cohorts in 2011, 2012 and 2013.

COURSE REFORM BASED ON MVES

Depending on the Industry, Building the Platform

The Zhejiang Industry Polytechnic College is chair of the Society of Automobile Engineers of Shaoxing (SAE-SX), Zhejiang province, People's Republic of China. Members of SAE-SX come not only from universities, HVE colleges and SVE schools, but also from automobile 4S shops, maintenance enterprises at all levels (most of which are also speciality teaching base training members at the College), the Transportation Management Bureau of Shaoxing, the Traffic Bureau of Shaoxing, Shaoxing City Automobile Repair Industry Association and the Shaoxing City Business Association. SAE-SX has a good communications system and standardised operations; communication and cooperation among members is extensive, which provides a good platform for the course reform.

In addition, the College set up a Vocational Training Union of Shaoxing (VTU-SX), and there are many downstream industrial automobile enterprises in the Union. Regular training, mutual exchanges and cooperation among the members of VTU-SX can also advance course reform in the right direction, make it sustainable and relevant. The cooperation can assist in the revision of textbook materials and ensure that students are learning exactly what is required by business and also what the business is currently lacking and is in need of. In that way, the establishment of VTU-SX creates yet another platform for the course reform.

Reform Textbooks Materials to Adapt to New Technology Trends

According to the course reform process as shown in Figure 1, the course reform team investigated several enterprises, analysed their vocational occupation needs and discussed vocational abilities with automobile experts, then, the team summarised the typical enterprise's tasks in automobile electronic control technology [5], and designed a learning environment according to the typical tasks.

The automobile electronic control technology learning environment includes three main parts of an automobile, i.e. engine, chassis and automobile body systems, involving the vehicle's power performance, safety and comfort. Each learning environment unit has a complete work process, which is a real enterprises task.

To develop students' ability to apply the learned knowledge and skills to solve practical problems, students were grouped into a theory-practice integrated classroom, where they could learn by doing real things and solving real problems.

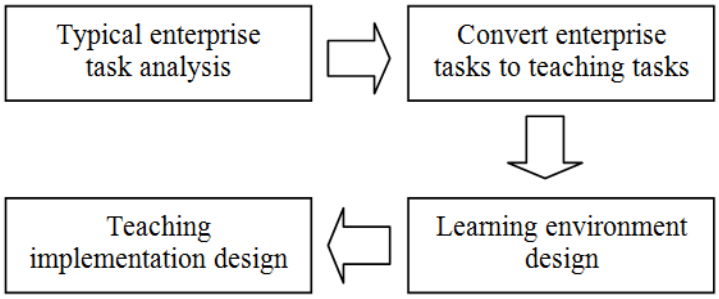

Figure 1: Course reform process.

Developing Training Equipment, Reflecting on Lifelong Education

According to the investigation's goals, the automobile electronic control technology course reform team researched and developed their own teaching equipment, which cannot be bought in the market, but is urgently needed by enterprises, such as EFI engine test benches, automatic transmission test benches, automatic air conditioning test benches, etc. Developing this equipment not only exercised the technical ability of teachers, but also it enabled them to further understand and practice the concept of lifelong learning, which in turn prepared them to educate students to become lifelong learners as well.

Improving Teaching Standards, Promoting the Coordinated Development of Vocational Education

Because of the diversification of HVE student cohorts, using a single mode of teaching evaluation might distort and one-sidedly evaluate student learning processes and outcomes. The automobile electronic control technology course team, based on the basic characteristics of HVE students, applied the TCE model; thus, focusing on different aspects in the overall evaluation, which allowed identification of highly skilled students with a variety of abilities relevant to the current automobile repair industry and its dynamic development.

In addition, in order to respond to students' lively interest in the Internet, the course team has also developed a course teaching Web site, on to which the team has uploaded teaching videos, automobile parts assembly animations and other multimedia materials. Embedding audio and video, combining static and dynamic materials have been beneficial to student learning and developing interest in the learned knowledge.

Attracting the attention of students through such forms as animation, fonts, colours and others, lectures can greatly improve the teaching effectiveness of the course. Moreover, in line with the diversity of student materials accessible on-line, the course Web site also includes an on-line FAQ channel. With the help of the campus Wi-Fi system, teachers and students can engage in discussions at any time and place, which limits or even eliminates teachers who only deliver static lectures, without student feedback. The Web site also has student self-test questions, so the students can personalise the learning program according to their individual differences, improve their learning efficiency and cultivate their ability for analysing and solving problems.

CONCLUSIONS

The automobile electronic control technology course reform team has achieved positive results, such as a continuous improvement in the graduate employment rate, and a high appraisal of students by several enterprises. Through this course reform, students have made a significant advance in their professional skill set, learned more about innovation, competition, national patent application, etc. An additional gain of the reform, is the enhancement of teachers' abilities and their preparedness to educate lifelong learners.

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