Teaching Innovation for the Course of Principles of Automotive Engine

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Abstract. According to the training objective of the university that “implements elite education, train elite talents”, this paper conducts some teaching innovations and practices for the course “principles of automotive engine”. For the teaching contents, the latest technologies and devices for modern automotive engines are introduced in detail to embody the advancement of the course. For the teaching methods, the research-oriented teaching mode is implemented to improve the practical and innovation abilities of students, which can also fully mobilize the enthusiasm of students. Finally, the exam pattern mainly concentrates on evaluating the comprehensive abilities of students. The evaluation and feedback of teaching quality shows that the innovations and practices can achieve better teaching results.

Introduction

Implementation of elite education and training of elite talents is the new requirements of the research universities personnel training with the development of higher education. Graduating from research universities with elite qualities are generally associated with higher wages, and those who attend such universities are both likely to graduate and to go on to post-graduate study. Hanley and Treiman [1] examined the recruitment into elite administrative and professional positions during the state-socialist period (1949-1988) in the following six Eastern European societies: Bulgaria, the Czech Republic, Hungary, Poland, Russia, and Slovakia. Zang [2] proposed an alternative approach, by emphasizing the role of functional differentiation and its effect on elite recruitment in China using a data set on top Chinese leaders. Ono [3] pointed out that the outcome of national university graduates resembled an elite perspective under which income differences arose from differences in ability. Rivera [4] had analyzed how elite professional service employers use and interpret educational credentials in real-life hiring decisions. The above researches indicate that elite education for higher education is very important.

As for China, a number of significant projects have been introduced into the management of higher education in recent years to create world-class universities. Among other initiatives, the state embarked upon two key programs, the “211” and “985” projects in the mid-1990s to subsidize a certain number of selected universities or disciplines to make them globally competitive [5]. With the rapid development of higher education, China has realized the change from the “elite” education to “popular” education. To confront the increasingly serious employment situation, and to optimize the allocation of human resources, it is urgent for the universities to cooperate to collect employment information and hold job fairs. Chinese political leaders also pay much attention on Chinese higher education [6]. Premier Wen Jiabao said “The whole world is talking about China's rise, and what the people talk about most is GDP. But I think China's rise lies in talents and education”. He also said an important aspect for China's higher-learning education reform is to encourage students' creative spirit and independent thinking, in a bid to foster more high-calibre talents. With the support of “985” and “211” projects and aiming to bring forth the spirit of innovation, Dalian University of Technology (DUT) is engaged in grasping the historic opportunity of rejuvenating the old northeastern industrial base, and carries out a talent-training strategy in the hope of building DUT into a world-famous and research-oriented university. In 2008, DUT held the 14th seminar on teaching and education and
issued the document “Several opinions on implementing elite education and cultivating elite talents of Dalian University of Technology” [7].

As a teacher in DUT, it’s my obligation to implement elite education in my work with a higher sense of responsibility and enthusiasm. To carry out the elite education and cultivate talents of the university, this paper presents the teaching innovation and practice for the course “principles of automotive engine”.

Introduction of the Course

The course “principles of automotive engine” is one of the key fundamental courses for automobile engineering, vehicle operation engineering and other auto-related professional students. It is an introductory course for other professionals to understand automobiles quickly. This course is designed to teach you the principles of automotive engine, including instruction on how to identify component functions, characteristics, and principles of operations of the two stroke, four stroke spark, compression ignition, and turbine engines, to include a comparison of gasoline and diesel system components. The course emphasizes technical training and development of skills through the study of the various systems and principles of the automobile engines. After learning this course, undergraduates own some technologies and theories to design, diagnose, manufacture and research automotive engines when they graduate from the university. At the same time, it is a course with very strong practicality. Therefore, practical training needs to be conducted to improve the undergraduate practice and innovation capacity using the theory combining with practice teaching method.

With the development of automotive industries and new technologies, continuous improvements of abilities of the workers have been enforced. They are expected to be adaptable to the new developments which strives the need for continuing efficiency in teaching of automotive technologies. Especially, incorporates project-based activities to understand the theoretical depth of the course, increases the success as measured by an assessment questionnaire at the end of the course program is helpful to enhance the teaching effects. Designing a curriculum for students from both physics and automotive mechanics classes resulted in collaboration, sharing their expertise and talents [8]. This paper objects to train students the spirits of collaboration and innovation.

Many universities are now offering this course for students from automobile engineering or internal combustion engines. When conducting the instruction, a certain amount of teaching experiences and methods have been accumulated. Some universities or colleges have constructed this course of principles of automotive engine into national, provincial or ministry level excellent course, such as Tsinghua University, Chang’An University and Shandong Jiaotong University etc. Commonly, the main contents of this course include the following parts.

Part A: the characteristics and principles of automotive engines. The students should identify the internal functions of selected components of spark and compression ignition and turbine internal combustion engines, especially for the four-stroke gasoline and diesel engines. At the same time, the students should follow the modern technology of automobile engine.

Part B: the fuel of the engine, fuel characteristics, some basic knowledge of combustion, combustion process for gasoline and diesel engine, fuel injection and atomization, the mixture formation and combustion chamber, as well as the factors affecting the combustion process. The students should master the basic knowledge of the fuel characteristics and combustion in the engine, the design requirements for combustion chamber for both gasoline and diesel engine.

Part C: Generation of engine emission and its hazard, main factors affecting emissions and how to control them, engine emission standards and testing, as well as engine noise sources and control. The students should analysis the main factors affecting the engine emission and know how to control emission and noise.

During the past five years, we mainly responsible for the undergraduate curriculum the principles of automotive engine and conduct some practices of teaching innovation for this course. The reform subjects are the junior students in our school during the teaching semesters from 2014 to 2015 and from 2015 to 2016.

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Contents Reflect Its Advancement of Automobile Engine Technology

The invention of the automobile has been past 100 years. A complete set of theoretical system for engine mixture formation, control of combustion and exhausts has been formed. More important, the automobile engine technology is in the form of continuous innovation and development. Especially in recent years, as the requirements of society increasing energy conservation and emission reduction, modern automobile engine technology has been developed rapidly. Contents of existing teaching materials cannot keep up with the content of these new technologies. Therefore, the contents of this course replenish some of the latest automobile engine technology, reflecting the advancement of the teaching content. The curriculum could reflect the latest scientific and technological achievements, results in expanding the knowledge of students and greatly improve the students’ interest in learning.

The contents of the course “principles of modern automobile engine” mainly concentrates on engine performance and characteristics, the basic working process of the mixture formation and combustion chamber, exhaust emissions and noise control. As to the arrangement of teaching contents, eliminating or simplifying the carburetor engine mixture formation, because some parts of the contents are outdated. While some of the latest technologies of modern engines are supplemented, such as gasoline direct injection (GDI) engine, homogeneous charge compression ignition (HCCI) engine, variable valve timing (VVT), high-pressure common rail injection diesel engine, etc. These new technologies combine the basic theory of modern electronic control technology with automobile engine, reflecting the development trends of the modern automobile engine.

Moreover, to help students better understand and master the principles of modern automobile engine, we pay much attention to the arrangement of teaching contents so as to embody the contrast of gasoline and diesel engines. These two kinds of engines are typical and generally used. In the teaching process, the gasoline and diesel mixture formation and combustion mode are introduced be the means of comparing with each other. Class discussions are organized to guide students to compare and analyze their superiorities and shortcomings, to encourage they think about whether the combination of gasoline and diesel engines is possible. After using the contrast arrangement teaching of the content, the novelty of the course is increased and the innovative thinking ability of student is trained.

Research-Oriented Teaching Mode

In order to increase the students’ initiative, a flexible teaching mode is utilized, such as group discussions, project guidance, research oriented. This can lead students to active learning, active thinking and active participate, and found the problem independently, analyze problems and solve the problem, so as to achieve the goal of accumulating knowledge, build capacity and improve the quality of teaching.

When teaching the engine working process, the students are encouraged to consider the reasons behind these phenomena on the basis of the description to explain the features and phenomena of the working process. Guide them to make use of specialized courses learned before and to conduct a comprehensive analysis. In such way, the students can own the ability to put forward all possible ways and means to achieve the optimal or desired target on engine performances.

In addition, in order to guide the students to participate in the teaching progress, the students are divided into different interest groups. They can utilize all extra-curricular time to prepare materials and design innovative practical projects, such as some of the new structure of the engine or new technology. The students can discuss and exchange opinions with students who are interested on those structures or technologies. Moreover, they can design or improve some parts of the engine or structures, which is helpful to improve students’ knowledge to solve practical problems. Table 1 displays some projects put forward for students during the teaching semester from 2014 to 2015 to do some researches and practices. Fig.1 shows the pictures that the students present their works in class.
Table 1. Some projects put forward for students to do some researches and practices.

<table>
<thead>
<tr>
<th>No</th>
<th>Item</th>
<th>Participant</th>
<th>Teaching objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Design an equipment or modify current used equipment to enhance the engine volumetric efficiency</td>
<td>Student No.1-6</td>
<td>To understand the engine volumetric efficiency and know how to enhance it through different approaches</td>
</tr>
<tr>
<td></td>
<td>Design an equipment to realize continuous variable of engine intake manifold length</td>
<td>Student No.7-12</td>
<td>To learn the principles of variable intake-air system</td>
</tr>
<tr>
<td>2</td>
<td>Realize the variable valve timing or lift control using different methods or equipments</td>
<td>Student No.13-18</td>
<td>To master the current variable valve timing systems and analyze their merits and demerits</td>
</tr>
<tr>
<td>3</td>
<td>Think over how to avoid detonation for gasoline engines</td>
<td>Student No.19-24</td>
<td>To understand factors affecting detonation and know how to avoid it through different approaches</td>
</tr>
<tr>
<td>4</td>
<td>Design a new type gasoline combustion chamber</td>
<td>Student No.25-30</td>
<td>To comprehend the requirements for the designing of gasoline combustion chamber</td>
</tr>
</tbody>
</table>

Figure 1. Students present their works in class.

As to the teaching methods, the multimedia teaching, on-the-spot teaching and the network-assisted teaching are combined to improve teaching effectiveness, which connect classroom and laboratory, curricular and extracurricular, theory and practice. Especially for those scenes that can not recur in the classroom, such as fuel combustion process, the work of the turbocharger, and so on, the multimedia animation is used. In that way, the vivid picture, colors and animation or image can reproduce the automotive engine structure and working process. The vision, hearing and other senses of students can be fully mobilized so that they can understand and master the engine basic theoretical knowledge, to stimulate students’ interests.

**Evaluation of the Students’ Comprehensive Ability**

This course mainly evaluates the students’ ability focusing on the everyday contribution and the final presentation of the designated project. Commonly, the assessment score distribution is roughly as follows: usually accounts for 20%, after-class practice operating result accounts for 40% and final presentation accounts for 40%. Unlike the previous assessment method according to the final exam, this way can relieve student’s pressure of final exam and encourage him to pay more attention to the study process.

Usually, everyday contribution of the course study process mainly depends on see the student’s attitude and the usual performance, for example, attendance, class assignment, and the enthusiasm and active participation in the class discussion.

After-class practice mainly evaluates the students’ practical abilities. The course of principles of automotive engine is a practical course and the final written examination cannot assess the students’ practical abilities. Therefore, the class is divided into different groups based on interest to complete a certain project, for example, the design of a certain device or adopt a certain technology for the engine to improve the mixture formation, how to save energy or reduce emissions. After class, they are required to submit a report and make representation in class. In order to complete the project successfully, each student is encouraging to active thinking instead of passive receiving. They need to
spend more time to search relevant information, analyzing the existing structure or technology. They can also discuss with each other. The interaction between students enhances the learning environment. In such way, the enthusiasm of student and initiative is fully mobilized, and can assess its practical ability.

Final examination or assessment of students can reflect the understanding of course of learning, teaching emphasis and difficulty of the course syllabus, as well as a comprehensive analysis of problem solving skills.

Discussion and Conclusion

The teaching method of the course “principles of automotive engine” is reformed and conducted through teaching contents, teaching methods, and assessment pattern. Evaluation and feedback from the students verify that we can achieve the teaching goals and is helpful to train the creative spirit and enhance the practical ability of students. Students show more interest and enthusiasm to the projects.

With the rapid development of automotive technology, the requirements for market-oriented employment of college graduates increase gradually. To stay in an invincible position under fierce market competition for enterprises, they need more elites with a certain amount of accumulation of knowledge and practical ability. The teaching innovation and practice for this course enables students to master the theoretical knowledge of the modern automotive engines. At the same time, their senses of innovation and abilities to integrate theory with practical can be improved, which is helpful to lay a solid theoretical foundation for them to work and scientific research engaged in automotive related fields after graduation.

References


