

# *Exploration of Automobile Engine Structure Course Reform under the Background of New Energy Vehicles Development*

Fayi Yan<sup>a,\*</sup>, Xinhai Li<sup>b</sup>, Zongxi Zhang<sup>c</sup>

*School of Mechanical and Electrical Engineering, Shandong Jianzhu University, Fengming Road, Jinan, China*

*<sup>a</sup>yanfayi@sdjzu.edu.cn, <sup>b</sup>lixinhai19@sdjzu.edu.cn, <sup>c</sup>zhangzongxi@sdjzu.edu.cn*

*\*Corresponding author*

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**Abstract:** Automotive engine structure is a compulsory and specialized course in the field of vehicle engineering, serving as a backbone course that connects the past courses and the future courses, laying a foundation for learning subsequent courses and engaging in automotive related work. Traditional automotive engine structure course cannot adapt to the current rapidly development situation of new energy vehicles and require teaching reform. This article analyzes the problems in the teaching of the automotive structure course, proposes to optimize the course content setting, add the teaching content of new energy vehicles, increase practical teaching, and improve the integration of industry, academia and research. The reform means can provide references for the cultivation of undergraduate talents in applied vehicle majors.

## 1. Introduction

Under the background of the current energy crisis and technological progress, new energy vehicles (NEVs) have been developing rapidly. The penetration rate of NEVs in China, or the proportion of NEVs in all car sales, rose to almost 30 percent in 2023, and the penetration rate of NEVs in the world also reached 22 percent [1]. The rapid development of NEVs has brought great impact on the curriculum of vehicle engineering majors, especially the curriculum of automobile engine construction.

New energy vehicles use clean energy as power, and their engine structure and working principle are significantly different from traditional fuel vehicles. The traditional automobile engine construction course often focuses on the technology of fuel vehicles and lacks in-depth explanation and practical operation of new energy vehicle technology [2]. Most of the current new energy vehicle curriculum reforms focus on the reform of battery, motor and controller courses, and pay little attention to the teaching reform of engine courses [3-5]. With the rapid development of new energy vehicle technology, the traditional automobile engine construction course has been unable to meet the current teaching needs.

This paper introduces relevant content on new energy vehicle technology through teaching reform, enabling students to have a more comprehensive understanding of the functions, structures, and working principles of automotive engines under the current background of new energy and new technologies. This helps to improve the professional literacy and practical ability of students majoring in vehicle engineering, cultivate applied vehicle professionals who are adaptable to the development trend of new energy vehicles, and enable them to better adapt to the needs of the automotive industry.

## **2. Problems in teaching the curriculum**

### **2.1 Aging of teaching content**

The textbooks and teaching contents of the automobile engine construction course are not updated in time to keep pace with the development of automobile science and technology. Some outdated or no longer used technologies in automobile, such as carburetor and traditional gasoline pumps, still occupy a lot of space in the textbooks. At the same time, the new technologies, techniques and methods of enterprises are not introduced into the teaching materials in time, which leads to a serious disconnect between teaching and the actual enterprises, and the lack of school-based teaching materials combined with the actual.

Secondly, the teaching equipment is limited and outdated, and cannot be used in conjunction with the textbook. This not only affects the relevance and operability of teaching, but also limits students' understanding and mastery of advanced automobile engine construction.

In addition, the teaching methods are relatively backward. The traditional teaching method usually relies on textbooks, blackboards, wall charts and teaching models, which lacks intuition and interactivity, making it difficult for students to understand the working process of automobile engine construction and the connection among automobile engine parts.

To sum up, the problem of aging teaching content of automobile engine construction is a multifaceted problem, which requires the joint efforts of textbook writers, educators and related organizations to update the teaching content in a timely manner and to introduce new teaching techniques and methods in order to improve the quality and effect of teaching. At the same time, it is also necessary to strengthen the cooperation with enterprises and introduce more actual cases and practical experience, so that the teaching can be closer to reality and more in line with the development needs of the automobile industry.

### **2.2 Outdated teaching methods**

Traditional automobile engine construction courses often focus on theoretical teaching and lack sufficient opportunities for practical operation, which makes it difficult for students to deeply understand and master the relevant knowledge. At the same time, due to the limitations of the teaching content and methods, students are often unable to get in touch with the latest technology and concepts of automobile engine construction in time.

In addition, the course mainly adopts the teacher's classroom teaching as the main focus, supplemented by students doing homework and answering questions after class. This approach weakens the differences in individual students' knowledge perception, resulting in limited interaction between students and teachers and a gradual weakening of students' interest in learning. Current teaching methods need to emphasize more on student participation and interaction and abandon the single mode of indoctrination. Therefore, it is important to address the course to ensure that it is aligned with professional development and exhibits unique characteristics. This means focusing not only on the transfer of knowledge, but also on the development of students' ability to

practically apply what they have learned to solve problems.

### **3. Course reform measures**

#### **3.1 Renewal of teaching content**

With the rapid development of automobile technology, the content of the traditional automobile engine construction course can no longer meet the current teaching needs. The supercharged engine is a new type of power system that combines the traditional engine with new energy technologies such as electric motors and battery packs.

First, plug-in hybrid engine: plug-in hybrid engine is one of the important technologies in the field of new energy vehicles, which combines the advantages of traditional engines and electric motors, and is characterized by high efficiency and environmental protection. The course content should cover the working principle of plug-in hybrid engine, energy management strategy, charging facilities and charging technology, and guide students to carry out relevant practical operations.

Secondly, the non-plug-in additive hybrid engine is another important form of power in new energy vehicles, which achieves the goal of high efficiency and energy saving by optimizing the collaborative work of the conventional engine and the electric motor. In the course content, it should focus on the working principle, system structure, energy conversion and utilization of hybrid engines, and let students deepen their understanding of hybrid technology through experiments and simulation.

Third, the development of other fuel engines, such as hydrogen fuel engine, biofuel engine, etc.. The working principle, advantages and disadvantages as well as the development trend of these new fuel engines should be introduced in the course content in order to broaden students' horizons and improve their knowledge and understanding of new energy vehicle technology.

#### **3.2 Innovation in teaching methods**

1) By introducing digital technology, optimizing course content and teaching methods, students can enhance their learning interest and enthusiasm, cultivate their practical abilities and innovative spirit. Applying digital technology, we establish a library containing various teaching resources for automotive engine construction, such as 3D models, simulation software, teaching videos, etc., in order to build a digital teaching resource library and provide students with rich learning materials and practical operation opportunities.

2) In the teaching reform, we introduce digital courses into classroom teaching, dividing the courses into two major institutions and five major systems, namely crank connecting rod mechanism, valve distribution mechanism, fuel supply system, cooling system, lubrication system, ignition system, and starting system. Each of the seven parts becomes an independent system and is interconnected with other systems. According to the idea of system, the course is made into a three-dimensional digital course, which can be vividly demonstrated and convenient for students to learn independently. The main task of the course is to learn the function, structure, working principle and material of each system, component and part. In the digital course, the structure of each component can be demonstrated as a whole or individually, showing its function and carrying out the working principle, completing most of the teaching tasks with good results.

3) Through virtual simulation technology, we simulate the actual operating environment of car engine construction, allowing students to conduct practical operations in the virtual environment and deepen their understanding of engine construction principles. In teaching, online teaching activities are carried out, and online teaching platforms are utilized to carry out teaching activities such as remote lectures, online discussions, real-time interaction, etc., to break the limitations of

time and space, and to improve the efficiency and effect of teaching.

4) By establishing cooperative relationships with enterprises and research institutions, universities and enterprises jointly carry out research and teaching on automotive engine construction. This can introduce the latest technologies and concepts, provide students with more practical opportunities, and broaden employment channels.

5) By combining theoretical teaching with practical teaching, teachers can enhance students' understanding and comprehension of engine structure through experiments, simulations, and other means in class. By introducing enterprise cases, students can understand the practical application of new energy vehicle engines. Through industry university research cooperation, we invite enterprise experts to give lectures or provide guidance, providing students with more learning resources and practical opportunities.

In addition, the content of the Civics program is introduced in classroom teaching, and Civics teaching is integrated into engineering practice teaching. For example, in teaching the compression ratio of engines, a dialectical approach is used to explain it. If the compression ratio of an automobile is higher, then the car's engine is more capable of doing work and the better the economic performance. But can it be infinitely high, the answer is no, because in the design of the overall structure, but also consider the engine's resistance to violent combustion performance. Compression ratio is too large will lead to car engine knocking, economic performance and power performance are reduced.

### 3.3 Increase in practical teaching

First of all, the theory is linked to practice, and practical aspects are added in classroom teaching to make the course more vivid and students get a more intuitive impression. As the course is to learn the structure of the automobile engine, in the classroom before teaching, leading the students to disassemble the engine parts before the display, so that students generally understand the various functional modules of the engine, what the parts look like, what kind of structure. Thus, they have a good grasp of the course, but also stimulate the students' interest in learning.



Figure 1: Picture of the on-site Curriculum Reform

Secondly, the parts that can be brought into the classroom to the classroom, combined with the courseware, while explaining the demonstration. Due to the many auto engine parts, it is impossible to bring all parts and components into the classroom, but you can select the more complex and difficult to understand parts such as piston, throttle, distributor, etc. in the classroom demonstration

and explanation. This reform abandons the tediousness of the previous simple demonstration PPT, has a very good learning effect, students are also very interested. Figure 1 shows for the explanation of the second chapter of the engine crank connecting rod structure when students observe the construction of the piston scene.

Third, the students will be grouped into practical training; each group is equipped with experimental stand, tools and guide books, requiring students to complete the practical training content within the specified time. At the end of the practical training, the assessment will be carried out according to the group to ensure that each student can master the relevant knowledge and skills. In addition, we actively cooperate with enterprises to carry out practical teaching, so that students can learn and practice in the actual working environment and improve their professionalism and competitiveness in employment.

### 3.4 Optimization of the course assessment methods

Pay attention to the usual students' off-course research and practice. The course assessment is based on the usual grades and final examination, and the usual grades account for half of the total grades. The assessment of ordinary grades is based on homework, classroom tests and course papers. This can stimulate students' motivation for self-study, enable students to study actively and proactively outside the classroom, and enrich students' knowledge scope and learning depth.

## 4. Conclusions

This course has been studied in terms of strengthening the construction of Civics and Politics, adjusting the teaching content, improving the means of teaching, strengthening the practice and perfecting the course assessment methods, so as to stimulate the interest of students and promote the teaching and learning with scientific research and other aspects of reform! Enhance the teaching effect. After the teaching reform, students' interest and enthusiasm in learning have been improved, and the learning effect has been significantly improved. Students' practical ability and innovative spirit have been enhanced, and they can better adapt to the development needs of the automobile industry. The course content is richer and more practical, and the teaching quality is significantly improved. Industry-university-research cooperation has become closer, providing more resources and support for the research and teaching of automobile engine construction.

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