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Exploration on the Reform of All-English Teaching for the "Electrical Machines and Towage" Course for International Students

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Abstract: In recent years, with the rapid development of China's economy and the continuous improvement of its international influence, more and more international students have chosen to study in China. Due to the continuous update and iteration of technical fields such as new energy electric vehicles, intelligent robots, and electric aviation, the number of international students majoring in electrical engineering has also increased significantly. As a core professional basic course for international students majoring in electrical engineering, the teaching quality of the "Electrical Machines and Towage" course is directly related to the learning effect of subsequent professional courses. To further improve the teaching effect and fully consider the differences in culture, educational background, and professional foundation of international students from different countries, this study proposes and practices a trinity teaching method of "theory + simulation + experiment." By systematically optimizing the teaching content, teaching methods, and assessment system, this paper summarizes and discusses the all-English teaching reform practice of the "Electrical Machines and Towage" course, aiming to provide useful references for the teaching reform of related majors and courses in other domestic universities.

Keywords: Electrical Machines and Towage; All-English teaching; Teaching reform; International students; Trinity teaching

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1. Introduction

With the in-depth implementation of the "Belt and Road" Initiative and the continuous improvement of the internationalization level of China's higher education, the scale of international students studying in China has been expanding, and the structure of student sources has become increasingly diversified [1–3]. Among them, engineering education, especially the major of Electrical Engineering and Its Automation, is highly favored by international students due to its close connection with cutting-edge industries (such as new energy and

intelligent manufacturing). The "Electrical Machines and Towage" course is an important professional basic course that connects the preceding and the following in the electrical engineering major. It has abstract content, a strong theoretical nature, and a close combination with practice [4–5]. However, in the all-English teaching environment, facing the international student group with language barriers, cultural differences, and uneven professional foundations, the traditional "cramming" theoretical teaching model is insufficient and difficult to achieve the expected teaching goals [6–8].

Therefore, how to carry out all-around reforms on the course's teaching objectives, content, methods, and evaluation system according to the characteristics of international students, stimulate students' learning initiative and creativity, and cultivate their ability to solve complex engineering problems has become an urgent and important teaching research topic. Based on the teaching practice of Shanghai Dianji University, this paper discusses the reform path of all-English teaching for the "Electrical Machines and Towage" course for international students.

2. Course objectives and teaching team construction

2.1. Multi-dimensional course objectives

Through systematic theoretical learning, simulation training, and experimental operation, this course aims to help international students achieve the following four-dimensional objectives.

2.1.1. Objective 1: Master the basic knowledge of electrical machines

Deeply understand the basic structure, operating principles, and electromagnetic-mechanical energy conversion relationship of major electrical machine types, including DC machines, asynchronous machines, AC synchronous machines, permanent magnet machines, and transformers.

2.1.2. Objective 2: Master the driving characteristics of electrical machine systems

Proficiency in classic traction control methods for electrical machines, such as starting, speed regulation, and braking, and the ability to analyze their operating characteristics under different loads.

2.1.3. Objective 3: Master the basic experimental methods of electrical machines

Cultivate students' hands-on ability and awareness of engineering practice through the disassembly and assembly, no-load and load experiments of DC motors and three-phase asynchronous motors (**Figure 1**).

2.1.4. Objective 4: Understand modern electrical machine design methods

Introduce finite element analysis (FEA) methods based on industrial-grade software such as ANSYS, enabling students to understand the process of rapid design and simulation of modern electrical machine performance and broaden their technical horizons (**Figure 2**).

2.2. International teaching team construction

To support the achievement of course objectives, educators have built a joint teaching team consisting of "university teachers + enterprise experts + overseas renowned professors":

University teachers, as the leading force of the course, are responsible for systematic theoretical teaching and daily tutoring.

Enterprise mentors, invited from technical enterprises such as ANSYS China Co., Ltd., are responsible for teaching the latest engineering cases and practical skills of electrical machine simulation design, bringing the latest industrial needs into the classroom.

Overseas renowned professors, hired from world-renowned universities such as King's College London (UK), regularly give academic lectures to introduce cutting-edge international research results, ensuring the international advanced nature of the course content.

This "triple-teacher integration" model effectively integrates academic, industrial, and international resources, providing a solid guarantee for the high-quality implementation of the course.

3. Reconstruction and optimization of teaching content

The course adopts the internationally classic textbook Electric Machinery (Stephen Umans, Seventh Edition), absorbs advanced teaching concepts from British and American universities, and reconstructs the knowledge system based on the actual situation of international students in our university [9–10]. This forms an integrated model of "theoretical teaching (36 class hours) + experimental teaching (6 class hours) + simulation design (6 class hours)."

3.1. Theoretical teaching content: Maintaining essentials and pursuing innovation

On the basis of ensuring the teaching depth of classic content such as DC machines, transformers, induction machines, and synchronous machines, the educators have significantly increased the teaching content of new types of electrical machines widely used in modern electric vehicles and industrial drives, including permanent magnet synchronous machines (PMSM) and switched reluctance machines (SRM). This measure has greatly stimulated students' interest in learning and kept the course content closely focused on the frontiers of modern industry.

At the same time, ideological and political elements are subtly integrated into the course. In combination with the "Belt and Road" Initiative, when explaining the global cooperation cases of Chinese new energy enterprises (such as BYD and CATL), the educators naturally promote China's foreign policy of good-neighborliness, friendship, and win-win cooperation. This helps international students deepen their understanding of China's development and establish a positive image of China as a major country in the world.

3.2. Practical teaching link: Integration of virtual and real, and competence-oriented approach

The practical link is the key to cultivating students' engineering competence. Educators have deeply integrated the concept of Outcome-Based Education (OBE) for engineering education professional certification into teaching [11–13]:

3.2.1. Basic experiment level

Retain and strengthen traditional electrical machine experiments (such as disassembly and assembly, no-load/load experiments) to help students establish an intuitive understanding of the internal structure of electrical machines.

3.2.2. Virtual simulation level

Introduce software such as ANSYS Maxwell/SIMPLORER and offer special topics on electrical machine electromagnetic field and system simulation. Students are required to model the experimental electrical machines (**Figure 1**), compare and analyze the simulation results with experimental data, and deeply understand the differences and connections between theory and practice.

3.2.3. Comprehensive innovation level

Encourage students to conduct inquiry-based learning, try to carry out multi-physics field (such as electromagnetic-thermal-structural) coupling simulation of electrical machines, and think about how to optimize the design to deal with complex engineering problems in specific application scenarios such as electric vehicles and robots.

Figure 1. International students disassembling and assembling electrical machines

Figure 2. International students using ANSYS software for electrical machine design

This practical system, featuring "integration of virtual and real, and progressive advancement", has effectively strengthened students' abilities to think independently and innovatively solve complex engineering problems.

4. Reform and implementation of teaching methods

In view of the characteristics of international students—active thinking but uneven academic foundations, and English being a non-native language—educators have implemented a student-centered and diversified teaching method.

4.1. Implementation of heuristic and blended teaching

The one-way classroom model of "teacher lecturing and students listening" is abandoned, and heuristic teaching is adopted instead (**Figure 3**). Teachers guide students to think proactively by asking continuous questions and setting up problem scenarios. Students are encouraged to step onto the podium to explain exercises or share

insights, realizing a "flipped classroom" and maximizing the effect of in-class interaction [14].

At the same time, an online-offline blended teaching system is established. Using the Chaoxing Learning Platform, an online resource library is built (**Figure 4**), which includes course PPTs, teaching videos (12 videos), thematic discussion forums (4 forums), and a question bank (more than 100 questions). Students can preview, review, and take self-assessments at any time. Teachers gain a precise understanding of learning difficulties through online data and provide targeted explanations in offline classes, forming a teaching closed loop.

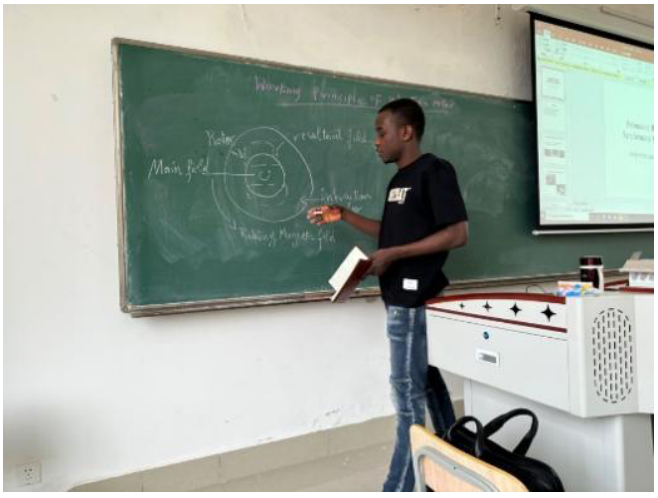

Figure 3. Heuristic classroom teaching

Figure 4. Established online course teaching website

4.2. Advocating the integration of Chinese and foreign cultures to enhance educational effects

Leveraging the multicultural backgrounds of international students, a "15-minute presentation" session is set up in class. Students can introduce their own country's culture, industries, or share application cases combined with professional knowledge. On this basis, teachers supplement relevant examples of China's technological

development and international cooperation (such as energy projects in the China-Pakistan Economic Corridor). This turns the classroom into a platform for cultural exchange, professional learning, and friendship cultivation, subtly enhancing the educational effect of ideological and political education in the course.

4.3. Optimizing assessment methods and increasing course challenge

To comprehensively evaluate learning outcomes, educators have reformed the assessment system, emphasizing process-oriented evaluation and competence orientation:

Reduce the proportion of the final exam and increase the weight of usual grades.

Enrich assessment forms: including online quizzes (for basic theories), in-class presentations (for expression ability), experimental reports (for practical ability), simulation project reports (for innovation and comprehensive analysis ability), and final exams (for mastery of systematic knowledge).

Emphasize "applying what is learned": In the assessment of simulation and experiments, special attention is paid to the process of students analyzing and solving complex engineering problems (**Figure 5**), rather than only focusing on the results. The assessment questions are designed with a certain degree of difficulty and openness to increase the course challenge and motivate students to engage in in-depth learning.

5. Course features and innovations

The teaching reform of this course highlights "high-level", "innovation", and "challenge."

5.1. High-level

It organically integrates knowledge impartment, competence development (solving complex engineering problems, cross-cultural communication), and quality improvement (innovation awareness, international cooperation perspective), cultivating students' high-level thinking and application abilities (**Figures 5** and **6**).

5.2. Innovation

In terms of content, cutting-edge technologies and scientific research achievements are introduced; in terms of methods, heuristic teaching, blended teaching, and practical teaching combining virtual and real are integrated; in terms of resources, self-compiled characteristic simulation textbooks are developed, and rich online resources are built, featuring advanced forms and strong interactivity.

5.3. Internationalization and challenge

Teaching cases, literature reading, and lectures all emphasize an international perspective. The assessment method focuses on academic English and application abilities, with a high difficulty coefficient. It poses a beneficial learning challenge to students and meets the requirements of cultivating first-class international talents.

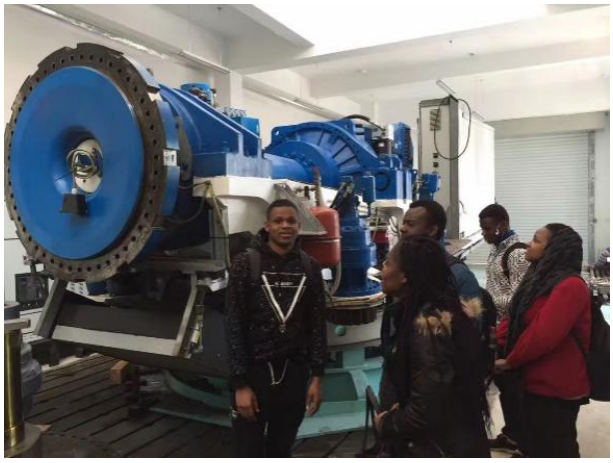

Figure 5. Students participating in the discussion of complex engineering problems

Figure 6. Students conducting electrical machine performance experiments

6. Conclusion

Through the systematic teaching reform of the all-English "Electrical Machines and Towage" course, which adheres to the principles of "student-centered, competence-oriented, integration of virtual and real, and cultural integration", the study has initially constructed a new teaching model suitable for the characteristics of international students [15–16]. Practice shows that this model has effectively improved international students' learning enthusiasm, engineering practical ability, and cross-cultural academic communication ability, and the teaching effect has been significantly enhanced.

In the future, the course team will continue to deepen cooperation with enterprises and overseas universities, continuously update teaching cases and simulation projects, and further enrich online teaching resources. Educators are committed to building this course into a first-class all-English demonstration course in Shanghai, so as to cultivate more international high-quality engineering and technical talents who understand China, are friendly to China, and have strong competitiveness for the country.

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Disclosure statement

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