

Exploration and Practice on Bilingual Course “Principles of Electrical Engineering”

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Abstract—Bilingual teaching has been encouraged by the government and adopted by most Chinese universities. Based on the research and practice of bilingual teaching of “Principles of Electrical Engineering”, some experiences are shared in this paper, which are the course orientation, teaching materials, effective teaching techniques, and effective teaching methods to activate students’ learning, etc. Students should be the center of learning, so the course objectives of bilingual teaching should be set to meet the students’ level of English and requirement of the course. A step-by-step method is more appropriate for bilingual teaching with the application of effective teaching techniques and teaching methods to achieve bilingual teaching goals such as cultivating the students’ professional quality, expanding students’ international vision, integrating the professional knowledge and language knowledge.

Index Terms—Principles of electrical engineering, bilingual teaching’ teaching innovation, teaching method.

I. INTRODUCTION

“Principles of electrical engineering” is a basic electrical module for non-electrical engineering majors in Tongji University. With the increasing exchanges between China and other countries, foreigner students come to learn in Tongji University, as well as the Chinese students go abroad through varieties of ways show a trend of rapid growth. In 2001, “Several opinions about to strengthen undergraduate education and improve the teaching quality” issued by the Ministry of Education points out that condition of general courses or specialized courses taught in foreign languages such as English should be created in undergraduate education [1]. In order to adapt to the demand of such an increasingly internationalized teaching environment, and to improve the global competition ability of the graduates, the research and teaching group of “principles of electrical engineering” of Tongji University decided to conduct bilingual teaching research and practice.

There are a lot of regular or irregular academic exchanges and cooperation in running schools between Tongji University and foreign colleges and universities, especially of Europe and America, which brings many opportunities for teachers to study or to investigate abroad, and helps to improve the teachers’ English and professional level. At the same time, many teachers are also improving their English through various other ways. Several teachers of the course “Principles of Electrical Engineering” have experience with

overseas education or training, therefore, bilingual teaching has the corresponding professional foundation.

However, how to improve the efficiency of bilingual teaching is still a problem faced by the bilingual teachers. The thought of “teach students in accordance with their aptitude” proposed by Kongfuzi a few thousand years ago is still true in modern days. Bearing this in mind, efficient teaching may be produced given appropriate objectives and teaching methodologies according to the student needs and learning progress [2].

II. SET APPROPRIATE BILINGUAL TEACHING ORIENTATION OF THE COURSE

Bilingual education can be defined as “using a non-dominant language as the medium of instruction during some substantial part of the school day” [3]. Its actual meaning is different because of the differences between different countries and regions. Such as in Canada, bilingual teaching generally refers to teach in French in English language area. In China, normally, bilingual teaching points to in addition to Chinese, use a foreign language, mostly in English, as the language for part or all of the teaching of non-language-oriented subjects. The goal of bilingual teaching is of duality, one is to obtain subject knowledge, the second is to develop and improve students’ ability to use a foreign language.

The ideal goal of bilingual teaching for high education is to realize the integration of professional knowledge and foreign language, both to master professional knowledge, and to think and communicate professional knowledge fluently in a second language (written and oral), and can switch between mother tongue and second language according to need, this is so-called bilingual thinking level [4]. However, to achieve the ideal goal is by no means easy, and is not a year or two will be able to achieve. Besides the language, there are four main modules of teaching contents of “principles of electrical engineering”, which include basic circuit analysis, magnetic circuit analysis and electrical motors, analog electronic technology and digital electronic technology. And there are so many concepts, calculations, and teaching contents demanded by syllabus, but the available class hours are limited. Generally by experience, it will take three years for a teacher to be skilled in teaching a new lesson in native language, so it needs to spend more time to teach in English for a Chinese teacher; and for students, if the prerequisite courses of “Principles of Electrical Engineering” are taught in Chinese, their specialized English level and professional knowledge is inadequate and hard to meet the demand of understanding smoothly. Therefore, reasonable position of bilingual teaching should be set according to the nature of the

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course, the students' English level and their investment of time. And it must be avoided that professional knowledge learning, even the students' interests in learning, is affected because of bilingual teaching. Otherwise the students haven't learned solid professional knowledge, as well as their specialized English has got no progress [5]. Based on the above analysis, in the early stages, the course "Principles of Electrical Engineering" is not suitable for teaching in English completely, and the orientation of the bilingual teaching should be:

- 1) Master professional knowledge is the premise. That is, lectures should focus more on technical knowledge rather than language teaching at the primary stage of bilingual teaching.
- 2) Help the students improve their level of specialized English. Those who have good base of knowledge and work hard may approach the level of bilingual thinking, others at least can master the specialized vocabulary and expression of professional knowledge.
- 3) Usually connect the theory with practice. Always acknowledge that what student needs and what they can learn is the main concern, train the students to find and solve problems, and stimulate students' interest in study, exploration, and innovation.

III. PRACTICE OF BILINGUAL TEACHING

A. Bilingual Teaching Survey

It's essential to understand the student needs and learning progress in both technical knowledge and language so as to adjust teaching schedule and adopt effective teaching methods accordingly. In order to learn the English level of students, their acceptance and expectation of bilingual teaching of "Principles of Electrical Engineering", a questionnaire was carried out, and 88 questionnaires were received. The respondents are mainly from mechanical engineering and its automation, automotive engineering and industrial engineering. The statistics of the questionnaire is shown as the following Table I.

The first question is about the students' English level, 80% of the students has reached or even exceeded CET-6, some of them achieved good performance in GRE and TOFEL, etc. So in the second question, it's no doubt most of the students, about 60%, chose "English, Chinese is complementary" as the mode of bilingual teaching. However, the students are still lack of confidence in their oral English, on the choice of "whether to answer questions in English", only 11 students, 12.5% of them decisively chose "English", while 67% of the students chose "major in English, really have difficulties can be expressed in Chinese". Of course that there are still some students among the 67% err on the side of the choice though their oral English is very good in fact. Relative to "answer questions in English", the proportion of students that chose "complete exercises and tests in English" has obvious increased, up to 40%. For the position of the course, the vast majority chose "to improve the professional English communication level", and "to learn more specialized English vocabulary" and "to learn more specialized English vocabulary". In the mode of teaching, 54% of the students

chose bilingual teaching, while 25% chose teaching in English.

Summarize the statistics of the questionnaire, the students have high level of English level generally. So there are few difficulties for them to use original English teaching materials, and to teach in English. However, it puts forward higher requirements to the teacher's English teaching level. Consider they know little technical knowledge at the beginning of the course, it's better to gradually increase the proportion of English teaching from 70% ~ 100%, those concepts and principles which are difficult to understand can be explained in Chinese.

B. Textbook

The teaching material, "Electrical Engineering Principles and Applications, Fifth Edition", is a classic and popular textbook, which is written by professor Allen R. Hambley of the Electrical and Computer Engineering Department of Michigan University. It contains contents of six courses, which are circuit principles, basic electromagnetic measurements, analog electronic technology, digital electronic technology, microcomputer principles and basic knowledge of electrical machinery and so on. It is quite suitable for non-electrical undergraduate bilingual and English teaching apply to majors of science and technology, such as mechanical, chemical, biological, environmental resources, civil engineering and so on. At the point of view of structure and contents of the textbook, it nearly meets the requirements of current domestic syllabus of the course. Besides a complete theoretical system, it also pays attention to applications and practices; the written description is concise and vivid, with the introduction of knowledge and concepts are clear, rich lists examples of circuits and software analysis are close to the engineering applications.

C. Bilingual Teaching Means

Multimedia teaching means has been widely used and loved by college teachers, especially when there is a large amount of information need to be shown. Images can be used flexibly and directly, and vivid animation can show those complicated working principles. However, blackboard still has its advantage to use. Writing on the blackboard could leave students more time and space to think and remember; on the other hand, the writing which always carries the information of the teacher's personality also greatly enhances the affinity of teachers, makes the distance more closely between the teachers and students. So arrange the contents of slides and blackboard writing reasonably, and play their advantages respectively. There are many circuit diagrams in the course, and sometimes some circuits have to be used over and over to be a contrast or a reference; Some system diagrams of electronics are very complex, it can be very time consuming if hand-drawn on the blackboard; the complex structure and principles of electrical motor can be very intuitional if animation is used to perform, multimedia teaching techniques provide a great help in such areas. A lot of text must be avoided in a slide, otherwise the students could produce visual fatigue, and they are disgusted with the way if the teacher read text mechanical. So for the bilingual teaching of "Principles of Electrical Engineering", images

and animations are the majority in slides, accounting for 90%; text is mainly used to represent the knowledge outlines, formulas, and theorems; the relevant deduction and calculation are carried out through the blackboard writing;

most of the time in teaching is facing to the students, stating ideas or questions, slides are used to explain concepts and phenomena when needed.

TABLE I: QUESTIONNAIRE ON STUDENT MOTIVATION AND ENGLISH LEVEL

1 · what's your current English level? ()	
CET-4	18
CET-6	64
Others	6
2 · English slides and English textbook will be used in bilingual teaching of "Principles of Electrical Engineering", and what language do you expect the teacher use in teaching? ()	
A. English, Chinese is complementary	50
B. Chinese, English is complementary	32
C. Chinese	6
3 · What language do you think the students could be use when answering questions? ()	
A. English	11
B. Chinese	18
C. Major in English, really have difficulty can be expressed in Chinese	59
4 · How do you think that exercises and exam must answer in English for the bilingual course ()	
A. No problem	35
B. Major in English, really have difficulty can be expressed in Chinese	53
5. What's your purpose of attending the bilingual course? () (optional multiple choices)	
A. To learn more specialized English vocabulary	
B. To learn the knowledge system of the course abroad	
C. To improve the professional English communication level	
A	3
B	6
C	7
A+B	8
A+C	15
B+C	12
A+B+C	33
6 · What kind of teaching do you prefer? ()	
A. Bilingual	47
B. English	22
C. Chinese	19
7 · What any other opinions and Suggestions do you have :	

IV. BILINGUAL TEACHING METHODS

A. Well-Designed Knowledge Introduction

The class hour of the course is an average of three hours a week, and the students tend to remember the knowledge of previous lesson vaguely when a week apart between two lessons. Therefore, at the beginning of every class, the knowledge of last class, especially the emphases and difficulties, can be stated for a recall. Let the students to participate in the interpretation and complement each other, and must be in English. The students show high enthusiasm to the recall, this is an opportunity to show their spoken English, it also promotes them review the knowledge well before class.

Interests play a great role in the learning process, and a well-designed introduction led up to the topics always inspire

the student's desire to independent learning. Using living examples and questions are always effective.

When teaching Flip-flops, a video about Knowledge Contest is played to the students and they are asked if they know how the responder works, which might be a reminder of their experience of using the responder. And then their questions come quickly which are usually why only one competitor gets the chance to respond though all the competitors press their buttons respectively. Then working principles of the Flip-flops begin to be taught and how the responder responds to the fastest pressing while blocking the others [6].

When teaching Counters, the Digital Clock is used to lead in, and the students are curious and thirst to know how the New Year's Countdown Clock works. The desire of learning is mobilized immediately. When teaching Combinational Logic Circuits, there are even much more living examples:

Adders, 7-segment Display, Traffic Light Control System, Failure Alarm Circuit, so and so on.

B. Game "Best Match"

In bilingual teaching of "Principles of Electrical Engineering", a game "best match" is designed to help the students better understand the concepts and theorems. There are two groups of knowledge description in the game. For example the knowledge in group A includes some concepts and theorem "a). The Node; b). The Loop; c) KCL; d) KVL, e). Passive reference configuration;...", while the knowledge in group B is the corresponding formula or explanation of each item of group A, but the number of knowledge in group B is great than that in group A, which means some knowledge in group B there is no matching entries in group A, which is helpful to expand the students' thinking space. At the beginning of the game, the knowledge of group B are written on pieces of A4 size paper and distributed to each student. Then, the teacher says each entry in the group A in turn, the student who thinks his sentence or formula on the paper is the best match of what the teacher just said, he stands up immediately and shows the knowledge to others and reads aloud and to be judged by the classmates. In the end, those not matched are also shown for thinking. This kind of interactive game activates the class atmosphere perfectly.

C. Knowledge Map

There is too much knowledge in the course, if the students don't take time to think about the relationship between the various knowledge points after class, it is easy to ignore the continuity of knowledge, therefore they cannot digest, even in class also don't know why they learn certain knowledge. "Knowledge map" is very helpful to solve this problem. The thinking mode of human is associative of net structure. Given the word resistances, for example, someone will think of "in the series—in parallel— voltages ..."; and some will think of "the Ohm's Law— voltages and currents— power...", and so on. The more people participate in, the more knowledge is associated, and a more complicated structure of internet is got. According to the way of associative thinking, in bilingual teaching of "Principles of Electrical Engineering", after learning a certain amount of knowledge, teachers and students would complete such a "knowledge map" together to link all the knowledge learned. Through the "knowledge map", the students can have an overall comprehensive understanding of the knowledge learned, and deepen the memory of professional English vocabulary.

V. EVALUATION

It is not a problem for the students that both questions and answers for homework, mid-term exam and final exam are all in English. 70% of the final overall grade depends on the grade of final exam, and 30% depends on the ordinary behavior which includes the comprehensive performance of mid-term exam, homework, and experiments.

VI. CONCLUSION

The bilingual teaching of "Principles of Electrical Engineering" is still at the beginning stage at present, it needs long time of exploration and practice in many aspects such as practice teaching, evaluation system and how to improve the effect of classroom teaching etc. And as the international exchange students growing and international exchange activities increasing, teaching in complete English is an inevitable trend. In the non-native language environment, both teachers and students need to pay great efforts for professional courses taught in English. However, to gain success is inevitable as long as having the correct teaching method, combined with efforts from the teacher and students. Of course, bumper harvest requires a gradual process.

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