



Optimization of teaching methods in bilingual teaching for separation engineering course

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Abstract

In order to increase the teaching efficiency in bilingual teaching of Separation Engineering course, three parts with different levels of difficulty were selected from textbook, and three teaching methods were investigated. After confirmation of the study object, the ratio of native/English language and the types of short videos with various play time were analyzed. The teaching efficiency was evaluated by classroom video recording data, questionnaire survey and test results. Finally, an optimal teaching method was evaluated and the research results from student identification revealed that the improved teaching method can increase the teaching efficiency obviously.

Keywords: Teaching method, bilingual teaching, short videos, optimization, teaching efficiency

Introduction

Separation engineering is an important branch of chemical engineering, which studies the methods, processes, materials, equipment, and other aspects in processes of classification, separation, concentration, and purification of various chemical substances. Separation engineering is very important because it is widely used in modern chemical industry and related industrial fields [1]. Currently, the whole world industry is vigorously advocating for resource utilization and green chemistry. Hence, chemical separation technology will play a more important role in many fields such as petrochemicals, resource environment, energy, materials, etc.

There are many professional journals on separation engineering internationally, and undergraduate students need to read a large amount of English literature to track the research hotspots. Therefore, to the students whose major are chemical engineering in university, bilingual teaching for Separation Engineering course is quite necessary to help the students to clearly understand the basic theory and knowledge points of separation processes [2, 3]. In previous classroom teaching, the major method was oral teaching. However, the teaching effect was not satisfied because that professional descriptions in textbook were difficult to understand and many equations and the mathematic models were difficult to analyze. Students were hardly to enhance their study interests for a deeper application of the knowledge [4].

Therefore, the methods of bilingual teaching need to be improved. Incorporating the language education method into classroom teaching can help students to understand English descriptions, and incorporating multimedia, especially short video content, can help students to understand the knowledge points. But currently, inappropriate teaching methods and the low correlation between most of multimedia resources and Separation Engineering made a limited improvement in classroom teaching [5, 6].

In order to solve the above problems, our course team analyzed the characteristics of undergraduate students and focused on the key points of this course. Then the teaching methods from the College of Education (Inha University, Korea) were applied in bilingual teaching in engineering

course to explore the integration of interdisciplinary teaching efficiency [7-9]. The undergraduate students who had participated in the course of Separation Engineering in recent five years were taken as the research objects, and the bilingual proportion and short video duration were adjusted in classroom teaching to achieve better teaching results.

Research Method in Bilingual Classroom Teaching

Selection of research objects

The research object of this research was a total of 310 undergraduate students who participated in the bilingual course of Separation Engineering from 2020 to 2024. After a questionnaire survey, it was concluded that these objects have the following characteristics: Firstly, these students had already studied previous courses such as Chemical Engineering Professional English and Physical Chemistry. Secondly, they have a good foundation in English. 90% of all students had intermediate English level and 36% of them had advanced English level. Thirdly, there is an academic pressure for students. Students have concerns and anxieties on bilingual teaching of this course because of many definitions and complex formulas. Fourthly, students hope to be exposed to some new teaching methods and more multimedia teaching.

Teaching method and learning time

This course had a total of 32 class hours, and three teaching methods were used.

Teaching method A: Classroom teaching is only conducted through lectures, using only English language to explain the key knowledge and difficult contents of the textbook.

Teaching method B: Classroom teaching is only conducted through lectures, using different ratio of native/English language to explain the key knowledge and difficult contents of the textbook.

Teaching method C: Classroom teaching is conducted in a mixed way of difficult contents by lectures and key knowledge by short videos. The textbooks used for this course are "Separation Engineering. Chemical Industry Press Co., Ltd, 2012" edited by Dongyan Xu, Qingguo Ye

and Xumei Tao, and "Separation Process Engineering Includes Mass Transfer Analysis (4th ed). Boston, Prentice Hall, 2017" edited by P. C. Wankat. Three parts were selected based on the different emphasis and difficulty of the textbook. The relationship between teaching methods, textbook contents and the class hours occupied are shown in Table 1. In part 1, students already learned some contents of design variables from Physical Chemistry course, so the difficulty was low and only English language was used during classroom teaching. In part 2, students learned a small part of the content from Unit Operation course, so the difficulty was medium and both native language and English language were used during classroom teaching. In part 3, because of the complex calculation process, the difficulty was high. So short videos were invited in classroom teaching.

Table 1: Contents and learning time of textbook with different teaching method

No.	Content in textbook	Difficulty	Class hours	Teaching method
Part 1	Degree of freedom and design variables	Low	4	A
Part 2	Single stage equilibrium calculations	Medium	8	B
Part 3	Equation-tearing procedures	High	12	C

Selective different ratio of both language and types of short videos

In teaching method B, the ratio of native/English language in classroom teaching was selected as 10:90, 30:70, 50:50, 70:30, and 90:10.

Based on the characteristics of bilingual teaching in this course, the teaching method C used native and English videos containing knowledge points of Separation Engineering (Table 2). Native and English documentary videos include basic separation instruments, mass transfer, phase changes, and other content. They involve a lot of popular science content, and the difficulty of knowledge points related to the core teaching content is low. The native and English online courses include all the core teaching contents. However, the fast-speaking speed and quick switching of knowledge points in native short videos require students to have a clear understanding of the textbook

The ratio of native/English language in Teaching Method B

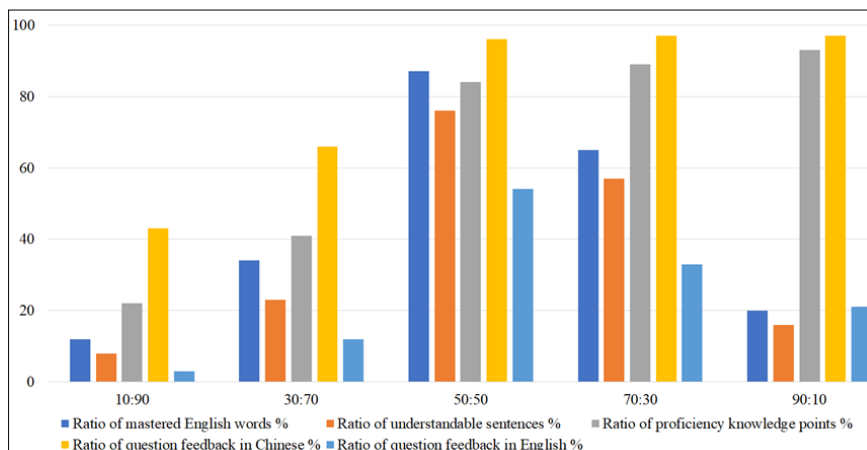


Fig 1: Ratios of various efficiencies by different teaching languages

content, while English short videos require students to flexibly apply relevant professional vocabulary.

Table 2: Types, names and advantages of chosen short videos

Type	Name	Advantages
Native	Documentary Exploring the Future World of Chemical Engineering (Tsinghua University, China)	Displaying unique separation instruments and processes
	Online course Chemical Separation Processes (Tianjin University, China)	45 min for each video, explain key knowledge in the textbook
English	Documentary Crash Course Chemistry (Hank Green)	Popular science videos, Involving general chemical vocabulary
	Online course Mass Transfer (Reinhold Kneer)	Detailed explanation of key knowledge of mass transfer theory

Evaluation method of teaching effectiveness

The evaluation of teaching effectiveness is analyzed by synthesizing data from the following three methods

1. Classroom video recording. Record the entire process of teaching through video cameras, the length of classroom focus, and the number of participants in classroom discussions by different teaching methods were calculated and compared.
2. Questionnaire survey. Collect feedback from students on the evaluation of the learning effectiveness of knowledge points, satisfaction with teaching methods, and the level of interest in video types.
3. Analysis of classroom test scores. After completing the two teaching methods separately, a classroom test based on all knowledge points was given to student and the scores were analyzed.

Analysis of teaching method effectiveness in classroom teaching

Although in teaching method A only English language was used to explain the content, the difficulty of Part 1 was low. Therefore, the teaching method A received a high efficiency and students can understand the English teaching content well. With the difficulty of teaching method B and C increasing, more detailed researches must be investigated.

Figure 1 shows various efficiencies by different ratio of teaching languages in Method B. In the bilingual teaching of Part 2, with the proportion of native language increasing, the understanding of professional words and sentences gradually increased. When the ratio was 50:50, students could combine the related content in native and English to fully understand professional words and sentences. When the proportion of native language increased high than 50%, the total number of learned English words decreased, leading to a decreasing in sentence comprehension. As well, when the proportion of native language increased to 50%, more than 84% of knowledge points was mastered by students and more than 96% of native questions could be answered accurately. However, because of the difficulty of Part 2, less than 54% of English questions were answered when the ratio was deviated from 50:50.

The effect of short video types and playing times

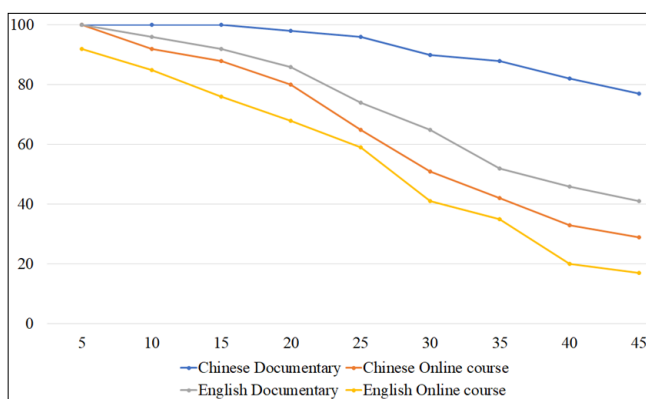


Fig 2: The proportion of total number of student focus on short videos with different types and playing times

Figure 2 showed the proportion of total number of student focus on short videos with different types and playing times. Compare to the traditional teaching method A, students were much more interested in short videos. Animation in short videos enabled students to have a deeper understanding of knowledge points from different perspectives. However, these four types of short videos had their own advantages and disadvantages. Native and English documentary had highly popular in science and had a moderate speaking speed, and English documentary contained more amount of specialized vocabulary. However, the vocabulary was too simple for undergraduate students with a certain English foundation. Moreover, these two types of short videos contained limited knowledge and weak professionalism, which deviated greatly from the knowledge points of the teaching syllabus. The results showed that 20% of students more inclined to native documentary than English documentary.

The online courses had a higher professionalism, slower speaking speed and suitable animations, so students can learn much more knowledge points than documentary. However, the online courses had some disadvantages. The native online course had weak interest and the English online course had high difficulty in some specialized vocabulary and complex grammar. In this situation, teachers had to frequently interrupt the videos and switch to classroom explanations. Students' attention switched too frequently between the video area and the teacher, which had a certain impact on their classroom concentration. The

results showed that less than 60% of students had low interest in online courses. By analyzing the data in Figure 2, it can be concluded that the addition of short videos in classroom teaching can indeed improve the effectiveness of classroom teaching. However, the content and form of a single type of short video is also relatively single, which can easily lead to students' visual fatigue. Therefore, the matching ratio between different types of short videos also needs to be optimized.

The teaching efficiency also can be illustrated by different playing times of short videos in Figure 2. At the beginning of the class, almost all students can focus on the classroom teaching. With the short video playing time increasing, especially for English language videos, the number of students who can focus on classroom teaching gradually decreased. After 20 minutes, the number of students who can focus on classroom teaching significantly decreased. Therefore, based on the result of Figure 2, the optimal short video playing time was 20 minutes. After playing, teachers could use interspersed explanations to deeply analyze the key points in the video content and expand their knowledge points, which can maximize students' classroom learning efficiency.

Questionnaire survey analysis

The ratio of native/English language and an addition of short videos in classroom teaching can indeed improve the effectiveness of classroom teaching. According to the survey data, almost 100% of students considered that Teaching Method A was not conducive to improving learning efficiency. For Teaching Method B, 86% and 13% of students preferred the 50:50 and 70:30 ratio of native/English language teaching, respectively. For Teaching Method C, 95% of students were more interested in documentaries. Therefore, an improved teaching method which mixed optimal ratio of native/English language and different types of short videos should be investigated.

Optimization of classroom teaching method

According to previous results, the optimal ratio of native/English language was 50:50 (from Method B) and the optimal short video playing time was 20 minutes (from Method C). From classroom video recordings and the trend of data changes in Figure 1 and 2, it can be concluded that short videos had limited impact on improving classroom learning efficiency as the difficulty of content increasing. Therefore, after comprehensive analyzing the results from the classroom video recordings, the advantages and disadvantages of native and English short videos, and questionnaire survey data, it is concluded that the short videos should include English documentaries, native online courses, and English online courses. Documentaries were used to increase students' interest in this course. English online courses can help students to learn key knowledge, and native online courses were used to consolidate knowledge points and strengthen students' understanding. The optimal ratio of English documentaries, native online courses, and English online courses was 20:40:40. This ratio not only enhanced the fun of bilingual teaching, but also helped students to focus on professional knowledge within a limited period.

Therefore, based on these optimal results, the improved Teaching Method D was applied as: the 50:50 ratio of native/English language, the 20:40:40 ratio of English

documentaries, native online courses, and English online courses videos with a total 20 minutes playing time in each class hour. Lecturer can then use interspersed explanations to deeply analyze the key and difficult points in the video content and expand their knowledge points, which can maximize students' learning efficiency.

Student identification with Teaching Method D

After application of Teaching Method D in classroom teaching, the following data were obtained by analyzing the questionnaire survey results, homework scores, and classroom test scores:

1. According to the analysis of questionnaire survey results, the number of students who agreed with the view that "Bilingual Teaching is Necessary for Separation Engineering Course" had increased from 10% to 79%. The number of students who agreed with the view that "The Study of Separation Engineering Course Should Combine with Current Internet Information Resources" has increased from 66% to 95%. The number of students who agreed that "Teaching Method D is Well Organized and Improved for Learning Separation Engineering Course" was almost 100%. The improved teaching methods had significantly increased students' interest in this course. Students had a 100% agreement with the selected short video content for this course, a 100% agreement with the fit between selected short videos and key knowledge, and a 99% positive rating for the playing time. These results indicated that students were highly receptive to the application of short videos in classroom teaching.
2. With the Teaching Method D, more than 86% of students had accomplished the knowledge in Part 3.
3. According to the score of homework, after teaching with Method D, students can apply key knowledge more logically and had a clear approach to solve homework problems. The average score of homework had increased from B- to A.

The above data and analysis indicated that the improved teaching Method D was not only conducive to improving the effectiveness of classroom teaching in this course, but also guided students to reasonably allocate the multimedia resources. This ability can provide assistance for future self-learning and other course learning.

Conclusion

In the bilingual teaching of Separation Engineering course, this study explored three teaching methods. According to the advantages and disadvantages of each teaching method, the parameters were optimized and they were integrated into an improved Teaching Method D. This method not only increased students' interest in learning but also cultivated their learning abilities. Our teaching team had applied this method in classroom teaching. The method can provide theoretical basis for future teaching of this and other courses, and also can make contributions to the cultivation of high-end talents in the chemical industry profession.

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