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Optimization of short videos in bilingual teaching for chemical engineering thermodynamics course

Tian Minglei*, Wang Qi
College of Chemistry and Environmental Engineering, Yangtze Universit, Jingzhou, China

Abstract
Short videos were applied in bilingual teaching for chemical engineering thermodynamics, and gas state equation, liquid state equation and vapor-liquid equilibrium are selected as the main contents. After confirmation of the study object, the types of English short videos and play time were analyzed. The teaching efficiency was evaluated by classroom video recording data, questionnaire survey and test results. Finally, the proportion of short videos in classroom teaching was optimized. The research results revealed that the classroom teaching efficiency increased with reasonable proportion of short videos in 20 min.

Keywords: Chemical engineering thermodynamics, bilingual teaching, short videos, optimization, teaching efficiency

Introduction

With the development of local chemical industry, engineering education becomes more and more important. For students majoring in chemical engineering and technology, chemical engineering thermodynamics is one of the core courses. Its knowledge system is crucial in the research of chemical engineering, and plays an important role of connecting other courses, such as physical chemistry, chemical engineering principles, chemical engineering design, etc [1]. This course aims to enhance students' understanding of basic theories such as phase changes and energy transfer in chemical processes, and also to consolidate basic knowledge for cultivating high-end talents in the chemical industry [2, 3].

Since the first "chemical engineering thermodynamics" book was published by Prof. B.F. Dodge in 1944, several related textbooks in English or in local language were published with developing of this subject [4]. Hence, to the students whose major are chemical engineering in university, bilingual teaching in classroom is quite necessary to help the students to clearly understand the history and knowledge points of chemical engineering thermodynamics. In previous classroom teaching, the major method was oral teaching with an assistance of PowerPoint. However, the teaching effect was not satisfied because of a large number of equations and the mathematic models were difficult to analyze. Students were hardly to enhance their study interests for a deeper application of the knowledge [5-7].

With the application of multimedia resources in classroom teaching, students' acceptance of difficult knowledge points has been partially improved. But currently, the low correlation between most of multimedia resources and chemical engineering thermodynamics made a limited improvement in classroom teaching [8,9]. In order to improve the teaching efficiency, our team analyzed the characteristics of students whose major are chemical engineering in our university, and we selected undergraduate students who have participated in the course of chemical engineering thermodynamics for the past 5 years as the research object. Then, based on the key knowledge of this course, several screened short videos were added to bilingual classroom teaching. According to the analysis result of teaching efficiency, the type and running time of short videos were optimized.

Research Method of Short Video Application in Bilingual Classroom Teaching

Selection of research objects

The research object of this research was a total of 327 undergraduate students who participated in the bilingual course of Chemical Engineering Thermodynamics from 2018 to 2022. 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. 93% of all students had intermediate English level and 31% of them had advanced English level. Thirdly, there is an anxious psychology towards this course. Before delving deeper into the course, students have reviewed the textbook and found that the course has many definitions, complex formulas, and great difficulties in learning. They have some concerns and anxiety about classroom teaching, especially bilingual teaching. Fourthly, some students considered that the learning method of this course is outdated. Students believe that they have to learn a large number of mathematical equations, and plenty of practices are required. The fifth is all students accept multimedia teaching. The students have long-term exposure to the internet and can access large amount of online multimedia resources. Especially, influenced by the global COVID-19, offline teaching will be the main teaching method in the years of 2018, 2019 and 2022, while the proportion of online teaching will be greatly increased in 2020 and 2021. Therefore, students who took this course in 2020 and 2021 are more inclined to accept multimedia content.

Teaching method and learning time

This course has a total of 48 class hours, and two teaching methods are used. Teaching method A: Classroom teaching is only conducted through lectures, using PowerPoint, text, and pictures to explain the key knowledge and difficult contents of the textbook. Teaching method B: Classroom teaching is conducted in a mixed way of difficult contents

by lectures and key knowledge by short videos. The textbook used for this course is "Introduction to chemical engineering thermodynamics (Seventh Edition), McGraw-Hill" edited by J.M. Smith, H.C. Van Ness, and M.M. Abbott. Three parts of chapters were selected based on the different emphasis and difficulty of the textbook. The relationship between short videos and textbook content and the class hours occupied are shown in Table 1.

Table 1: Contents and learning time of textbook and short videos

No.	Content in textbook	Content in short videos	Class hours	Playing time of short videos
Part 1	Volumetric properties of fluids	State relation of vapor phase	8	0-4
Part 2	Solution thermodynamics	State relation of liquid phase	12	0-6
Part 3	Vapor-liquid equilibrium	Vapor-liquid equilibrium	12	0-6

Selection and advantages of short videos

Based on the characteristics of bilingual teaching in this course, this study selected Chinese and English videos containing knowledge points of chemical engineering thermodynamics (Table 2). Chinese and English documentary videos include basic chemical substance names, heat 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. Moreover, the proportion of professional vocabulary related to chemical engineering thermodynamics appearing in English short videos is less than 8%. The Chinese and English online courses include all the core teaching contents. However, the fast-speaking speed and quick switching of knowledge points in Chinese short videos require students to have a clear understanding of the textbook 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
Chinese	Documentary	Beauty of Science (Chinese Chemical Society, China)	Displaying unique chemical reactions and structures at both macro and micro scales
	Online course	Chemical engineering thermodynamics (Tianjin University, China)	6-12 min for each video, divide and explain each key knowledge in the textbook
English	Documentary	Chemistry: A Volatile History (BBC, UK)	Popular science videos, Involving general chemical vocabulary
	Online course	Thermodynamics and Kinetics (MIT, USA)	Detailed explanation of key knowledge accompanied by electronic board writing

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, and after class, the number of students active in the classroom, 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, the level of interest in video types, and the duration of video playback.
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

The effect of short video types using classroom video recordings

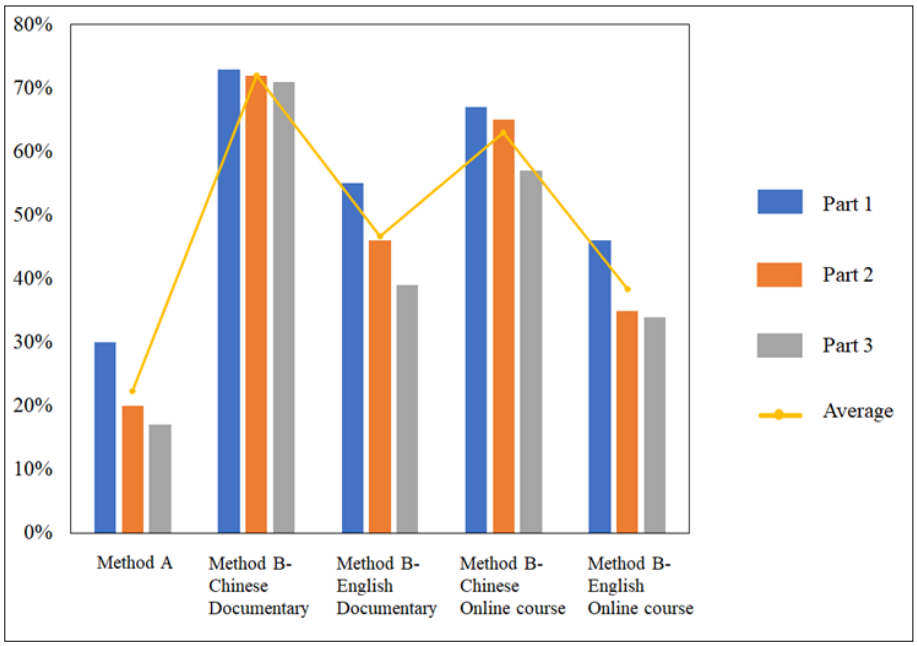

Fig 1: Effect of short videos on class activity

Figure 1 shows the effect of short videos on activity level from classroom video recordings. For teaching method A, although students were accustomed to the lecturer's traditional teaching method, due to the high difficulty and complexity of knowledge points, students' understanding of knowledge points would be disconnected to the lecturer's explanation. Only 24% of students actively participated in the classroom interaction of part 1 and part 2. With the increasing of difficulty, the number of students participated in classroom interactions or answered questions decreased to 18% of part 3.

When the same knowledge points were taught using method B, students were interested in short videos and their activity in the classroom had significantly increased. The number of participants in the three parts was increased more than 40%. Sensory factors such as sound, light, and animation in short videos enabled students to have a deeper understanding of knowledge points from different perspectives. After playing the short videos, 72% of the total students participated in question and answer, and the accuracy of responses was also significantly improved.

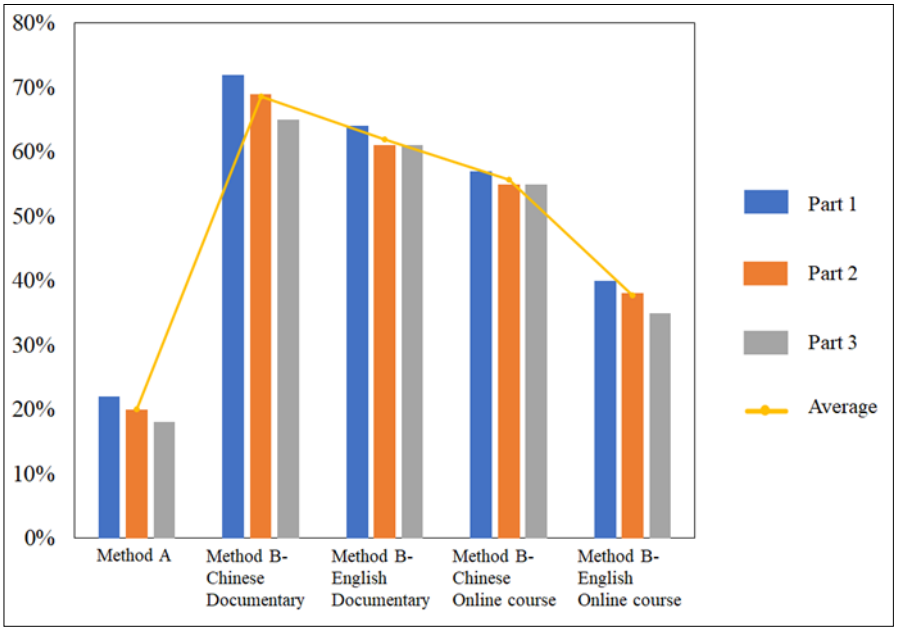

Fig 2: Effect of short videos on classes attention time

Figure 2 shows the effect of short videos on classes attention time from classroom video recordings. Within 45 minutes, students only had 20% of the class time focused on classroom teaching by teaching method A. Due to a low learning efficiency, they needed long time to think and respond the lecturer's questions. When teaching method B was applied, students' focus time on short videos had greatly improved. Even several professional vocabularies were used, the duration of students' focus on classroom teaching had increased to 69%, and they can quickly participate in classroom interaction and correctly answer the questions.

Questionnaire survey analysis

The addition of short videos in classroom teaching can indeed improve the effectiveness of classroom teaching. However, single type of short video content had limitations, it caused students' visual fatigue and affected the effectiveness of classroom teaching. According to the survey data, 92% of students were more interested in documentaries. Similarly, based on the data in Figure 1 and 2, this trend indicated that students had a higher interest in popular science documentaries. However, the disadvantages of documentaries, such as limited knowledge content, limited professionalism, and a large deviation from the course, mistakenly guided students to focus on general knowledge more than professional knowledge. This result affected the classroom teaching effectiveness. Moreover, 89% of students prefer to learn Chinese short videos. This result can be analyzed that when playing short videos in English, professional vocabularies were substantially increased, the lecturer had to interrupt the videos and switch to explanations. Students' attention switched too frequently between the video and the lecturer, which had a certain impact on their classroom focus.

Therefore, the matching ratio between different types of short videos also needed to be optimized.

Optimization of short videos in classroom teaching

Ratio of short videos type

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 Chinese and English short videos, and questionnaire survey data, it is concluded that the short videos should include Chinese documentaries, Chinese 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, such as equation of state and calculation of liquid phase state relationship. Chinese online courses were used to consolidate knowledge points and strengthen students' understanding vapor-liquid equilibrium. The

optimal ratio of Chinese documentaries, Chinese online courses, and English online courses is 1:1:2. This ratio not only enhanced the fun of bilingual teaching, but also helped students to focus on professional knowledge within a limited period of time.

Playing time of short videos

In the questionnaire survey, more than 76% of the students expected to learn short videos for more than 30 minutes per class hour. However, the results of the answer accuracy for questions shown in Figure 3 provided an opposite result. In classroom teaching, 5 questions were listed before playing a short video and students are required to answer immediately after watching the video. As the playing duration increased from 5 minutes to 20 minutes, the knowledge points mastered by students increased with the answer accuracy increasing. But when the duration exceeded 25 minutes, students' focus was diverted by other content in the video, resulting in a decrease in answer accuracy and obviously a decrease in learning efficiency.

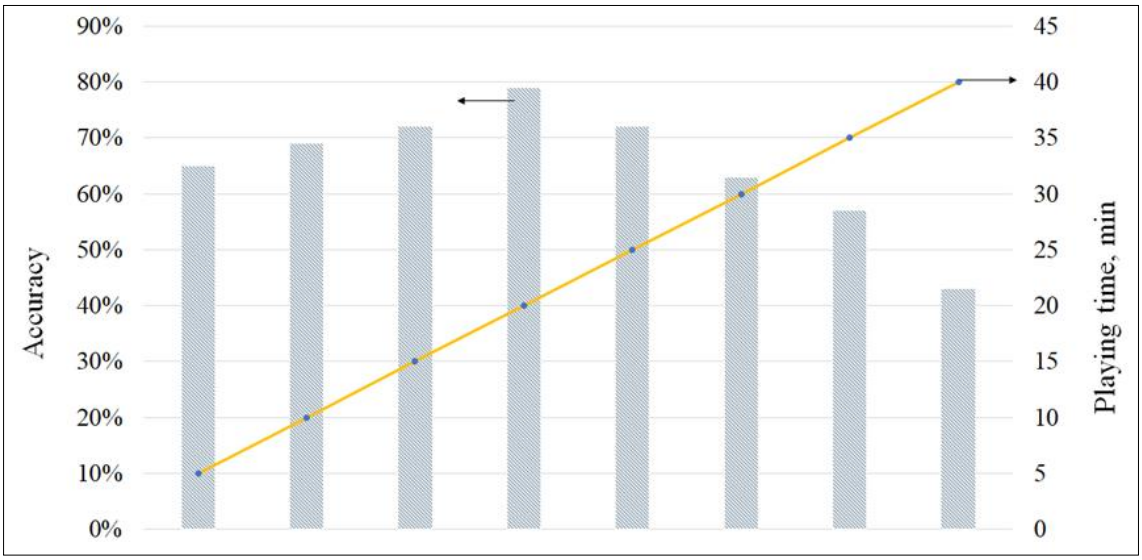

Fig 3: Relationship between time of short videos and rate of correct answers

Therefore, based on the comprehensive analysis of Figure 3, survey questionnaire, and answer accuracy data, it was determined that the optimal short video playing time for each class hour should be less than 20 minutes. 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 short video teaching

After optimizing the use of short videos 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 Chemical Engineering Thermodynamics Course" had increased from 12% to 84%. The number of students who agreed with the view that "The Study of Chemical Engineering Thermodynamics should Combine with Current Internet Information Resources" has increased from 64% to 100%. The number of students who believed that "Chemical Engineering Thermodynamics is Difficult to Learn and Cannot Fully Grasp the Knowledge Points at Present" has decreased from 95% to 34%. The improvement of 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 98% 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 short video teaching method, more than 74% of students had accomplished the state relation of vapor phase, and their scores related to state relation of liquid phase and vapor-liquid equilibrium had increased more than 59%.
3. According to the score of homework, after the short video teaching, students can apply key knowledge more logically and had a clear approach to solve homework problems. The average score of homework had increased by 12.5%.

The above data and analysis indicated that the short video teaching method 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 classroom teaching of Chemical Engineering Thermodynamics course, the application of multimedia resources had become an inevitable trend. Selection of appropriate resources can effectively improve teaching effectiveness. Bilingual teaching with short videos not only increased students' interest in learning but also cultivated their learning abilities.

Our teaching team had optimized the application of short videos 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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References

1. Yang Q, Che Y, Liu Z, Chen X. Reform and Practice of Teaching Method for the Basic Relations in Chemical Engineering Thermodynamics. Higher Education in Chemical Engineering,2021:38:121-128.
2. Han X, Wang B, Song Y, Wang Z, Chen M, Gao X. Study of Chemical Engineering Thermodynamics Teaching Reform. Higher Education in Chemical Engineering,2014:4:26-29.
3. Gong H, Chen Y. Research on the Teaching Method of Chemical Engineering Thermodynamics Course in the Energy and Power Engineering,2021:48:256-257.
4. Dodge BF. Chemical Engineering Thermodynamics. McGraw-Hill, New York, 1944.
5. Bian X, Zhao S, Guo Y, Tan X, Gui J. The Teaching Experience to Dissolve the Teaching and Learning Difficulty of Chemical Thermodynamics. Education Modernization,2019:11:99-101.
6. Xiao D. In-Class Student Questions and Take-Home Projects for Chemical Engineering Thermodynamics. Journal of Chemical Education,2021:98:1193-1200.
7. Sandler SI. Chemical Engineering Thermodynamics: Education and Application. Journal of Non-Equilibrium Thermodynamics,2009:11:67-84.
8. Zhang Y, Yang C, Wang D, Lyu N, Li Q. Syllabus Design of “Chemical Engineering Thermodynamics” Course Based on Engineering Education Certification. Shandong Chemical Industry,2021:50:182-185.
9. Zhao J, Lan C, Duan Y, Chen H. The Teaching Reform and Practice in Chemical Thermodynamics. Higher Education in Chemical Engineering,2015:2:77-79.