

Curriculum Reform and Practice on Bilingual Teaching of Fine Chemicals Chemistry

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Abstract

Fine Chemicals Chemistry is one of the most important courses of Applied Chemistry specialty in colleges and universities in China. In response of the call of “combining professional knowledge and foreign languages together” by Zhejiang International Studies University, to develop the internationalized and inter-disciplinary talents for undergraduates, we have tried to implement bilingual teaching for the Fine Chemicals Chemistry since 2014. Syllabus and classroom teaching were conducted bilingually (both in Chinese and English), micro-videos were made to encourage the students to absorb the knowledge more efficiently. Meanwhile, the well-known academic databases, such as “Web of Science” was used for retrieval of advanced articles to ensure the students keep track of the dynamic of the industry and achieve the goal of characteristic development for science majors in foreign languages professional universities.

Keywords: Fine Chemicals Chemistry, bilingual teaching, curriculum reform.

1. Introduction

In order to achieve the goal of “cultivating internationalized and inter-disciplinary talents for students” by Zhejiang International Studies University (ZISU), curriculum reform of bilingual teaching is necessary to conduct. Fine Chemicals Chemistry is science that study all aspects of the dynamic chemical industry, an important branch of Chemistry, also one of important necessary technologies of industrial development and research for pharmaceutical industry, agrochemical industry, food additives, flavors and fragrances, surfactants, detergents, cosmetics, adhesives and sealants and etc.

Among all the major courses of Applied Chemistry specialty, Fine Chemicals Chemistry is relatively easy for students to learn, as the contents of the course are close to daily life compared to other chemistry courses [1-3]. In our school, Fine Chemicals Chemistry is a required basic course for food analysis, drug analysis, daily chemical detection, fabric dyeing and detection, medicinal chemistry and etc. In the year 2010, Zhejiang Education College experienced by an institutional reform and changed to Zhejiang International Studies University, as approved by Ministry of Education in China. After the institutional reform, ZISU set a goal of “constructing a characteristic language university, with high quality in education level, and multi-disciplinary teaching undergraduate university”, as required by the need of economic and social development for Zhejiang Province, Yangtze River Delta region and even the nation level.

Based on the school-running characteristic of ZISU, the Chemistry major existed as a traditional specialty, expected to practice a characteristic development of science specialty in foreign languages and foreign trade university, to cultivate students with both foreign languages skills and also professional

knowledge in chemistry. Thus, for the training program of students enrolled in 2012-2016, Fine Chemicals Chemistry was planned as bilingual teaching course. For the past three years, a few achievements were observed on bilingual teaching, along with some difficulties during the curriculum reform. Therefore, the experience of curriculum reform of bilingual teaching on Fine Chemicals Chemistry were shared in this paper, including selection of teaching materials, screening of teaching contents, discussion on teaching methods, and the course assessment and etc.

2. Selection of teaching materials

Bilingual teaching of Fine Chemicals Chemistry is unprecedented in our university, neither in the whole Zhejiang Province and most of the colleges and universities across the country, especially rare in science and engineering colleges and universities, so the curriculum reform met a lot of difficulties in the selection of teaching materials. As far as we know, there were currently few bilingual teaching material of Fine Chemicals Chemistry on the market, and few original teaching materials from foreign universities worldwide for Fine Chemicals Chemistry, so finally the book "Fine Chemicals- the industry and the business" edited by Peter Pollak [4] was chosen as the original teaching material. Compared to the existing Chinese textbooks, the selected teaching material covers wider and large amount of information, not only introduced the traditional fine chemical industry, but also mentioned the corresponding characteristics of industry and associated world's top 500 enterprises and their superior products.

This book [4] provides an insider's view of the status of the fine chemical industry, as well as its outlook. It covers all aspects of this dynamic industry, with all of its stakeholders in mind, namely employees, customers, suppliers, investors, students and educators, media representatives, neighboring communities, public officials, and anyone else who has an interest in this segment of the chemical industry. Safety, health, environmental, and regulatory issues are discussed only briefly, as the related subjects are extensively reported in the specialized literature [5-8]. In the professional aspect, the book is less difficult than the domestic Chinese teaching materials; on practicality, the contents kept the pace with the development of the dynamic industry, therefore overcome the shortcomings of traditional Chinese teaching material content with relatively backward information. The teaching contents were relatively simple as close to daily life, and the students in our university have better general English skills at enrolment, providing a basis for the proceeding of bilingual course.

3. Screening of teaching contents

Within the chemical universe, the fine chemical industry is positioned between the commodity and specialty chemical industries in western countries [4]. The commodity and specialty chemical industries are their suppliers and customers, respectively. In the broad sense, the chemical companies are active in research and development, manufacturing, and marketing of fine chemicals, making it a changing and dynamic industry. The products extend from surfactants, daily chemicals, papermaking chemicals, leather chemicals, food additives, dye chemicals, sealants, painting, and agrochemicals to electronic chemicals and etc. in Japan, amounting to 51 different kinds. The emphasis of each existing Chinese textbook differs from each other, and part of the contents is out of date. If taught with contents of the fine chemical products, the structure of the production process, and the basic principle of plant operation, students may lose interest and feel boring. Therefore, screening of teaching contents is of great importance to conduct the curriculum reform effectively.

On the basis of experience in teaching fine chemicals in Chinese, taking overall consideration among the common Chinese textbooks and the book by Peter Pollak, the teaching outline was revised and the teaching contents were screened to meet the requirements of the development direction of the applied chemistry specialty. Meanwhile, to satisfy the interest of students, main teaching contents were chosen as follows: Food additives, Flavors and Fragrances, Surfactants, Detergents, Cosmetics, Pharmaceuticals, Agrochemicals, Adhesives and Sealants and etc. Those subjects are basically close to daily life, thus providing foundation for students' innovative research projects at the same time, and reference for preparation of students' employment.

All fine chemicals are used for making specialty chemicals, either by direct formulation or after chemical/biochemical transformation of intermediates to active substances [4]. Specialty chemicals are solid (e.g. tablets) or liquid (e.g. solutions) mixtures of commodities or fine chemicals and exhibit specific properties. Fine chemicals account for only about 4% of the universe of chemicals, with value of 2500 billion USD. Despite the huge business opportunity, the fine chemical industry is challenged by overcapacity and intense competition.

At present, the industry is going through radical change; therefore, the teaching contents should not be limited by the textbooks, advanced information for the fine chemical industry from specialized database (e.g. Web of Science) was also offered as supplementary materials [9-10], to provide guidance for industry dynamic for the students. For example, in the chapter of Cosmetics, most students are interested in brands of cosmetics in malls, and will pay attention to well-known enterprises such as L'oreal, Unilever, P&G, Shiseido and Estee Lauder and etc. The background of these top companies worldwide was introduced in the class; see Fig.1 for common brands of P& G Company. Cosmetics is a chapter that with content close to students' daily life, OLAY, SK- II , VS, Tide, Oral-B and Gillette are common brands in daily life of the students, their motivation for learning was observed to increase evidently, thus the interest of students were inspired during the discussion section in class. Furthermore, introduction of the knowledge on industry dynamic also played a positive role in employment of senior students. The students will be strict with themselves to meet the higher standard requirements of the target company. Students got the offer from Clinique and Estee Lauder mentioned that bilingual teaching of Fine Chemicals Chemistry gave them a very good guide for job hunting.



Fig. 1. Brands for P&G Company.

4. Selection of teaching methods

4.1 heuristic approach of teaching

Evidence of a gap in student understanding has been well documented in chemistry: the typical student holds an abundance of misconceptions [11]. The current expectation is that educational reform will foster greater student achievement via inquiry teaching within classrooms. Assessment involving conceptual knowledge in Fine Chemical Chemistry was used to determine the relationship between inquiry teaching and student achievement. Student achievement was found to positively correlate with the use of inquiry teaching about the assessed concepts, regardless of teacher experience or school context.

Fine chemicals linked with all aspects of people's daily life, the characteristics of which can easily raise the students' interest in learning. For example, in the chapter of Surfactants and Detergents, common phenomena in life were related to enhance the teaching of conceptual knowledge as surface tension. The teacher helped the students to recall the process of dish washing, analyze the change of the water surface at the moment when the detergent entered the solution. In the chapter of Cosmetics, hair dye, hair perm and sunscreen products are also interested topics among the students. The teacher helped the students to recall the process of hair perm, and distinguish the different function of two solutions used in the perm process. For sunscreen products, sun protecting factor (SPF) was the emphasis to raise the attention of students, inspire them think from daily life, and actively participate in the classroom. Then the principle for sunscreen of both chemical effect and physical effect were introduced to give a deep impression. In the chapter of Pharmaceuticals, pharmaceuticals containing more than 2000 different active ingredients are in commerce today; a sizable number of them are sourced from the fine chemical industry [4]. Some process in this chapter was too abstract and hard to understand by only oral interpretation, with the aid of multimedia pictures and video display, students can understand faster and keep in memory. As shown in Fig.2, the mechanism of action of antihistamines through cutting down the connection of H1 or H2 receptor. Also, the roots of both the term "fine chemicals" and the emergence of the industry as a distinct entity date back to the late 1970s, when the overwhelming success of the histamine H2 receptor antagonists Tagemet (cimetidine) and Zantac (ranitidine hydrochloride) created a strong demand for advanced intermediates used in their manufacturing process.

Pharmaceutical

Antihistamine drugs

□ Histamine-chemical mediator



Fig. 2. Mechanism for antihistamine drugs.

Due to different base of knowledge, students absorb knowledge to significantly different extent even in the same class. Therefore, for students that can't understand completely in the class, micro video with highlights of the class allow students to learn by themselves over and over again, especially suitable for students to learn out of class, anywhere if they want for fragmented learning [12]. Application of micro

video as one way of education reforms can make the study of students not be restricted by time and place. The teacher can avoid repeated the knowledge again and again in the class for students with learning difficulty, without affecting the efficiency and polarization of the whole class. The students can benefit from the micro video from learning continuously until fully understood. The micro video platform can also improve the teaching efficiency through preview before class, learning in class, and review after class. Besides, for micro video teaching, the integrity of the teaching contents should be paid high attention, especially heuristic approach of teaching should be applied throughout each lesson. By “practice in learning” and “learning in practice”, students are expected to improve the skills in application of basic principle and experimental method, to solve complicated problems in real life [12].

Food additives, also known as dietary supplements, are minor ingredients added to improve the product quality. Most commonly, the effects desired relate to color (colorants), flavor (flavor and fragrances), nutrient value (vitamins), taste (thickeners and emulsifiers), or stability in storage (antimicrobials, preservatives and antioxidants) [4]. In daily life, many people mistaken illegal ingredients in food for food additives, for example, the well-known "Sudan red events", the detection of industry dye in KFC Orleans roast wing cause big shock to the public. KFC Orleans roast wing is very popular among college students; take this related food safety problem as the breakthrough point, and let students pay attention to different kinds and function of food additives added in the snacks or food in their ordinary life. The market size is estimated to be 20-25 billion USD for food additives, and the major customers for food additives are introduced in class. Most big food companies such as Ajinomoto (Japan), Danone, Kraft Foods, and Nestle are customers of food additives. Nowadays, students usually has taken special care of physical health, the interpretation of different kinds of antimicrobials (benzoic acid, sorbic acid, propionic acid, and p-hydroxy-benzoate ester), antioxidants (BHA, BHT, PG, TBHQ, THBP and EMQ) based on ADI (acceptable daily intake) and LD₅₀ can help them make better decision in daily life. The students are required to distinguish different kinds and associated function of food additives in the ingredients list of snacks or processed food before purchase. In a word, the teaching efficiency can be enhanced in the process of “practice in learning” and “learning in practice”.

4.2 discussion-oriented approach of teaching

It would take a period of time for the students to adapt to the original English textbooks. In order to shorten the adaptation period, and help the students quickly adjust their study status to the expression of native English and participate in the class, discussion-oriented approach of teaching method was adopted. At the beginning of the class, the classification of Fine Chemicals was introduced in three categories, including "Commodity Chemicals", "Fine Chemicals" and "Specialty Chemicals" [4]. Among them, the "Commodity Chemicals" is defined as the "Commodities are large - volume, low price, homogeneous, and standardized Chemicals produced in dedicated the plants and used for a large variety of applications." The "Fine Chemicals" is defined as “Fine chemicals are complex, single, pure chemical substances. They are produced in limited quantities (up to 1000 MT per year) in multipurpose plants by multistep batch chemical or biotechnological processes.” "Specialty Chemicals" is defined as “Specialty Chemicals are formulations of chemicals containing one or more fine chemicals as active ingredients. They are identified according to performance properties.”

Evidence of a gap in student understanding has been well documented in chemistry: the typical student holds an abundance of misconceptions [11]. The current expectation is that educational reform will foster greater student achievement via inquiry teaching with classrooms. In the process of teaching,

students are encouraged to try to their individual understanding of each definition. It was observed that for the definition of "Commodity Chemicals", many students' understanding of the "plants" stay on the meaning of "plant" (such as trees, grasses and flowers), teacher should help them clarify that "plants" in this definition actually represent the meaning of "factories". Then Fig.3 was used to help them recognize the similarities and differences among three kinds of chemicals. Finally, at the end of this session, translation assignment on the definition of three kinds of chemicals was arranged, to help them consolidate and deepen the understanding after class [11].

5. Assessment of the course

Assessment of the course is composed of homework, attendance, in-class activity, mid-exam, and final exam. The homework and exams for bilingual courses was required to finish in English, except the assignments for professional translation. Few students really have difficulty in written English; written in Chinese but with correct answer can get a little point. Part 1 (homework, attendance and in-class activity) accounted for 20% for the final score of the course, part 2 (midterm-exam) and part 3 (final exam) accounted for 30% and 50% for the final score, respectively. The score for students enrolled in 2012 to 2014 was presented in Table 1. The pass rate for all students in the three years was relatively stable above 90%, indicating the teaching efficiency is good.

Commodities	Fine Chemicals	Specialities
single pure chemical substances...	single pure chemical substances	mixtures
produced in dedicated plants	produced in multi-purpose plants	formulated
high volume/ low price	low vol. (<1000 mtpa) high price (>\$10/kg)	undifferentiated
many applications	few applications	undifferentiated
sold on specifications	sold on specifications "what they are"	sold on performance "what they can do"

Fig. 3. Differences between commodities, specialties and fine chemicals.

Although some students in the final exam did not reach 60 points (but all were more than 50 points), the contribution of mid-term exam achievement and conversion of part 1 finally make the students enrolled in 2012 and 2013 qualified for the course. Feedback collected from the students was analyzed and discussed each year, in order to improve this course accordingly. For students enrolled in 2014, the excellent rate for the final account, the passing rate for final exam, excellent rate for final exam have significantly improved compared to the past two years. Students are encouraged to do self-directed study with creativity and passion, the results indicating that the effect of bilingual teaching reform for students in the upper level of the class is remarkable. In spite of this, the passing rate for final account of the course dropped down for the students enrolled in 2014, mainly because suspension schooling of only one student.

Table 1. Scores for students enrolled from 2012 to 2014 (%)

The year for enrollment of the students	Passing rate for final account of the course	Excellent rate for final account of the course	Passing rate for final exam of the course	Excellent rate for final exam of the course
2012	100.0	12.9	93.5	12.9
2013	100.0	15.2	90.5	6.1
2014	98.4	29.0	95.2	21.0

Note: Pass (score from 60 to 100), Excellent (score from 90 to 100).

6. Conclusions

Bilingual teaching of “Fine Chemicals Chemistry” is a tentative practice and necessary way for science specialty in foreign language oriented university, to develop the internationalized and inter-disciplinary talents for undergraduates. Heuristic approach of teaching and discussion-oriented approach of teaching were used to conduct the curriculum reform. Students are encouraged to do self-directed study with creativity and passion through micro video. Feedback collected from the students was analyzed and discussed, in order to improve this course accordingly. The results indicated that the effect of bilingual teaching reform for students in the upper level of the class is remarkable. In the future, more effort is needed to strengthen the implementation of bilingual teaching, to improve the teaching quality, and cultivate more students with high quality professional talents.

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