Received: 16 Nov. 2026 | Revised: 17 Nov. 2026 | Accepted: 20 Nov. 2026 | Published online: 25 Nov. 2026
RESEARCH ARTICLE

Contemporary Education and Teaching Research
2026,Vol. 7(11)442-446
DOI: 10.61360/BoniCETR262021171112

Exploration and Practice of Bilingual Teaching in Analytical Chemistry Experiments for International Students

Hongguo Wu[1,*] & Hu Li[2]

[1]School of Pharmaceutical Sciences, Guizhou University, Guiyang 550025, Guizhou, China

[2]Center for R&D of Fine Chemicals, Guizhou University, Guiyang 550025, Guizhou, China

Abstract: This study targets the training needs of international undergraduate pharmacy students at Guizhou University. It builds on the high-quality course Analytical Chemistry Experiments. Systematic reforms are carried out in four dimensions: teaching content, teaching methods, teaching resources, and curriculum ideological and political education. The course establishes a progressive framework of "classical titration – instrumental analysis – drug testing". It uses real pharmaceutical samples for analysis to highlight pharmacy features. Taking sodium salicylate content determination as an example, this paper presents bilingual teaching practice. The practice covers online and offline blended resources, diverse teaching modes, and multi-dimensional assessment. This course can offer references for the development of bilingual experimental courses in chemistry and chemical engineering.

Keywords: analytical chemistry experiment, international students, bilingual teaching, teaching practice

1. Introduction

In the English-only curriculum for chemistry and chemical engineering majors, experimental courses are especially difficult to develop. They feature heavy hands-on operations and abundant technical terms. Analytical Chemistry Experiments is a compulsory practical course for pharmacy, chemistry, and chemical engineering majors (Wang et al., 2026). It helps students build operational skills, data analysis ability, and scientific literacy (Xu et al., 2023). This course has formed a relatively mature system for domestic undergraduates. However, English-only teaching for international students in China is still under exploration (Zhang et al., 2016). Three main challenges exist. First, students come from countries with different educational backgrounds (Xiao & Yu, 2017). Their foundations in chemical experiments vary greatly. Second, the course contains numerous technical terms. Language barriers hinder clear delivery of operational instructions (Ren, 2021). They also limit students' performance in group discussions and experimental summaries. Third, large instruments such as high-performance liquid chromatography require complicated procedures and strict safety rules (Zhang et al., 2026; Li et al., 2025). These factors increase difficulties in teaching arrangements. Among these issues, language runs through the whole training process. Its importance is not limited to lecture comprehension. It also supports graduation projects, laboratory teamwork, and further postgraduate study in China (Xia, 2017). English-only teaching makes course content easier to follow, but it cannot develop students' Chinese academic proficiency. Bilingual teaching enables repeated comparison of terms, instructions, records, and presentations in one class (Ma et al., 2026). Therefore, experimental courses should not merely switch the teaching language. Bilingual design is required for these four parts. Relevant research on this topic remains limited.

This study is based on the high-quality course development of Analytical Chemistry Experiments for international undergraduate pharmacy students at Guizhou University. It explores and practices bilingual teaching from four aspects: optimized teaching content, reformed teaching methods, developed teaching resources, and integrated curriculum ideological and political education. The course goals go beyond knowledge delivery and skill training. International students need to master basic principles and standard operations of analytical chemistry experiments. They should also learn common Chinese experimental terms, follow basic Chinese instructions, read reagent labels and

Corresponding Author: Dr. Hongguo Wu
Guizhou University, Guiyang 550025, Guizhou, China.
©The Author(s) 2026. Published by BONI FUTURE DIGITAL PUBLISHING CO.,LIMITED This is an open access article under the CC BY License(https://creativecommons.org/licenses/by/4.0/).

instrument marks, and complete experiment records and result communication in Chinese. Group discussions, question responses, and experimental summaries in class alternate between Chinese and English. Students practice oral and academic expression in real experimental scenarios. This helps them solve the problem of "understanding but being unable to speak". Such language ability supports international students' future development in China. These goals require coordinated support from teaching content, methods, and resources. This exploration aims to offer references for the construction of similar courses.

2. Background of Bilingual Experimental Teaching

Analytical Chemistry Experiment was first launched in the second semester of the 2024–2025 academic year. It is a compulsory practical course for first-year international pharmacy students. The course has a total of 36 class hours and includes eight experimental modules. The course follows the training objectives of pharmacy professionals. It connects closely with students' prior learning of Inorganic Chemistry Experiment in the first semester of freshman year and adopts a teaching principle from simple to complex. The experimental content is designed reasonably. The core content of this bilingual course covers classic titration techniques and integrates modern instrumental analysis methods such as ultraviolet absorption spectrophotometry and high-performance liquid chromatography. The course balances basic operational training and modern analytical testing ability development.

3. Construction and Practice of Bilingual Experimental Teaching

3.1. Optimization of Teaching Content

The course builds on the foundation of the freshman course Inorganic Chemistry Experiment. It optimizes the content following three principles: from simple to complex, linking theory with practice, and focusing on pharmacy. Common titration analyses, including acid-base titration, redox titration, and complexometric titration, serve as the core to consolidate basic operational skills. These experiments match key points in the analytical chemistry theory course. Meanwhile, modern instrumental analysis experiments are arranged. Examples include ultraviolet spectrophotometry for identification and assay of vitamin B_{12} injection, and high-performance liquid chromatography for hydrocortisone content determination. The course closely follows practical demands of pharmaceutical quality control. Real drug samples such as sodium salicylate, vitamin B_{12} injection and hydrocortisone are selected as analytical targets. This feature reinforces the course's pharmacy orientation and practical value. Verified and practical experimental modules are arranged properly. The teaching forms a progressive sequence: basic skills, instrument operation, and drug detection. This design fits the cognitive rules and training requirements of international students.

3.2. Teaching Method Reform

The course adopts a diversified teaching model integrating online and offline resources, bilingual interaction, and process-oriented guidance. It shifts classroom teaching from one-way lecturing to joint exploration between teachers and students. Offline classes focus on operation demonstrations, group collaboration, and problem-driven learning. Online resources are provided on the Chaoxing Learning Platform with short operation videos. Students learn instrument structures and key procedures before class by watching the videos repeatedly. This strategy eases the constraints of insufficient instruments and limited opening hours, reserving more instrument time for real sample analysis. Bilingual teaching runs through the whole course. Key terms are presented in both Chinese and English with unified expressions. This reduces language barriers and improves cross-cultural learning adaptation. The assessment uses process evaluation, with grading covering operational standards, raw data records, experimental reports, and teamwork. This approach reverses the tendency to prioritize final results over learning processes and encourages independent study and exploration.

3.3. Teaching Resource Development

The three-in-one teaching resource is established, consisting of authoritative textbooks, self-compiled handouts, and bilingual materials. For basic titration and ultraviolet spectrum experiments, Analytical Chemistry Experiments and Guidance (3rd edition, edited by Zhengyu Yan and Yingxiang Du, China Medical Science Press) serves as the core textbook to guarantee standardized teaching. Considering the available instruments in our school, we compiled a bilingual laboratory guide for high-performance liquid chromatography. Key terms, operating procedures, and safety tips are provided in both Chinese and English. The guide fits the teaching needs of international classes. We also develop supporting resources, which include standard operation videos, bilingual laboratory manuals, and online preview materials. They form a reusable and expandable bilingual resource library for experimental teaching. The library offers comprehensive learning support for international students. Online experimental chapters have been built on the Chaoxing Learning Platform in advance. International students can check relevant experimental content anytime.

3.4. Integration of Curriculum Ideology and Politics

We integrate ideological and political elements subtly according to the training characteristics of international students. Standard experimental operations and truthful data recording are required in teaching. These practices cultivate students' rigorous scientific spirit and academic integrity. Professional content such as drug quality testing and pharmaceutical analysis is introduced. Students recognize that drug safety is vital to public health, and build professional responsibility and craftsmanship rooted in precise testing, strict standard implementation, and reliable drug safety assurance. We share research progress in analytical chemistry to convey the notion that science has no borders and cooperation fuels development. Group experiments help students build communication skills and an international vision of mutual respect and inclusiveness. Knowledge instruction, ability training, and value guidance function jointly to help international students develop into global pharmacy talents with professional competence and humanistic care.

4. Case of Bilingual Teaching in Analytical Chemistry Experiments

Sodium salicylate is a common raw material for antipyretic and analgesic drugs. Two reasons support the selection of this drug as a teaching case. First, students do not titrate an abstract "unknown sample". Instead, they test a batch of bulk drug pending release. The purpose of the operation and the meaning of data become concrete. Second, this system creates a clear cognitive conflict. Sodium salicylate is a salt of a weak acid and a strong base. Its $K_{b2} = K_w/K_{a1} = 9.4\times10^{-10}$. At the concentration of 0.1 mol/L, $C\cdot K_{b2} = 9.4\times10^{-11}$. This value is lower than the criterion 10^{-8} for direct titration. No obvious titration jump can be observed in aqueous solution. Students have to change the solvent and rebuild titration conditions. This "failure-reconstruction" process turns the solvent effect from an abstract concept into a practical problem to solve. For international students, this case also provides concentrated language training. Terms such as criterion, solvent, endpoint, and blank are matched repeatedly between Chinese and English. Both principle explanations and operation instructions are delivered in two languages.

4.1. Teaching Implementation

Two to three days before class, experiment notices, bilingual courseware, and demonstration videos are released on the Chaoxing Learning Platform. Students finish pre-class quizzes after previewing. Related instruments are cleaned, dried, and labeled in English. Mixed solvents are freshly prepared and sealed. This prevents moisture absorption during storage. Key terms in bilingual courseware are arranged in three columns: English—Chinese—Symbol. Demonstration videos carry both Chinese and English subtitles. Operation instructions are provided in two languages simultaneously. The pre-class quiz includes term-matching questions. Students match English terms with their Chinese equivalents. This prepares them for Chinese expression in class.

The theoretical part starts with a guiding question: "Why cannot sodium salicylate be titrated directly in aqueous solution?" The teacher raises the question first in English and then repeats it in Chinese. Students may answer in either language. The $C\cdot Kb_2$ criterion explains the absence of a titration jump. Next, the function of the solvent is introduced. Glacial acetic acid acts as a protic acidic solvent. It strengthens the basicity of weak bases. Acetic anhydride absorbs trace water and reacts with water to form acetic acid. It reduces water interference in titration. The overall reaction $C_7H_5O_3Na + HClO_4 \rightarrow C_7H_6O_3 + NaClO_4$ is written on the blackboard. Its essence is proton transfer, where a stronger acid produces a weaker acid. The mass fraction is calculated by $w\ (\%) = [(V-V_0)\times C\times M]/(1000\times W\text{sample})\times100$. Blank correction is highlighted. The solvent and indicator consume a small amount of perchloric acid. The result will be systematically high without subtracting this blank value. Therefore, blank tests are run in parallel with sample tests. Temperature correction follows the formula $C_1=C_0/[1+0.0011\ (t_1-t_0)]$. Take $t_0 = 25$ ℃、$t_1 = 30$ ℃、$C_0 = 0.1000$ mol/L as an example. The calculated $C_1 = 0.09945$ mol/L. Students are informed that recalibration is required when the temperature difference exceeds 10 °C. For the question "why moisture must be avoided", a simple explanation is given. Water is a weak base. It competes with sodium salicylate for perchloric acid. This keeps the focus away from mere operational rules.

The practical session follows a demonstration-then-practice sequence. The demonstration states acceptable criteria for four key steps. First, dry the sample at 105 °C to constant weight, and weigh approximately 0.13 g (accurate to 0.0001 g). Second, add 10 mL of mixed solvent and one drop of 0.5% crystal violet indicator into a dry 50 mL conical flask. Third, titrate with 0.1 mol/L perchloric acid. Add the titrant dropwise by half-drops near the endpoint. Fourth, the endpoint is reached when the colour changes from purple to blue-green and remains stable for 30 seconds. Read the volume to 0.01 mL. Two faulty endpoint groups are set for comparison. One stops too early when the solution just turns blue. The other is over-titrated until the solution turns green. Standard colour cards are provided. They convert vague colour descriptions into visible references. Students work in pairs and swap roles. One carries out the operation, and the

other records data. The recording sheet has bilingual headers in Chinese and English. Students fill in data in Chinese. English terms can be added for professional nouns. Teachers patrol the laboratory to inspect glassware drying, burette rinsing, bubble removal, half-drop control, and timely raw-data recording. They also remind students to recycle solvents.

The summary session uses a series of guiding questions. Why is direct titration unavailable? What changes after solvent replacement? Which factors lead to high or low results? How do blank and temperature corrections eliminate systematic errors? How should we calculate and present final results? The lab report must include initial and final burette readings. A comparative thinking question is assigned. The endpoint of potassium hydrogen phthalate titration is blue, while that of sodium salicylate titration is blue-green. What causes this difference? This question links endpoint colour to the acidity of titration products and the medium acidity at the endpoint. It prevents students from memorising colour results mechanically.

4.2. Implementation Outcomes and Improvements

Two obvious positive changes were observed in practice. When explaining why an anhydrous environment is required, students can refer to the underlying mechanism. They know that water consumes perchloric acid and lowers the final result. They no longer merely repeat operational rules. After colour cards and wrong endpoint controls were introduced, group members reached consistent judgements on colour changes. The rework rate caused by premature endpoint recognition decreased. Progress in language performance was also noticed. Most students could only state terms in English during preview. By the summary session, they could actively report operations with Chinese expressions such as “half-drop”, “blue-green” and “blank”. Group discussions gradually shifted from full English to mixed Chinese and English. Students with limited Chinese proficiency could join discussions with the help of term lists. Existing problems and corresponding improvements are listed below. Students with weak Chinese still struggle to explain principles. English handouts will be distributed before class. Students with better foundations tend to take over the whole titration task in groups. Fixed mixed-ability grouping will be adopted. The assessment rule requires every student to finish one independent titration. Students often mix up t_0 and t_1 in the temperature correction formula. In-class calculation examples will be added. Some lab reports lack initial burette readings and show inconsistent significant figures. Filled templates will be supplied, and raw data recording will begin immediately after practical operation.

4.3. Process Assessment of the Experiment

This study adopts process-oriented assessment. The total score is 100 points. Pre-class preview accounts for 20 points. It covers online micro-video learning, preview quizzes, and discussions. Term matching and Chinese reading practice take up 5 points of this section. Experimental operation accounts for 30 points. Grading items include weighing, endpoint judgement, safety management, and solvent recycling. The laboratory report accounts for 30 points. It evaluates data organization and error analysis. Post-class thinking tasks account for 20 points. Students reflect on existing problems in the experiment and put forward improvement suggestions. Experimental performance is no longer dominated by laboratory reports. This changes the tendency of valuing final results over learning processes. Diversified final assessments help evaluate the effect of bilingual teaching. They also further stimulate international students’ interest in analytical chemistry experiments.

5. Teaching Outcomes and Reflections

After one semester of teaching practice, the construction of the English-only course Analytical Chemistry Experiments has achieved preliminary results. The course forms a complete progressive system: classic titration, modern instrumental analysis and drug testing. Its eight experimental modules cover core techniques of analytical chemistry. The online-offline blended teaching model effectively improves international students’ preview efficiency and classroom engagement. The developed bilingual teaching resources offer comprehensive learning support for international students. Judging from laboratory reports and operation assessments, international students show obvious progress. They perform better in standard titration operations, skilled instrument manipulation, and data processing, along with improved professional English proficiency and cross-cultural communication skills.

Meanwhile, several problems remain to be solved. (1) Some international students have poor Chinese proficiency. They struggle to understand Chinese explanations in bilingual sessions. More complete and readable English handouts will be prepared. (2) International students vary in prior experimental foundations, leading to uneven progress among groups in hands-on practice. We will optimize grouping strategies by pairing students of different levels and providing targeted guidance for slower groups. (3) Temperature correction and endpoint colour judgment in non-aqueous titration remain difficult points. More examples and practice tasks will be added. (4) The number of high-performance liquid chromatography instruments is limited. Each student gets insufficient operating time. Virtual simulation experiments and operation videos can be used as supplementary teaching tools. We will

continuously optimize course content and teaching methods to address these issues and further improve the quality of this English experimental course.

6. Conclusion

This study is based on the high-quality course development of Analytical Chemistry Experiments for international undergraduate pharmacy students. It systematically illustrates the reform practice from four dimensions: teaching content, teaching methods, teaching resources, and curriculum ideological and political education. The course highlights the features of pharmacy. It features strong pharmacy orientation and practical value, and applies a diversified teaching mode suitable for bilingual learning. The mode effectively improves international students' experimental skills and professional competence. Besides, their Chinese academic expression ability is improved simultaneously, laying a linguistic foundation for their future development in China. The experience of this course can provide useful references for the reform and practice of experimental courses for international students majoring in chemistry and chemical engineering.

Conflict of Interest

The authors declare that they have no conflicts of interest in this work.

Acknowledgement

This research was supported by the High-quality Course Project of Guizhou University (XJGYW015) and the Curriculum Ideology and Politics Demonstration Course of Guizhou University (kcsz2026036).

References

Li, Y., Ding, F., Yan, J., et al. (2025). Improving instrumental analytical chemistry laboratory teaching: Developing a bilingual classroom to cultivate innovative talents. *University Chemistry*, *40*(7), 83–89.

Ma, J., Li, X., Cheng, J., et al. (2026). Integrated education of polymer chemistry between domestic and international students. *Chemistry Education (Chinese and English)*, *47*(10), 118–123.

Ren, K. (2021). Reflections and strategies on Chinese language teaching for international engineering students taught in English. *Chinese Character Culture*, (S1), 85–87.

Wang, S., Zheng, X., & Wang, F. (2026). An exploration of educational reform in analytical chemistry experiment under the new engineering discipline. *Journal of Science and Education*, *20*(20), 103–106.

Xia, C. K. (2017). Some thoughts on bilingual teaching for undergraduate international students in chemical engineering. *Contemporary Education Research and Teaching Practice*, (8), 77–78.

Xiao, Y., & Yu, Q. (2017). Experience on analytical chemistry laboratory teaching in English for international students major in pharmaceuticals. *University Chemistry*, *32*(8), 37–41.

Xu, F., Li, R. Y., Zou, Q., et al. (2023). Investigation and research on self-designed experiments in analytical chemistry experiment teaching. *Guangdong Chemical Industry*, *50*(1), 220–222+203.

Zhang, R., Liu, H., Jia, W., et al. (2026). Teaching reform pathways for instrumental analysis courses in light chemical engineering under the new engineering disciplines. *Journal of Science and Education*, *20*(9), 119–123.

Zhang, Z., & Li, G. (2016). English-based teaching methods for chemical analysis laboratory course. *University Chemistry*, *31*(4), 12–16.

How to Cite: Wu, H., & Li, H. (2026). Exploration and Practice of Bilingual Teaching in Analytical Chemistry Experiments for International Students. *Contemporary Education and Teaching Research*, 7(11), 442-446. https://doi.org/10.61360/BoniCETR262021171112