

Advances in Teaching Research on English for Chemistry Majors (2014-2025)

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Abstract. The interdisciplinary approach of "foreign language + specialty" education has driven a significant shift in higher education from traditional single-discipline instruction to cross-disciplinary integration, reflecting its profound contemporary relevance. Based on 334 research articles indexed in the CNKI database (2014–2025) under the theme of "Chemistry English Teaching," this study employs bibliometric and content analysis methods to systematically review research advancements. By constructing keyword co-occurrence and author collaboration networks, the paper delineates the evolution of research hotspots. Findings indicate that the field of Chemical English education has achieved great progresses over the past decade, with notable upgrade in resource development and pedagogical models. However, persistent challenges, such as inadequate teacher qualifications, insufficient strategic planning, misalignment with employment demands, and limited engagement from educators and students, continue to hinder educational effectiveness. Given this, the study integrates insights from ESP (English for Specific Purposes) teaching theory to propose actionable recommendations, offering a reference for reforming Chemistry English instruction in the new era.

Keywords: interdisciplinary teaching, Chemistry English teaching, bibliometrics, ESP teaching, English teaching reform

1. Introduction

1.1. Research background and significance of study

1.1.1. Research background

Interdisciplinary talents must master both specialized knowledge and advanced English proficiency, serving as key drivers of national innovation. As chemistry underpins critical sectors like the chemical industry, pharmaceuticals, and new materials, the English competence of chemistry professionals significantly impacts China's global competitiveness. ESP theory addresses this challenge by integrating language instruction with disciplinary demands. Its branch, English for Academic Purposes (ESAP), specifically supports international scholarly exchange in specialized fields [1]. For chemistry, ESP teaching focuses on equipping students with the skills to access

cutting-edge research and engage in global academic discourse—fulfilling the societal demand for versatile talent.

However, English teaching for chemistry majors in colleges and universities in China is still facing severe challenges. The traditional teaching mode is difficult to meet the requirements of the construction of “new engineering” for the cultivation of international talents; on top of that, there are obvious inter-school differences in teaching effects, especially the students in local colleges still have great room for improvement in the application ability of professional English [2]. Based on ESP theory, many scholars have analyzed the current situation of chemistry English teaching and explored the way of teaching reform.

1.1.2. Significance of study

In the report of the 20th National Congress of the Communist Party of China, General Secretary Xi proposed, “Expand international scientific and technological exchanges and cooperation, strengthen the construction of an international scientific research environment, and form an open and innovative ecology with global competitiveness.” Therefore, it is necessary to internationalize chemistry specialty. Internationalization process is a two-way dynamic process of externalization and internalization simultaneously, that is, internationalization and localization should be realized in parallel [3]. However, to cultivate talents with international consciousness, understanding of world culture and international competitiveness, we need not only talents who understand foreign languages, but also talents who understand both foreign languages and majors. As an important driving force for social development, undergraduate education in colleges and universities must have a global vision and should be able to cultivate both broad and solid basic knowledge and basic skills according to the standards of international cooperation and global competition. And have the ability to cooperate with others and international exchanges of high-quality compound talents [2]. English teaching for chemistry majors is the first and most important step towards internationalized talents. The establishment of chemistry English can help students accurately obtain international cutting-edge chemical literature and scientific research trends, and promote academic exchange and achievement sharing. At the same time, improve the international communication ability of chemical professionals, adapt to the needs of transnational scientific research cooperation and international development of chemical industry, and promote knowledge dissemination and professional development.

Therefore, the author can clarify the development of chemical English teaching theory and construct a more systematic teaching theory framework by combining the research progress of more than ten years. At the practical level, the author summarizes the successful teaching models and experiences, which can provide reference for front-line teachers and avoid repeated exploration. At the strategic level, the author analyzes the current challenges and future trends, which is helpful for education management departments to formulate more scientific chemical talent training policies.

The research focuses on the following core questions:

- 1) What significant advancements have been made in the teaching of English for chemistry majors over the past decade? What major challenges still persist?
- 2) Looking ahead, what developmental trends can we expect in the field of English language instruction for chemistry?

Between 2014 and 2025, many innovative research findings and practical explorations have emerged in the field of Chemistry English teaching, fundamentally transforming traditional teaching methods and paving new pathways for enhancing students' professional English proficiency. By

examining these issues, this paper aims to offer valuable insights for the ongoing improvement and innovation in the teaching of English for chemistry.

2. Research methods measurement

This study is based on the literature collected by China Knowledge Network (CNKI) as the data source. Through advanced search, 580 related articles were obtained. Screening was conducted according to the following criteria: the time range should be clearly defined from 2014 to 2025; non-academic literature such as conference abstracts and news reports should be excluded; teaching research in basic education should be eliminated; and duplicate publications should be eliminated.

Finally, 334 valid articles were determined to constitute the study sample, and CiteSpace 6.2.R4 and VOSviewer 1.6.19 were used for quantitative analysis. Using Python to plot the number of annual publications, you can get the following figure:

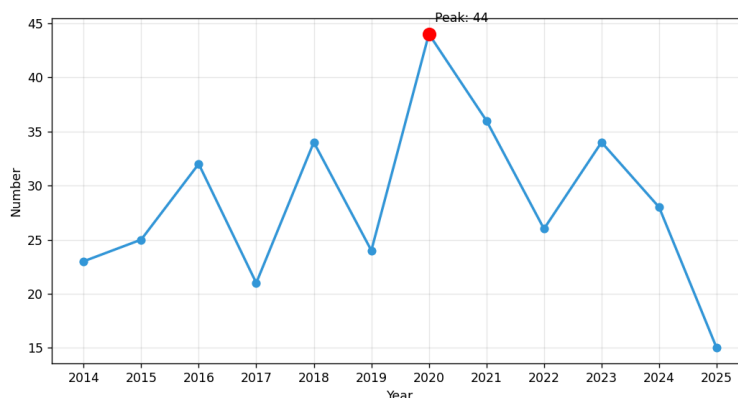


Figure 1. Annual publication volume of literature on Chemistry English teaching

As illustrated in the graph, the annual publication count of chemistry-related English research papers demonstrates an overall pattern of initial fluctuation followed by decline. During the fluctuation exploration period (2014-2018), the average yearly output stood at 27 articles (± 5.6 standard deviation), peaking at 32 publications in 2016 before dropping sharply to 21 in 2017. This anomalous variation may correlate with academic debates surrounding subject positioning, potentially triggered by the 2017 College English Teaching Guide's first explicit classification of ESP (English for Specific Purposes) curriculum status. These fluctuations reflect ongoing theoretical discussions within academia regarding the pedagogical nature of chemical English. The subsequent policy adjustment period (2019-2022) exhibits characteristic policy-responsive trends. Notably, publication numbers surged to a historic high of 44 articles in 2020, marking an 83.3% increase from 2019. This dramatic rise appears directly linked to the mandatory "deep integration of professional English and curriculum ideology" requirements introduced in that year's New Engineering Construction Program. The subsequent decline from 2021 to 2022 represents a typical pattern of policy effect absorption and normalization. Entering the transformation and development phase (2023-2025), publication numbers rebounded to 34 in 2023 - the second-highest recorded level. However, the sharp decline to 15 articles in 2025 requires cautious interpretation: this apparent drop may reflect data collection time lags, particularly delays in the publication cycles of core journals, rather than representing an actual reduction in research activity.

Therefore, it is of great significance to carry out a systematic review of the research on English teaching for chemistry majors from 2014 to 2025. At the theoretical level, by combing the research

progress of more than ten years, we can clarify the development of chemical English teaching theory and construct a more systematic teaching theory framework; at the practical level, we can summarize the successful teaching models and experiences, which can provide reference for front-line teachers and avoid repeated exploration; at the strategic level, we can analyze the current challenges and future trends, which will help the education management departments to formulate more scientific chemical talent training policies.

3. In-depth analysis of research topics

This paper discusses the application of ESP theory in English teaching for chemistry majors from two aspects: teaching mode and teaching materials.

3.1. Plurality and innovation of teaching mode

3.1.1. PBL

Problem-based learning (PBL) is needed to solve the mismatch between learning ability and career development. Its core is to encourage and support learners to explore actively, solve problems cooperatively, develop interpersonal communication and other comprehensive qualities, change learners 'passive learning methods, emphasize learners' knowledge and skill formation process, and develop learners 'comprehensive qualities [4].

Chemistry is an experimental subject, usually in the process of scientific research is to study and life problems as a guide to promote the development of experiments. For instance, in an organic chemistry English course, instructors might pose the question: "How can the synthesis mechanism of ethyl acetate be accurately described in English?" Students would then work collaboratively to research English-language literature, discuss the reaction steps and reagent functions in English, and ultimately deliver a structured presentation explaining the chemical process. The introduction of PBL method in chemistry English strengthens students 'ability to think independently about problems, promotes students to acquire knowledge consciously, not only exercises students' problem-oriented ability, but also greatly improves students 'English comprehensive ability, and realizes the ultimate goal of international talent cultivation.

3.1.2. Method of discussion

Discussion teaching is based on heuristic teaching thought, under the teacher's prompt and guidance, students are inspired to think actively about problems, and students and teachers communicate and interact with each other to think and learn, so that students can master teaching knowledge points. Through discussion teaching, we can not only accomplish the task of imparting knowledge in traditional teaching, but also improve students 'comprehensive quality [5]. Discussion teaching is generally divided into two types:

The leading style emphasizes that the teacher designs a series of step-by-step problems, and the students achieve the purpose of learning new knowledge through discussion of these problems. In order to make students master the corresponding knowledge points, teachers guide the classroom. Some scholars mentioned that students were asked to observe the naming rules of Ag^+ and Fe^{2+} , and independently obtain the single valence metal element, i.e. element name +ion (cation's name=element+ion), and the metal element with variable valence was represented by Roman numerals (cation's name=element name (oxidation state)) [6]. Open-ended free discussion around a certain theme, not setting up knowledge points that must be mastered through discussion, but to

inspire students 'divergent and critical thinking, exercise discussion and communication skills as the main purpose. Students can ask and discuss various interesting questions about this topic. In the early teaching activities, teachers can use guided teaching method to cultivate students 'interest in chemical English and their ability to review literature. When students 'knowledge thickness increases and they can construct knowledge points into knowledge maps independently and discover differences and commonalities, we should use open teaching methods to cultivate students' ability to discover problems and assist students in future scientific research and work.

3.1.3. Interactive

Interactive teaching method refers to the process of achieving the above goals through mutual promotion and communication between teaching and learning in an all-round way from the perspective of modern education, aiming at meeting the effective needs of students and social talents under the conditions of market economy, and promoting the improvement of teachers 'own level and teaching effect. Interactive teaching method emphasizes the interaction and communication between students and between teachers and students, and focuses on cultivating students 'overall ability [7]. This teaching method requires students to have the exploration spirit of "breaking the casserole and asking the end", and also has greater requirements for teachers 'teaching ability. It requires teachers to have a good mentality of being "asked" by students and a broader knowledge breadth, and finally complete the ultimate goal of teaching and learning.

3.2. Teaching materials

3.2.1. Traditional textbooks

Since the rise of university education, paper textbooks have been occupying the mainstream position. At present, the compilation and publication of professional English textbooks are flourishing in China. According to statistics, there are 16 kinds of English textbooks for chemistry majors published in the new century [8]. However, since ESP teaching in China is still in its infancy, there is a lack of systematic theoretical research [9]. Most of the paper textbooks are compiled with teachers 'limited experience. Due to the rapid development of chemistry major with the times, some textbooks are aging and cannot keep up with the speed of professional development. Some textbooks are compiled by English teachers or chemistry teachers or chemistry and English teachers in partnership. They lack systematic and theoretical mastery of professional English. English teachers do not understand chemistry and chemistry teachers are not good at English. The two partners can not achieve real integration, resulting in uneven quality of this part of the textbook.

3.2.2. Mind mapping

Mind mapping (mind map), also known as mind map, was developed by Tony Buzan, a famous British educator and psychologist. (Tony Buzan) invented and created [10] the Mind Map in 1971 by the central topic, according to the producer's thinking logic.

English words are generally composed of prefix, root and suffix. Chemical English vocabulary is usually composed of three common ways: prefix + root, root + suffix, prefix + root + suffix. Prefix changes the meaning, suffix changes the part of speech. For example, fluorine element (fluorine), its root "fluorine-", derived from Latin, has the meaning of "flow (flow) or fluorite", in chemical terms means "fluorine or fluorine". The corresponding halogen ion naming rule is "root +ide", so the fluoride ion is named "fluoride" [11]. From this, it can be deduced that by summarizing and

inducing suffixes, roots and prefixes, a large and complex vocabulary can be disassembled to help students understand, recite and apply vocabulary.

3.2.3. Multimedia software

As an interdisciplinary integration of chemistry and English, Chemistry English education is undergoing technological transformation, particularly through multimedia applications: audio technology enhances listening comprehension by helping students master professional vocabulary pronunciation and improve auditory recognition; video resources revolutionize teaching through micro-lectures (5-15 minutes) for fragmented mobile learning and recorded lectures for self-paced mastery of complex concepts; while online classrooms, empowered by 5G technology, enable cross-campus interactive teaching and asynchronous learning, though current PPT-based courseware often suffers from outdated content and uninspired design that fails to keep pace with chemical advancements. In addition, modern paper books (RAYS system) combine paper textbooks with two-dimensional codes, realizing the digital transformation of traditional textbooks. Embed richer multimodal content such as audio explanations and experimental videos in addition to retaining the advantages of paper textbooks [12]. The appearance of modern paper books makes the unified teaching materials glow with vitality. Through the two-dimensional code, audio and video are integrated, the transformation of paper teaching materials in the Internet era is realized, the monotonous and single problems of teaching materials are made up, and students' understanding of knowledge points is deepened.

4. Existing challenges

Despite these advances, English teaching for chemistry majors still faces profound challenges. The disjunction between teaching content and actual demand, students' lack of motivation and weak foundation, structural contradiction of teachers' team and imbalance in technology application constitute the main bottlenecks restricting the improvement of teaching quality.

4.1. Faculty resources

A part of chemistry English teachers are chemistry teachers. Although they have a certain language foundation, they have not studied language education theory professionally and systematically. Therefore, in order to enrich and improve the teachers' strength, teachers need to train listening, speaking, reading, writing and translating constantly on the basis of chemistry study, maintain language level and train systematic English language teaching theory. Part of English teachers for chemistry majors are English teachers, lacking understanding of chemistry subjects and frontier chemical knowledge. There are also some colleges and universities that have established cooperation mechanisms, but both of them lack theoretical teaching for each other and cannot realize real cooperation.

4.2. Microscopic limitation

ESP curriculum construction is limited to foreign language educators' exploration of micro-teaching ecology, such as teaching ideas, teaching design, teaching methods, teaching evaluation, etc., and lacks strategic thinking on the overall planning of higher education [3]. There is no consideration of macro and long-term issues such as how ESAP courses are more closely integrated with students' professional learning and future career development, how to serve the school's talent training

objectives, discipline construction planning, and even how to adapt to the social demand for compound talents. When constructing English education for chemistry majors, educators should take POA (Output-Oriented Approach) as theoretical basis, truly understand the problems students encounter in their major work, and design courses with problem-solving orientation.

4.3. Outdated teaching materials

The reality is that many schools still use the old textbooks of the 1980s, some directly use professional literature as teaching materials, and some self-compiled handouts. Theoretically, these materials lack the guidance of linguistics, pedagogy and psychology when they are selected and compiled; in practice, they are difficult, inappropriate in content, lack of creativity, timeliness and interest, and are difficult to satisfy students [3]. Therefore, the innovation of teaching materials, the integration of modern multimedia teaching methods, and the study of more modern paper books have become the focus and difficulty of the reform of chemical English major education.

4.4. Lack of attention

The marginalized status of English curriculum has not changed. Most teachers of chemistry major regard English as an auxiliary course, which leads to students of chemistry major regard English as a secondary course. Both of them pay little attention to English learning, which leads to a single learning method and a single examination method. Students only think that they can know words, but ignore the training of writing, listening and speaking, which makes it difficult to meet the needs of students' English level in future work.

5. Conclusions and recommendations

Based on the CNKI database of 334 articles on the subject of "chemistry English teaching" from 2014 to 2025, the following conclusions and prospects are drawn from the above analysis:

5.1. Research conclusions

Over the past decade, ESP curriculum development in chemical English education has achieved systematic progress in curriculum design, teaching resources, faculty development, and pedagogical innovation, particularly in materials development. The rapid advancement of internet technologies has significantly diversified multimedia applications in higher education, with teaching tools evolving from basic PPTs to audio, video, and ultimately online classrooms—a transition accelerated during the pandemic. Modern digital resources have gradually replaced traditional textbooks, establishing a more robust foundation for instruction. Compared to a decade ago, these developments reflect comprehensive, profound improvements, driven by interdisciplinary integration and societal demands, resulting in both quantitative expansion and qualitative enhancement of ESP courses. However, persistent challenges remain, particularly in faculty development: the current quantity and quality of teachers fall short of supporting high-quality instruction, failing to meet the discipline's specialized and systematic demands. Additionally, chemical English education lacks strategic integration within higher education frameworks, resulting in insufficient long-term planning and disconnects between instructional objectives, industry needs, and student career readiness. Compounding these issues, both faculty and students often undervalue the discipline's role in academic and professional development, further limiting educational outcomes.

5.2. Research prospects

Future efforts must deepen theoretical research to establish a more rigorous framework for chemical English education while achieving a qualitative leap in faculty development through enhanced training and interdisciplinary collaboration. To align with evolving educational demands, teaching practices should integrate cutting-edge trends, leveraging AI and digital tools to innovate pedagogy. Key recommendations include: [1] increasing institutional support through dedicated funding for curriculum development, resource sharing platforms, and cross-departmental collaboration; [2] building interdisciplinary teaching teams that combine expertise in chemistry and English, supported by regular training and workload incentives; and [3] shifting pedagogical focus from language mechanics to communicative competence, using task-based and project-based methods. Faculty should cultivate three core competencies: linguistic proficiency, subject-matter expertise, and intercultural communication skills, achieved through ongoing engagement with international journals, academic exchanges, and case-based learning. Additionally, AI-driven tools like virtual simulations and intelligent learning platforms should be strategically incorporated, balanced with guidance on ethical technology use and academic integrity. Therefore, the future teaching concept needs to shift from knowledge transmission to ability cultivation and lifelong learning; intelligent technology needs to develop from auxiliary tools to deep integration into the whole teaching process; curriculum system needs to move from fixed unity to flexible modularization and interdisciplinary integration; in order to achieve a more personalized, intelligent and practical future of chemical English teaching.

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