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Exploring teaching reform of the course *Scientific Writing and Communication* in the AI era

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Abstract. *Scientific Writing and Communication* is a specialized course offered in undergraduate education for the major of Special Energy Technology and Engineering. In the course's teaching practice, several issues have emerged, including insufficient practical training for students, weak scientific research foundations, limited awareness of academic norms, and a single-dimensional evaluation system. Against the backdrop of AI empowerment, this paper proposes reforms from multiple perspectives, including optimizing teaching content, constructing innovative teaching models, implementing project- and task-driven learning, diversifying feedback mechanisms, regulating the use of AI tools, and adopting varied assessment methods. These measures aim to improve the teaching effectiveness of the course, enhance students' abilities in literature retrieval and scientific paper writing, and support the cultivation of interdisciplinary professionals in special energy technologies.

Keywords: *Scientific Writing and Communication*, practical teaching, artificial intelligence, teaching reform

1. Introduction

Scientific papers serve as an important medium for the dissemination of research achievements, academic communication, and the accumulation of knowledge. For science and engineering students in higher education institutions, mastering the methods and norms of scientific paper writing is not only necessary for completing course papers, graduation theses, and research training, but also constitutes an essential foundation for future engagement in scientific research, engineering and technological development, project application, and academic exchange [1]. As a methodological course, *Scientific Writing and Communication* aims to help students understand the basic procedures of scientific research, become familiar with the linguistic characteristics, structural conventions, and writing requirements of scientific papers, and develop fundamental competencies in literature retrieval, information analysis, paper composition, figure and table preparation, research presentation, and academic communication.

The major of Special Energy Technology and Engineering is characterized by strong interdisciplinarity, engineering orientation, and innovation, involving multiple fields such as chemistry, materials science, mechanics, energy engineering, information technology, equipment manufacturing, and safety engineering. Students in this discipline are expected not only to possess solid professional knowledge, but also to develop strong capabilities in scientific expression, engineering communication, information acquisition and

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processing, as well as lifelong learning. Therefore, the course *Scientific Writing and Communication* plays an important role in supporting the talent cultivation objectives of this major.

In recent years, generative artificial intelligence technologies represented by OpenAI's ChatGPT have developed rapidly. Artificial intelligence has been widely applied in literature retrieval, manuscript polishing, language translation, data analysis, figure generation, topic selection assistance, and academic communication [2]. AI technology has introduced new tools and learning scenarios for the teaching of scientific writing, while also posing new challenges to traditional teaching models, student competency development, and academic ethics education [3]. Against this background, how to scientifically understand the influence of AI on scientific writing courses, appropriately utilize AI to improve teaching quality, and at the same time prevent academic misconduct and excessive dependence on AI has become an important issue that urgently requires exploration in the reform of this course.

2. Analysis of the current situation of the *Scientific Writing and Communication* course

Scientific Writing and Communication is a general education course offered in the undergraduate program of Special Energy Technology and Engineering. The course aims to enable students to gain insight into frontier developments and research hotspots in their discipline, while developing the ability to actively retrieve, acquire, summarize, and update relevant knowledge and skills. In addition, students are expected to become familiar with the norms and methods of scientific writing and to be capable of correctly and professionally composing research papers, technical reports, and other academic documents in the field of special energy technology. As a skills-oriented course, *Scientific Writing and Communication* possesses strong practical relevance. However, several problems have gradually emerged during the teaching process, which are summarized as follows.

2.1. Excessive emphasis on normative instruction and insufficient practical training

At present, the course *Scientific Writing and Communication* mainly covers topics such as an overview of scientific papers, literature retrieval, paper structure, abstract writing, introduction writing, organization of the main text, conclusion writing, and reference formatting. These contents help students establish a fundamental knowledge framework for scientific writing. However, in actual teaching practice, some classes still rely predominantly on teacher-centered instruction, with students remaining largely passive recipients of knowledge. The development of scientific writing competence cannot be achieved solely through theoretical explanation; rather, it requires continuous practice through reading, imitation, revision, and feedback. Nevertheless, due to limited teaching hours, large class sizes, and the heavy workload associated with grading, students often receive insufficient writing practice and limited individualized feedback during the course. As a result, some students may understand the writing norms in theory but still struggle to produce high-quality academic papers in practice.

2.2. Weak research foundations and insufficient academic awareness among students

Lower-grade undergraduate students often lack research experience and have only a superficial understanding of the basic procedures of scientific research, including problem identification, research design, data analysis, and conclusion formulation. Without the support of authentic research tasks, students tend to regard scientific writing merely as a matter of formatting, while overlooking the scientific logic, evidence-based reasoning, and innovative thinking embodied in academic papers. For students majoring in Special Energy Technology and

Engineering, although their professional courses involve strong experimental and engineering application components, opportunities to engage with authentic scientific papers and engineering technical reports at an early stage remain limited. Consequently, many students demonstrate insufficient ability in reading professional literature, identifying research problems, analyzing experimental data, and presenting technical results in a standardized academic manner.

2.3. Academic norm awareness needs further strengthening

Scientific paper writing requires not only standardized structure and precise language, but also adherence to the principles of academic ethics and academic integrity. At present, some students lack sufficient understanding of issues such as citation practices, paraphrasing, reference annotation, figure and table usage, data authenticity, and similarity detection. There is a tendency to emphasize results over process and formatting over academic norms. In the AI era, this issue has become even more prominent. Generative AI technologies are capable of rapidly producing paper sections, abstracts, literature reviews, and even experimental designs. However, the generated content may contain factual inaccuracies, fabricated references, weak logical coherence, and unreliable data [4]. If students lack basic critical judgment and awareness of academic standards, improper use of AI, plagiarism, and fabrication of references may easily occur.

2.4. Relatively single-dimensional course evaluation methods

Traditional course evaluation methods mainly rely on final papers, coursework assignments, or closed-book examinations, with the primary focus placed on the final written product. Insufficient attention is paid to students' topic selection process, literature retrieval process, draft revision process, peer review participation, and oral communication performance. Scientific writing is fundamentally a process-oriented competence. From topic selection to the completion of a manuscript, students must go through multiple rounds of revision and reflection. If the evaluation system fails to reflect the procedural, practical, and comprehensive nature of scientific writing, it becomes difficult to effectively promote the improvement of students' overall abilities.

3. Advantages of AI-empowered teaching in *Scientific Writing and Communication*

3.1. Improving the efficiency of literature retrieval and information acquisition

AI technology can help students conduct literature retrieval, topic clustering, keyword expansion, and research hotspot analysis more efficiently. Traditional literature retrieval generally depends on students' mastery of database operation methods and search strategy construction, whereas AI tools can assist students in generating search keywords, organizing research directions, and summarizing literature themes, thereby lowering the entry barrier for beginners engaging in scientific research. For example, when working on topics related to Special Energy Technology and Engineering, students can use AI tools to expand keywords surrounding themes such as "safety performance of energetic materials", "aging mechanisms of solid propellants", and "combustion characteristics of new energy materials". Through this process, students can gain a preliminary understanding of the research background, major issues, and development trends before conducting more targeted searches in databases such as China National Knowledge Infrastructure (CNKI), Clarivate's Web of Science, and Elsevier's Engineering Village.

3.2. Supporting personalized writing feedback

In the teaching of scientific writing, students often demonstrate considerable differences in writing proficiency, making it difficult for instructors to provide detailed and continuous feedback on every manuscript throughout the entire writing process. AI tools can offer immediate feedback on language expression, logical structure, abstract conciseness, paragraph coherence, grammatical accuracy, and figure and table descriptions, thereby helping students identify problems and revise their work effectively. For instance, after completing the first draft of an abstract, students may use AI tools to check whether the abstract includes the four essential elements: research objective, methodology, results, and conclusion. After finishing the introduction section, students may ask AI tools to assess whether it adequately presents the research background, current research status, existing problems, and research significance. Such applications can improve students' revision efficiency while also fostering their abilities in self-diagnosis and autonomous learning.

3.3. Promoting the development of scientific thinking and logical expression

The core of scientific paper writing lies not in the accumulation of words, but in the clear presentation of scientific logic. Through questioning, follow-up inquiry, and structured analysis, AI can guide students to reflect on issues such as whether the research problem is clearly defined, whether the argumentation chain is logically complete, whether the data sufficiently support the conclusions, and whether figures and tables effectively serve the argument. In teaching practice, instructors may design AI-assisted inquiry-based writing exercises in which students engage in dialogue with AI around a specific research topic. For example, AI may ask questions such as: What is the scientific problem addressed by this research? What are the limitations of existing studies? How does your experimental design verify the hypothesis? Do the conclusions exceed the scope supported by the data? Through such interactive processes, students can gradually develop a stronger awareness of scientific reasoning and logical expression in academic writing.

4. Exploration and practice of course teaching reform

4.1. Reconstructing the course teaching content

In the AI era, the teaching content of *Scientific Writing and Communication* should not only retain the traditional norms of scientific paper writing, but also incorporate topics such as AI tool utilization, the boundaries of AI-assisted writing, identification of AI-generated content, academic integrity, and ethical standards. The course may establish an integrated teaching framework consisting of six components: research cognition, literature retrieval, paper writing, AI assistance, academic communication, and academic ethics. Specifically, the course may include the following modules: The basic cognition of scientific papers module introduces the types, functions, structures, and writing conventions of scientific papers, enabling students to understand that scientific papers are an important means of presenting research achievements. The literature retrieval and reading module trains students to use professional databases and master techniques such as keyword construction, literature screening, reference management, and literature review writing. The paper structure and writing module provides targeted training on elements including titles, abstracts, keywords, introductions, materials and methods, results and discussion, conclusions, and references. The AI-assisted writing module introduces the appropriate application of AI in topic inspiration, literature organization, structural optimization, language polishing, and simulated peer review. The academic norms and ethics module emphasizes requirements related to data authenticity, citation standards, AI-use disclosure, plagiarism prevention, and the prohibition of fabricated references.

4.2. Constructing a blended teaching model

The course may adopt a blended teaching model that integrates online and offline instruction to improve student participation and learning efficiency [5]. Before class, instructors may provide learning resources, including scientific paper case studies, database retrieval tutorials, AI tool usage guidelines, and preview assignments. Based on their professional interests, students may select relevant papers for reading and complete literature summaries or question lists. During class, instructors may organize explanations and discussions centered on representative cases. For example, high-quality papers in the field of Special Energy Technology and Engineering may be selected for analysis of title design, abstract structure, introduction logic, figure and table presentation, and conclusion refinement. In class activities, students may use AI tools to deconstruct the structure of academic papers, after which instructors guide them in evaluating whether the AI-generated analysis is accurate, thereby cultivating students' ability to use AI critically and rationally. After class, students complete staged writing assignments such as literature retrieval reports, paper abstracts, draft introductions, figure and table descriptions, review article excerpts, and academic presentation slides. By combining AI-assisted grading with instructor evaluation, teachers can provide revision suggestions and encourage students to improve their writing skills through repeated practice and refinement.

4.3. Promoting writing training through project-driven tasks

The teaching of scientific writing should avoid relying solely on explanations of formatting conventions and instead focus on project-based learning centered on authentic or simulated research tasks. Project-based learning emphasizes real-world problems or tasks and promotes the development of students' comprehensive abilities through information collection, collaborative inquiry, presentation of outcomes, and reflective improvement [6]. Based on the characteristics of the Special Energy Technology and Engineering major, instructors may design a series of writing tasks with professional relevance, such as a review of the thermal decomposition characteristics of energetic materials, an analysis of factors influencing the aging performance of solid propellants, or a study of advances in safety storage technologies for special energy materials. Students may work in groups to complete the entire process, including topic selection, literature retrieval, literature reading, outline preparation, draft writing, revision, and classroom presentation. Through project-driven tasks, students are able not only to master scientific writing methods, but also to understand the fundamental procedures and basic principles of scientific research activities.

4.4. Establishing a diversified feedback mechanism

Effective feedback is essential for improving students' scientific writing abilities. The course may establish a diversified feedback mechanism integrating AI assistance, teacher guidance, and peer review. At the stage of AI-assisted preliminary feedback, students may use AI tools to examine the structure, language expression, and logical coherence of their manuscripts and generate revision records accordingly. During the peer review stage, students may evaluate one another's work according to assessment rubrics provided by the instructor, focusing on aspects such as topic significance, structural completeness, argumentative logic, literature citation, and writing conventions. For in-depth teacher guidance, instructors may concentrate on issues that students find difficult to judge independently, such as whether the research question is valid, whether the conclusions are reliable, whether citations are appropriate, and whether AI-generated content contains potential risks. This mechanism can not only improve the efficiency of feedback delivery, but also encourage students to shift from passively receiving revisions to actively identifying, analyzing, and solving problems.

4.5. Strengthening the regulation of AI usage

Although AI can assist scientific writing, it cannot replace students' independent thinking and original intellectual work. Therefore, the regulation of AI usage must become an important component of course reform. Instructors should clearly define the scope and requirements for AI usage in course assignments. Students may use AI for topic inspiration, outline optimization, language polishing, grammar checking, and simulated thesis defense exercises. However, they must not use AI to fabricate experimental data, invent references, or directly generate entire papers and submit them as original personal work. Whenever AI is involved in the writing process, students should specify in the assignment statement the tools used, the stages in which AI was applied, and the subsequent modifications made. Students must remain fully responsible for the authenticity, accuracy of the final submitted work and comply with all guidelines. By establishing an AI usage disclosure system and a process-oriented material submission system, instructors can effectively reduce the risk of academic misconduct while cultivating students' awareness of the responsible use of artificial intelligence tools.

4.6. Improving the course evaluation system

Course assessment should shift from a single result-oriented evaluation model (as shown in Table 1) to a comprehensive system integrating both process evaluation and outcome evaluation. The course grade may be allocated as follows: literature retrieval and reading reports account for 20%; staged writing assignments account for 30%; AI-assisted writing records and revision explanations account for 10%; classroom discussions, peer review participation, and academic communication performance account for 15%; and the final course paper accounts for 25%. Evaluation indicators should cover multiple dimensions, including scientific rigor, normative, logical coherence, innovation, clarity of expression, and academic integrity. Through process-oriented assessment, instructors can gain a more comprehensive understanding of students' learning progress, while students can continuously improve their overall competencies through repeated revision and feedback.

Table 1. Weight distribution of different assessment methods for the achievement evaluation of course objectives

Course Objective	Assessment Method and Score Proportion (%)		Sub-course Objective Weight P_i (%)
	Test (1)	Course Paper (2)	
1	20	50	70
2	20	10	30
Total Proportion of Assessment Components (%)	40	60	100

5. Conclusion

The arrival of the AI era has created new opportunities for the teaching reform of the course *Scientific Writing and Communication*. Artificial intelligence technologies can play a positive role in literature retrieval, writing feedback, language polishing, logical analysis, and academic communication training, thereby contributing to improvements in teaching efficiency and student learning outcomes. At the same time, however, AI has also introduced challenges related to academic integrity, content authenticity, and students' excessive dependence

on intelligent tools. Therefore, course reform should adhere to the principles of "technology empowerment, competency orientation, and norm-first education", integrating AI tools appropriately into the entire teaching process. In response to the talent cultivation requirements of the Special Energy Technology and Engineering major, the course should further optimize its teaching content, innovate teaching models, strengthen project-based training, improve diversified evaluation systems, and reinforce education in AI literacy and academic ethics. Through continuous reform and practical exploration, the course can promote the comprehensive development of students' scientific literacy, research competence, scientific writing ability, academic communication skills, and lifelong learning capacity, thereby laying a solid foundation for their future engagement in scientific research, engineering and technological development, and innovation within specialized professional fields.

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