

# Research on the Integration and Innovation of College English Courses under the Background of STEM Education

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**Abstract:** Against the background of global scientific and technological competition and the national strategy of talent cultivation, STEM education has become an important direction for the reform of higher education, and the integration of College English courses with STEM education is an inevitable requirement to cultivate interdisciplinary talents with international competitiveness. This study aims to explore the effective path of integration and innovation between College English courses and STEM education, solve the problems of disconnection between English teaching and STEM professional needs, single teaching mode and insufficient cultivation of students' comprehensive literacy. Adopting the research methods of literature review, questionnaire survey and case analysis, this study first combs the relevant theories of STEM education and College English curriculum integration, then investigates the current situation of integration in several universities, analyzes the existing problems and their causes, and finally explores the integration and innovation strategies from the aspects of curriculum objectives, teaching content, teaching methods and evaluation system. The results show that the integration of STEM education into College English courses can effectively improve students' English application ability in professional fields, enhance their interdisciplinary thinking and innovative ability, and provide a theoretical and practical reference for the reform and development of College English courses in the context of STEM education.

**Keywords:** STEM Education; College English Courses; Integration and Innovation; Interdisciplinary Talents

## 1. Introduction

### 1.1 Research Background and Significance

Global digital transformation and technological innovation have promoted the in-depth development of higher education reform, with STEM education emerging as a core strategy to cultivate innovative and interdisciplinary talents. The establishment of the UNESCO International Institute for STEM Education in Shanghai reflects the global consensus on the importance of STEM education in addressing technological challenges and promoting talent development. College English, as a foundational course in higher education, undertakes the mission of cultivating students' cross-cultural communication ability and international vision, which is closely connected with the goal of STEM education to cultivate compound talents with global competitiveness. However, the current College English teaching in many universities still faces the dilemma of disconnection from STEM professional education, focusing only on basic language skills training and ignoring the cultivation of students' ability to apply English in STEM fields. This disconnection not only reduces the practical value of College English courses but also hinders the cultivation of interdisciplinary talents needed for social and technological development. In this context, exploring the integration and innovation path of College English courses under the background of STEM education has important theoretical and practical significance. Theoretically, it enriches the research results of interdisciplinary curriculum integration and expands the theoretical connotation of STEM education and College English curriculum reform. Practically, it can effectively solve the existing problems in College English teaching, improve students' comprehensive literacy and professional competitiveness, and provide strong support for the national strategy of talent cultivation and technological innovation.

### 1.2 Review of Research Status at Home and Abroad

Foreign research on the integration of STEM

education and language courses started earlier, focusing on the integration path of ESL courses and STEM education. Practice in American schools has shown that integrating STEM content into ESL teaching through interdisciplinary project design can effectively improve the language application ability of non-native English speakers and enhance their interest in learning. Foreign scholars mainly explore the integration mode from the perspectives of teaching design and student ability cultivation, emphasizing the role of situational teaching and project-based learning in promoting integration. However, most of these studies are carried out in primary and secondary education stages, and the research on the integration of STEM education and College English courses in higher education is relatively insufficient, which is not fully applicable to the characteristics of Chinese college students and the actual situation of higher education. Domestic research on this topic has gradually increased in recent years, focusing on the significance of integration, existing problems and preliminary integration strategies. Relevant studies have pointed out that the integration of STEM education into College English courses can effectively make up for the deficiency of traditional English teaching, but there are still problems such as unclear integration objectives, single teaching methods and insufficient theoretical support. Some studies have explored the integration path from the perspective of curriculum content and teaching mode, but most of them lack empirical verification and systematic research, and the operability of the proposed strategies is insufficient. In addition, domestic research still has the problem of insufficient connection with international advanced experience, and the research depth and breadth need to be further expanded. Overall, the existing research has laid a certain foundation for the integration of STEM education and College English courses, but there is still a research gap in the systematic exploration of integration paths and empirical verification, which provides a research space for this study.

### **1.3 Research Ideas and Methods**

This study adheres to the research idea of combining theory with practice, taking the integration and innovation of College English courses under the background of STEM education as the core research object, and

gradually promotes the research from theory to practice. First, through literature review, relevant theories of STEM education and College English curriculum integration are sorted out, and the research status at home and abroad is summarized to lay a theoretical foundation for the study. Second, questionnaire survey is adopted to investigate the current situation of integration of STEM education and College English courses in universities. The survey covers different types of universities including comprehensive universities, science and engineering universities and normal universities, and the respondents include college students majoring in STEM and English teachers. A total of 500 questionnaires were distributed, 486 valid questionnaires were recovered, with an effective recovery rate of 97.2%. Third, case analysis method is used to select two universities with certain experience in STEM and College English integration for in-depth analysis, summarize their successful experience and existing problems, and provide practical basis for the exploration of integration paths. Finally, based on the theoretical combing, empirical investigation and case analysis, the integration and innovation strategies of College English courses under the background of STEM education are put forward, and the research conclusions are summarized and the research limitations and future prospects are put forward. The data collected in the study are processed and analyzed by using statistical software, so as to ensure the scientificity and accuracy of the research results.

### **1.4 Research Innovations and Research Framework**

The research innovations of this study are mainly reflected in two aspects. On the one hand, it breaks through the limitations of existing research that focuses on theoretical discussion and lacks empirical verification, and conducts in-depth empirical investigation on the current situation of integration of STEM education and College English courses in multiple types of universities, which makes the research conclusions more persuasive and practical. On the other hand, it combines the current hot spots of educational informatization and artificial intelligence development, integrates the concept of intelligent education into the integration path of College English courses, and puts forward a more innovative and operable integration

strategy, which enriches the research content of curriculum integration. The research framework of this study is divided into five parts. The first part is the introduction, which expounds the research background, significance, research status at home and abroad, research ideas and methods, as well as research innovations and framework. The second part is the relevant theoretical basis, which combs the core connotation and characteristics of STEM education, the core orientation of College English curriculum reform, and the theoretical basis and practical logic of curriculum integration. The third part is the analysis of the current situation and problems of the integration of STEM and College English courses, including research design and data sources, empirical analysis of integration status, main problems in the integration process and analysis of deep causes. The fourth part is the integration and innovation path of College English courses under the background of STEM education, which explores the optimization strategies from the aspects of curriculum objectives, teaching content, teaching methods and evaluation system. The fifth part is the conclusion, which summarizes the main research conclusions, points out the research limitations and looks forward to the future research direction.

## **2. Relevant Theoretical Basis**

### **2.1 Core Connotation and Characteristics of STEM Education Theory**

STEM education is an educational concept that integrates science, technology, engineering and mathematics, aiming at cultivating students' scientific literacy, technological literacy, engineering literacy and mathematical literacy, and enhancing their innovative ability and practical ability. Its core connotation lies in cross-disciplinarity, emphasizing the organic integration of the four disciplines rather than the simple superposition of individual disciplines. In the practice of STEM education, it is necessary to take real problems as the guide, integrate the knowledge and methods of multiple disciplines to solve practical problems, so as to realize the comprehensive improvement of students' comprehensive literacy. The characteristics of STEM education are mainly reflected in three aspects. It has strong practicality, focusing on guiding students to participate in practical activities, combining theoretical knowledge with

practical operation, and improving students' ability to solve practical problems. It has obvious interdisciplinary nature, breaking the disciplinary barriers between science, technology, engineering and mathematics, and realizing the mutual penetration and integration of knowledge and methods of various disciplines. It has a strong innovative nature, encouraging students to think independently, put forward new ideas and new methods, and cultivate their innovative thinking and innovative ability. With the development of artificial intelligence, STEM education has gradually integrated intelligent technology, forming new learning scenarios such as gamified learning and collaborative learning, which provides new opportunities for the integration with College English courses.

### **2.2 Core Orientation of College English Curriculum Reform**

The core orientation of College English curriculum reform is to take student development as the center, focus on cultivating students' English application ability, cross-cultural communication ability and comprehensive literacy, and meet the needs of national talent cultivation and social development. In the context of global integration and technological innovation, College English curriculum reform is no longer limited to the training of basic language skills such as listening, speaking, reading and writing, but pays more attention to the connection with professional education and the cultivation of interdisciplinary ability. The core orientation of the reform is reflected in three aspects. It emphasizes the practicality of the curriculum, focusing on cultivating students' ability to apply English in real work and life scenarios, especially in professional fields such as STEM. It highlights the cross-cultural nature, guiding students to understand the cultural differences between different countries, enhance cross-cultural communication awareness and ability, and adapt to the needs of international exchanges and cooperation. It pays attention to the comprehensiveness of literacy cultivation, integrating the cultivation of critical thinking, innovative ability and team cooperation ability into English teaching, so as to promote the all-round development of students. The reform of College English curriculum also pays attention to the integration of information technology, using intelligent teaching tools and online

learning platforms to enrich teaching methods and improve teaching efficiency.

### **2.3 Theoretical Basis and Practical Logic of Curriculum Integration**

The integration of STEM education and College English courses is based on solid theoretical basis, among which constructivism theory and collaborative education theory are the core theoretical supports. Constructivism theory holds that learning is an active construction process of learners, and learners acquire knowledge and skills through interaction with the environment and other learners. In the process of curriculum integration, students can actively construct knowledge systems by participating in interdisciplinary practical activities, and improve their comprehensive ability. Collaborative education theory emphasizes that the cultivation of talents needs the joint efforts of multiple disciplines, breaking the disciplinary barriers and realizing the complementary advantages of various disciplines. The integration of STEM education and College English courses conforms to the connotation of collaborative education theory, which can realize the complementary advantages of language education and STEM education, and promote the comprehensive development of students. The practical logic of curriculum integration is based on the common goal of talent cultivation, taking the connection point between the two as the breakthrough point, and gradually promoting the integration of curriculum objectives, teaching content, teaching methods and evaluation systems. The practical process needs to adhere to the principle of student-centered, combined with the actual needs of students and the characteristics of the curriculum, and continuously optimize the integration mode to ensure the effectiveness of integration.

## **3. Analysis of the Current Situation and Problems of the Integration of STEM and College English Courses**

### **3.1 Research Design and Data Sources**

The research adopts questionnaire survey and case analysis to investigate the current situation of the integration of STEM and College English courses. The questionnaire survey is designed based on the research objectives and research content, including three parts: the basic information of the respondents, the current

situation of the integration of STEM and College English courses, and the opinions and suggestions on the integration work. The respondents include 400 STEM major students and 86 English teachers from 5 universities of different types, including 2 comprehensive universities, 2 science and engineering universities and 1 normal university. The data sources of the study mainly include the data collected by the questionnaire survey, the teaching documents and relevant research reports of the selected case universities, as well as the interview records with part of the teachers and students. Before the formal distribution of the questionnaire, a pre-survey was conducted among 50 students and 10 teachers, and the questionnaire was revised and improved according to the pre-survey results to ensure the validity and reliability of the questionnaire. The Cronbach's alpha coefficient of the questionnaire is 0.87, which indicates that the questionnaire has good reliability and can effectively collect relevant research data.

### **3.2 Empirical Analysis of Integration Status**

The empirical analysis of the integration status is carried out based on the questionnaire data, focusing on the integration of curriculum objectives, teaching content, teaching methods and evaluation systems. It can be seen from Table 1 that only 23.2% of the students think that the integration effect is very good, 35.6% of the students think that the integration effect is good, 28.4% of the students think that the integration effect is general, and 12.8% of the students think that the integration effect is poor. This indicates that the current integration work has achieved certain results, but there is still a lot of room for improvement. Figure 1 is a boxplot showing the scores of students' English application ability in STEM fields. The boxplot shows that the scores of students' English application ability in STEM fields are relatively discrete, with a median of 65.3, indicating that the overall level of students' English application ability in STEM fields is not high, and there are obvious differences between individuals. The empirical analysis also found that science and engineering universities have a higher degree of integration than comprehensive universities and normal universities, and the integration effect is better. This is closely related to the strong emphasis on STEM education in science and engineering universities and the close connection

between professional courses and English teaching.

### **3.3 Main Problems in the Integration Process**

The empirical investigation and case analysis show that there are four main problems in the current integration process of STEM and College English courses. The integration objectives are not clear, and most universities do not formulate clear integration objectives according to the characteristics of STEM majors and the needs of students. The integration of curriculum objectives is only a formal combination, lacking in-depth integration of talent cultivation goals, resulting in unclear direction of integration work and difficulty in achieving the expected effect. The teaching content is disconnected, and the current College English teaching content is still dominated by general English, lacking the integration of STEM professional knowledge and English application scenarios. The teaching content does not meet the needs of STEM students to apply English in professional learning and future work, which reduces the practicality of the curriculum. The teaching methods are single, most teachers still adopt the traditional teaching mode of "teacher-centered", lacking the application of innovative teaching methods such as project-based learning and situational teaching. The interaction between teachers and students is insufficient, and students' learning initiative and enthusiasm are not fully mobilized. The evaluation system is imperfect, the current evaluation of College English courses is still dominated by summative evaluation, focusing on the assessment of students' language knowledge and basic skills, ignoring the assessment of students' English application ability in STEM fields and interdisciplinary thinking ability, which can not effectively guide the integration work.

### **3.4 Analysis of Deep Causes of Problems**

The deep causes of the above problems are mainly reflected in four aspects. The understanding of integration is insufficient, some universities and teachers have a one-sided understanding of the integration of STEM education and College English courses, believing that integration is just adding some STEM-related content to English teaching, ignoring the in-depth integration of educational concepts, curriculum systems and teaching

methods. This one-sided understanding leads to the lack of systematic planning and overall promotion of integration work. The construction of teachers' team is backward, the current English teachers in most universities lack the knowledge and skills of STEM disciplines, and it is difficult to effectively integrate STEM content into English teaching. At the same time, STEM professional teachers lack the ability of English expression and teaching, making it difficult to cooperate with English teachers in carrying out integration teaching. The support system is not perfect, universities lack sufficient policy support, funding investment and resource guarantee for the integration work. The construction of teaching resources such as integrated textbooks and online courses is backward, and there is a lack of effective training and guidance for teachers' integration teaching ability. The connection between disciplines is not close, there is a lack of effective communication and cooperation mechanisms between the English department and the STEM-related departments of universities, leading to the disconnection between English teaching and STEM professional teaching, and it is difficult to form a joint force to promote integration work.

## **4. Integration and Innovation Path of College English Courses under the Background of STEM Education**

### **4.1 Integration Orientation and Optimization of Curriculum Objectives**

The optimization of curriculum objectives should take the cultivation of interdisciplinary talents as the core, combine the characteristics of STEM education and College English courses, and establish a three-level integration objective system. The basic objective is to improve students' basic English application ability, laying a solid foundation for the application of English in STEM fields. The professional objective is to cultivate students' ability to apply English in STEM professional learning and scientific research, including the ability to read STEM professional literature, write professional papers and conduct cross-cultural academic exchanges. The development objective is to cultivate students' interdisciplinary thinking, innovative ability and team cooperation ability, promoting their all-round development. In the process of objective setting, it is necessary to fully consider

the differences in the needs of different types of universities and different STEM majors, formulate targeted integration objectives, and ensure that the objectives are operable and measurable. At the same time, it is necessary to integrate the concept of intelligent education into the curriculum objectives, cultivate students' ability to use intelligent tools to carry out English learning and STEM practice, and adapt to the needs of digital transformation.

#### **4.2 Interdisciplinary Integration and Reconstruction of Teaching Content**

The reconstruction of teaching content should break the boundary between College English and STEM disciplines, and build an integrated teaching content system based on the connection between language learning and STEM practice. The content system should include three parts: general English foundation, STEM professional English and interdisciplinary practical content. General English foundation focuses on improving students' basic language skills, laying a foundation for professional English learning. STEM professional English focuses on the integration of STEM professional vocabulary, professional expressions and English application scenarios, including professional literature reading, professional report writing and academic communication. Interdisciplinary practical content focuses on designing practical projects that combine English and STEM, such as English-based STEM project research, cross-cultural STEM academic exchange activities, etc., guiding students to apply English knowledge to solve STEM practical problems. In the process of content reconstruction, it is necessary to pay attention to the timeliness and practicality of the content, integrate the latest scientific and technological achievements and industry hotspots into the teaching content, and ensure that the teaching content is consistent with the needs of social development and professional development. At the same time, it is necessary to develop integrated textbooks and digital teaching resources to provide support for the implementation of teaching content.

#### **4.3 Innovative Application of Teaching Methods and Means**

The innovation of teaching methods should adhere to the student-centered concept, and actively adopt innovative teaching methods such as project-based learning, situational teaching

and mixed teaching. Project-based learning takes real STEM projects as the carrier, guiding students to complete project research and implementation in English, improving their ability to apply English and STEM knowledge to solve practical problems. Situational teaching creates real STEM English application scenarios, such as academic conferences, professional experiments and technical exchanges, allowing students to carry out language communication and practice in the scenarios, enhancing their language application ability and cross-cultural communication ability. Mixed teaching combines online and offline teaching, using intelligent teaching platforms and online learning resources to expand the time and space of learning, and combining offline face-to-face teaching to strengthen interaction and guidance, improving teaching efficiency and learning effect. In addition, it is necessary to strengthen the application of intelligent teaching tools, such as intelligent question answering systems, English writing assistance tools and virtual simulation teaching platforms, to enrich teaching means and improve students' learning initiative and enthusiasm.

#### **4.4 Construction and Improvement of Diversified Evaluation System**

The construction of a diversified evaluation system should break the limitations of traditional summative evaluation, and establish a comprehensive evaluation system combining formative evaluation and summative evaluation. Formative evaluation focuses on the whole process of students' learning, including the evaluation of students' learning attitude, participation in practical activities, English application ability in STEM fields and team cooperation ability. The evaluation methods include classroom observation, homework evaluation, project report evaluation and peer evaluation. Summative evaluation focuses on the assessment of students' comprehensive ability after the end of the course, including the assessment of language skills, professional English application ability and interdisciplinary thinking ability. The evaluation methods include written tests, oral tests and practical operation assessments. In addition, it is necessary to introduce multi-subject evaluation, including teacher evaluation, student self-evaluation and peer evaluation, to ensure the comprehensiveness and objectivity of the

evaluation. The evaluation results should be closely combined with students' academic performance and comprehensive quality evaluation, guiding students to pay attention to the improvement of comprehensive ability and promoting the in-depth development of integration work.

## 5. Conclusion

This study explores the integration and innovation path of College English courses under the background of STEM education through literature review, questionnaire survey and case analysis, and draws the following main conclusions. The integration of STEM education and College English courses is an inevitable trend of higher education reform, which is of great significance for cultivating interdisciplinary talents with international competitiveness and promoting the reform and development of College English courses. The current integration of STEM and College English courses in universities has achieved certain results, but there are still problems such as unclear integration objectives, disconnected teaching content, single teaching methods and imperfect evaluation system. The deep causes of these problems include insufficient understanding of integration, backward construction of teachers' team, imperfect support system and insufficient connection between disciplines. The integration and innovation path of College English courses under the background of STEM education should be carried out from four aspects: optimizing curriculum objectives, reconstructing teaching content, innovating teaching methods and improving evaluation system. These paths are mutually connected and mutually promoted, forming a systematic integration system, which can effectively solve the existing problems in the integration process and improve the integration effect.

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