



# Research and Practice on Integrating STEM Education into Business English Professionals Training Reform

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**Abstract.** This study explores the methods and effects of integrating STEM (Science, Technology, Engineering, and Mathematics) education principles into the Business English curriculum at vocational colleges in China. Most students in the Business English program come from a humanities background, leading to significant deficiencies in quantitative subjects and technical skills, which affect their academic performance and career prospects in the modern business environment. Through curriculum reform, new courses were introduced, and existing ones were modified to include STEM content and emphasize the need for STEM knowledge. The study employs a mixed-methods approach, utilizing surveys and interviews with students and employers to evaluate the impact of the integrated curriculum on graduates' employability, academic performance, and skill proficiency. The results indicate that the integrated curriculum significantly improved graduates' employment rates, salary levels, and employer satisfaction, while enhancing students' quantitative and technical skills. The findings provide valuable insights for further improvement of the Business English program and contribute to the broader discussion on integrating STEM education into non-STEM fields.

**Keywords:** TEM education, Business English, employability, quantitative skills, technical skills

## 1 INTRODUCTION

### 1.1 Background on the Chinese Gaokao System and Early Specialization in Humanities or Sciences

The Gaokao, China's National College Entrance Examination, has been the cornerstone of the country's educational system since its inception in 1952. This high-stakes exam determines university admissions and shapes the educational trajectories and career prospects of millions of students each year. Influenced by China's historical, cultural, economic, and social contexts, the Gaokao system plays a crucial role in maintaining social equity, promoting social mobility, and ensuring national stability and unity<sup>[1]</sup>.

A key feature of the Gaokao system is the early specialization of students into either humanities or sciences tracks, typically starting in high school. By the final years of high school, students choose between a curriculum focused on humanities subjects

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(such as literature, history, and political education) or sciences subjects (such as mathematics, physics, and chemistry). This choice profoundly impacts their Gaokao preparation and subsequently their higher education and career paths<sup>[1]</sup>.

## **1.2 Challenges Faced by Business English Students Due to Limited Science and Math Education**

Most of the students in the Business English program come from a humanities background. Academically, Business English students struggle with quantitative subjects such as statistics, accounting, and finance, which are essential for business studies. Their limited math background hinders their ability to perform complex calculations, analyze data, and interpret financial statements. Moreover, understanding and applying technical concepts and tools in business practices becomes challenging, affecting their capability to use business software and understand technological advancements.

Professionally, the lack of STEM skills places these students at a disadvantage in the job market, where data analysis and technical problem-solving are increasingly valued. Employers seek candidates who can bridge the gap between business and technology, and students lacking these competencies may face fewer job opportunities and lower starting salaries. Additionally, the rapid pace of technological change in business sectors requires adaptability, which is difficult for students with insufficient STEM education.

To address these issues, integrating STEM principles into the Business English curriculum is crucial. By providing a balanced education, vocational colleges can help students develop necessary skills to excel in the modern business environment, enhancing their academic performance, professional prospects, and overall adaptability. This integration not only improves their employability but also supports the broader goal of creating a versatile and capable workforce.

## **1.3 Purpose and Significance of the Study**

The primary purpose of this study is to integrate STEM (Science, Technology, Engineering, and Mathematics) education principles into the Business English curriculum at vocational colleges in China. This integration aims to address the educational gaps of students with limited exposure to science and math, enhancing their quantitative, technical, and interdisciplinary skills.

The significance of this study lies in its potential to improve students' employability. By equipping Business English students with essential STEM skills, the study prepares them for a technology-driven global economy. Graduates with a blend of business and technical competencies are more attractive to employers, access a wider range of job opportunities, and can better adapt to modern workplace demands.

Furthermore, this integration promotes interdisciplinary learning, fostering critical thinking, creativity, and effective teamwork. The study also provides valuable insights for educational policymakers and practitioners, demonstrating the benefits of integrating STEM into non-STEM fields and informing future curriculum development and teaching strategies. Overall, this study aims to enhance the competitiveness and

versatility of Business English graduates in the job market, supporting broader economic development goals in China.

## 2 LITERATURE REVIEW

### 2.1 Examination of Existing Research on STEM Education in non-STEM Fields.

Existing research on STEM education in non-STEM fields highlights its interdisciplinary benefits and applications across various domains. For instance, a study on the integration of STEM principles in foreign-language professional communicative competence building emphasizes that STEM is not a separate discipline but a synthesis of multiple knowledge models, fostering both hard and soft skills, creativity, and collaboration among students in non-language faculties such as psychology and physical rehabilitation [2]. Additionally, the use of an interdisciplinary STEM didactic model in eco-farming demonstrates how non-formal education settings can effectively incorporate STEM subjects like chemistry, biology, and mathematics to address environmental challenges, thereby enhancing learning effectiveness through modern technologies and mobile applications [3]. Research also indicates that informal learning environments, such as summer camps, which integrate STEM disciplines, significantly boost students' interest, self-efficacy, and awareness in STEM fields, suggesting that these methods can be adapted for non-STEM education to foster similar outcomes [4]. Furthermore, the challenges faced by STEM teachers in multicultural classrooms, as compared to their non-STEM counterparts, underline the importance of professional development and instructional leadership, which are crucial for effective teaching across all disciplines [5]. Lastly, the narrative-qualitative study on course mismatch among former STEM students who transitioned to non-STEM college programs reveals that external factors like course availability and internal factors such as personal motivation play significant roles in their educational choices, suggesting the need for enhanced career guidance programs that could benefit students in both STEM and non-STEM fields [6]. Collectively, these studies underscore the versatility and applicability of STEM education principles in non-STEM fields, promoting a holistic and integrated approach to learning and professional development.

### 2.2 Analysis of the Impact of Early Specialization on Student Competencies.

Early sport specialization (ESS) has a multifaceted impact on student competencies, encompassing both physical and psychological dimensions. ESS, characterized by intensive, year-round training in a single sport starting in prepubertal years, can enhance specific skill acquisition but also poses risks for adverse outcomes such as burnout and overuse injuries [7, 8]. For instance, a study on ice hockey goaltenders revealed that early specialized athletes exhibited altered hip kinematics, potentially as a pain avoidance mechanism, which may predispose them to intra-articular hip injuries [9]. This suggests that while ESS might develop sport-specific skills, it can also lead to biomechanical

adaptations that increase injury risk. Furthermore, the emphasis on a single sport can limit the development of a well-rounded athletic skill set and reduce overall physical literacy, which is crucial for long-term athletic development <sup>[9]</sup>. On the psychological front, ESS can contribute to increased stress and burnout, as the intense focus on one sport from a young age may lead to a lack of enjoyment and motivation over time <sup>[7]</sup>. Conversely, early childhood education (ECE) programs, which emphasize holistic development through diverse activities, have been shown to enhance social competencies and language learning, suggesting that a varied approach in early development is beneficial for overall growth <sup>[10]</sup>. This aligns with the broader consensus among sports and athletic organizations advocating for diversified sports participation to foster well-rounded development and reduce the risks associated with early specialization <sup>[8]</sup>. Therefore, while ESS can lead to high levels of proficiency in a specific sport, it is crucial to balance this with varied physical activities to promote comprehensive development and mitigate the potential negative impacts on student competencies.

### **2.3 Review of Previous Attempts to Integrate STEM Approaches in Professionals Training**

Previous attempts to integrate STEM approaches in Business English professionals' training have shown promising results in enhancing both language and technical skills. One notable approach is the use of AI-supported platforms like "51 Learning," which combines AI technology with blended learning methods to foster deep learning in business English. This platform not only improves practical abilities and theoretical understanding but also broadens learning channels and enriches evaluation methods, thereby enhancing students' interest and engagement in business English <sup>[11]</sup>. Additionally, the integration of STEM activities with English language learning has been explored, particularly in high school settings. For instance, a study involving 11th-grade students demonstrated that combining STEM activities with English learning can significantly increase students' interest and perceived necessity of learning English, despite initial prejudices <sup>[12]</sup>. Furthermore, the interdisciplinary nature of STEM education, which emphasizes the logical connections between events and processes, has been applied in vocational and technical education. This approach ensures that students receive a holistic education that combines natural and mathematical training with professional skills, thus preparing them for high-tech modern production environments <sup>[13]</sup>. The concept of English for Specific Purposes (ESP), particularly English for Business Purposes, aligns well with STEM integration as it focuses on meeting the specific needs of learners and using methodologies and activities relevant to their disciplines. This shift from a traditional teacher-centered approach to a student-centered, outcome-based approach has been instrumental in making Business English more relevant and practical for professionals <sup>[13]</sup>. Overall, these attempts highlight the potential of integrating STEM approaches to create a more comprehensive and effective training program for Business English professionals, addressing both linguistic and technical competencies.

## **3 RESEARCH METHODOLOGY**

### **3.1 Curriculum Reform Implementation**

The curriculum reform for the Business English program at Ma'anshan Teachers College focuses on integrating STEM education principles to address the science and math knowledge gaps among students. Add relevant courses or modify existing ones to ensure that the talent cultivation program includes STEM content and emphasizes the need for STEM knowledge.

The course "Cross-Border E-Commerce Practices" was introduced to cover e-commerce fundamentals, platform operations, product selection, pricing strategies, and logistics. This course integrates data analytics, technology-driven marketing strategies, and the use of e-commerce platforms, necessitating basic programming and statistical analysis knowledge.

"International Trade Practices" focuses on international trade terms, practices, negotiation strategies, and logistics. This course now includes quantitative analysis for trade data, the use of trade-related software, and an understanding of logistics management systems.

"Business English Translation and Interpretation" teaches translation and interpretation skills in a business context. The course introduces translation software tools and technology-assisted interpretation techniques to align with STEM integration goals.

The "Financial Accounting" course provides knowledge on financial statement preparation and analysis. It incorporates the use of accounting software and basic principles of financial mathematics to strengthen students' quantitative skills.

In existing courses, the reform emphasizes the importance of STEM knowledge. For instance, "Comprehensive Business English" enhances the curriculum with business data interpretation, technology usage in business communication, and basic financial literacy.

The "Business Negotiation" course now incorporates quantitative negotiation strategies, the use of negotiation software, and analysis of negotiation outcomes.

"Cross-Cultural Business Communication" explores communication strategies in different cultural contexts and includes the use of digital communication tools, data analysis for cultural trends, and technology-driven communication platforms.

Lastly, "Logistics Management" teaches logistics and supply chain management, integrating logistics software, data analysis for supply chain optimization, and understanding technological advancements in logistics.

This integration process involves collaboration between Business English faculty and STEM educators to develop interdisciplinary teaching methods and course materials. Such collaboration ensures that the curriculum meets the Business English program requirements while equipping students with essential STEM skills.

### **3.2 Research Design and Approach**

To evaluate the effectiveness of integrating STEM education into the Business English program at Ma'anshan Teachers College, a comprehensive research design has been

implemented. The following are the research methods, participant selection, data collection methods, and data analysis techniques for this research project.

**Research Design and Approach.** The research adopts a mixed-methods approach, combining quantitative and qualitative data to assess the impact of the integrated curriculum. This approach allows for a thorough examination of both measurable outcomes and qualitative insights from key stakeholders.

**Participant Selection and Characteristics.** All Business English students enrolled from 2020 onwards are subject to the reformed curriculum, ensuring a consistent evaluation basis. Participants include these students and their respective educators. Additionally, employers who have hired graduates from this program are interviewed to provide qualitative data on the graduates' performance and preparedness.

**Data Collection Methods.** Data is primarily collected from the annual "Ma'anshan Teachers College 2022 Graduate Training Quality Evaluation Report." These reports provide comprehensive data on various performance indicators, including academic achievement, employability, and student satisfaction. Additional data sources include:

Surveys and Academic Performance Records: Surveys are conducted among students and educators to gather insights on their experiences and the effectiveness of the curriculum. Academic performance records are analyzed to assess improvements over the years.

Employer Interviews: Qualitative data is gathered through interviews with employers who have hired graduates from the Business English program. These interviews focus on the graduates' proficiency in STEM-related skills, adaptability, and overall job performance.

**Data Analysis Techniques.** Quantitative data from the evaluation reports and surveys are analyzed using statistical tools to identify trends and measure the impact of the curriculum reform. Qualitative data from employer interviews are analyzed using thematic analysis to capture insights into the graduates' job performance and the perceived value of their STEM-related skills.

**Expected Outcomes.** With the gradual accumulation of teaching resources and the enhancement of STEM proficiency among Business English faculty, it is expected that teaching quality will show a year-on-year improvement. Consequently, various graduate training quality evaluation metrics are anticipated to increase annually, reflecting the success of the integrated curriculum reform.

By utilizing comprehensive data from the "Graduate Training Quality Evaluation Reports" and qualitative insights from employer interviews, this research aims to provide a detailed assessment of the curriculum reform's effectiveness. The findings will inform further improvements to the Business English program and contribute to the broader discussion on integrating STEM education into non-STEM fields.

## 4 RESULTS AND ANALYSIS

### 4.1 Quantitative Results

The curriculum reform in the Business English program has led to measurable improvements across various key performance indicators, as demonstrated by the data from the "Graduate Training Quality Evaluation Reports" (2020–2023). The overall employment rate of graduates has increased from 82% in 2020 to 87% in 2023, while employment in relevant fields rose from 66% to 71% during the same period (see Table 1). This improvement indicates that integrating STEM education principles into the curriculum has enhanced students' employability by equipping them with the technical and quantitative skills necessary for modern business environments.

In addition to employment outcomes, the average salary of graduates saw a steady increase, rising from ¥5,780 per month in 2020 to ¥6,050 per month in 2023 (see Table 1). This increase reflects the higher value placed on graduates who possess both business and STEM competencies, making them more competitive in the job market.

Graduate satisfaction with their education has also shown consistent improvement, increasing from 4.15/5 in 2020 to 4.26/5 in 2023. Similarly, employer satisfaction has risen from 3.8/5 to 4.1/5 over the same period (see Table 1), with many employers noting that graduates are better prepared to handle technical challenges and adapt to technological changes.

The average GPA of graduates has improved as well, from 3.3 in 2020 to 3.6 in 2023, indicating an overall enhancement in academic performance. This can be attributed to the curriculum reform's focus on STEM-related courses, which has fostered a deeper understanding of quantitative and technical subjects among students.

Course completion rates remained stable, fluctuating slightly between 94% and 96%, but consistently demonstrating a high level of academic success. Moreover, graduates' proficiency in quantitative and technical skills has significantly improved, with ratings for quantitative skills increasing from 3.5/5 in 2020 to 3.9/5 in 2023, and technical skills improving from 3.3/5 to 3.7/5 (see Table 1). These results affirm the effectiveness of integrating STEM content into the Business English curriculum.

**Table 1.** Graduate Training Quality Evaluation Indicators (2020-2023)

Indicator	2020	2021	2022	2023
Overall Employment Rate	82%	83%	85%	87%
Employment in Relevant Field	66%	67%	70%	71%
Average Salary	¥5,780/month	¥5,820/month	¥6,000/month	¥6,050/month
Graduate Satisfaction	4.15/5	4.18/5	4.2/5	4.26/5
Employer Satisfaction	3.8/5	3.9/5	4.0/5	4.1/5
GPA (Average)	3.3	3.4	3.5	3.6
Course Completion Rate	95%	94%	95%	96%
Proficiency in Quantitative Skills	3.5/5	3.6/5	3.8/5	3.9/5
Proficiency in Technical Skills	3.3/5	3.4/5	3.6/5	3.7/5
Adaptability to Technological Changes	3.5/5	3.6/5	3.7/5	3.8/5

The data indicates a positive trend in graduate outcomes, demonstrating the effectiveness of the curriculum reform in enhancing the employability and skills of Business English graduates.

### 4.2 Qualitative Results

The research team conducted in-depth interviews with project managers and HR representatives from seven companies in Ma'anshan and surrounding areas where graduates from the Business English program are employed. The qualitative data collected from these interviews confirm the anticipated positive outcomes of the curriculum reform.

Overall, employers expressed high satisfaction with the graduates' performance, noting significant improvements in several key areas. Graduates demonstrated enhanced proficiency in quantitative and technical skills, reflecting the successful integration of STEM education into their curriculum. Employers also highlighted the graduates' strong adaptability to technological changes and their effective problem-solving abilities.

Communication skills were rated highly, with graduates excelling in both written and oral business communication, as well as cross-cultural communication and negotiation scenarios. Employers appreciated the graduates' professionalism and job readiness, noting their preparedness for workplace responsibilities and their strong work ethic.

While the overall feedback was positive, some employers suggested further enhancement in advanced data analytics and specific trade-related software skills. These insights provide valuable guidance for continuous improvement of the curriculum.

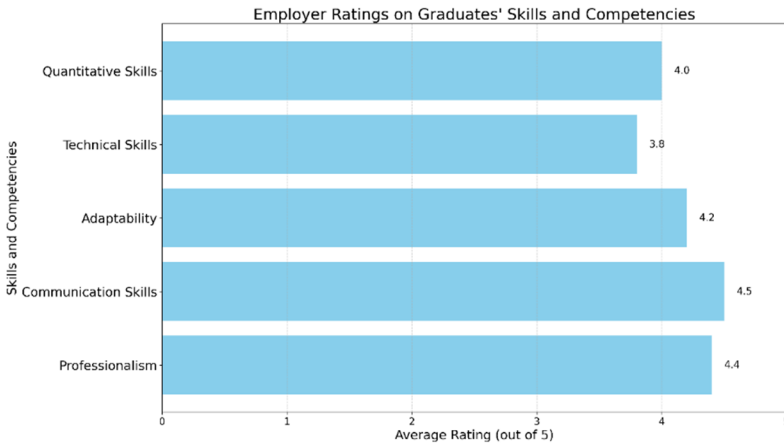


Fig. 1. Employer Ratings on Graduates' Skills and Competencies

The bar chart shown in Figure 1 provides a visual representation of the average employer ratings of graduates for various skills and competencies, reflecting overall positive feedback from interviews.



## **5 DISCUSSION**

### **5.1 Interpretation of Results**

The quantitative and qualitative data collected from the study reveal a significant positive impact of the curriculum reform that integrated STEM education into the Business English program. The improvements in employment rates, average salaries, and graduate and employer satisfaction ratings underscore the effectiveness of the reformed curriculum. The enhanced academic performance, as indicated by the increase in average GPA, further validates the positive outcomes of the curriculum changes.

The correlation between the improved metrics and STEM integration highlights the value of equipping students with essential technical and quantitative skills. These competencies are increasingly important in the modern job market, and the feedback from employers confirms that graduates are better prepared to meet the demands of their roles.

### **5.2 Benefits and Challenges**

The integration of STEM education into the Business English curriculum offers numerous benefits, including improved employability, enhanced technical proficiency, and better adaptability to technological changes. The interdisciplinary approach fosters critical thinking, problem-solving abilities, and effective communication skills, making graduates more versatile and capable professionals.

However, the implementation of this curriculum reform also presented challenges. Initially, there was resistance from both faculty and students accustomed to traditional teaching methods. Addressing these challenges required continuous faculty development, resource allocation, and adjustments to the curriculum based on ongoing feedback.

### **5.3 Implications for Curriculum Development**

The findings of this study provide valuable insights for further curriculum enhancements. Future curriculum development should continue to emphasize the integration of STEM principles, ensuring that students gain practical skills that align with industry needs. Additionally, incorporating advanced data analytics and trade-related software training will further enhance graduates' competitiveness.

This integrated approach can be applied to other non-STEM fields, promoting a more holistic education system that prepares students for the interdisciplinary demands of the modern workforce. Educational institutions and policymakers should consider adopting similar reforms to improve the overall quality of education and student outcomes.

## 6 CONCLUSION

### 6.1 Summary of Key Findings

The study confirms that integrating STEM education into the Business English curriculum at Ma'anshan Teachers College has led to substantial improvements in various performance indicators. The positive trends in employment rates, salary levels, and skill proficiency highlight the success of the reform. Both quantitative and qualitative data validate the effectiveness of the new curriculum in enhancing the employability and job readiness of graduates.

### 6.2 Recommendations for Educators and Policymakers

Educators should consider adopting interdisciplinary approaches in curriculum design to enhance student outcomes. Implementing similar reforms in other programs can provide students with a balanced skill set, making them more adaptable and competitive in the job market. Policymakers are encouraged to support initiatives that promote STEM integration across various disciplines, ensuring that educational systems remain relevant and effective.

### 6.3 Future Research Directions

Future research should focus on the long-term impact of integrating STEM education into non-STEM programs. Investigating additional ways to enhance interdisciplinary learning and continuously assessing the curriculum's effectiveness will be crucial. Longitudinal studies tracking graduates' career progression and performance in the workforce can provide deeper insights into the long-term benefits of the reformed curriculum.

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