Education Insights

Article

A Flipped Classroom Design for a Practical-Oriented Mechanical Engineering Curriculum Titled Technical English

Ziqiang Fang [1,*] and Yuhang Liu [1]

[1] Jianghan University, Wuhan, Hubei, China
* Correspondence: Ziqiang Fang, Jianghan University, Wuhan, Hubei, China

Abstract: The salient features of the Mechanical Engineering curriculum titled Technical English is that the professional terms and phrases are characterized by strong professionalism and a narrow application scope. The knowledge points covered in this curriculum are closely related to branches including Materials Science, Mechanics, and Graphics. During the long-term teaching practice, it was found that the current instructional process is challenged by the three problems: (1) The teaching content is not oriented towards engineering practice; (2) The knowledge system and modularization in instruction are insufficient; (3) A low level classroom participation are among the students. Aiming at the above problems, the knowledge of technical practice is introduced into the teaching process of Technical English. Through adopting the flipped classroom teaching method, students' role can be shifted from passive listeners to engaged learners in the classroom. Taking the cross-fusion teaching design between the two curriculum of Technical English and Production Line Course Design, a case study in practice-embedded Technical English instruction for Mechanical Engineering is designed and implemented.

Keywords: Mechanical Engineering; Technical English; classroom flipping; practical-oriented; teaching design

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1. Introduction

Mechanical Engineering is a discipline characterized by a high technical threshold and strong practical applicability. It serves as a fundamental specialty that supports the continuous upgrading and modernization of China's manufacturing industry. The cultivation of skilled professionals in this field plays a decisive role in promoting innovation and development within emerging industrial sectors [1,2]. Despite rapid growth in domestic research, some developed nations maintain a competitive advantage in the development of cutting-edge core technologies within Mechanical Engineering. In this context, studying advanced foreign technical literature and participating in academic exchanges can provide researchers and technical professionals with efficient access to the latest knowledge and best practices [3,4].

English has become the predominant global language for scholarly communication. Currently, the majority of academic literature indexed in major scientific databases is written in English, and most presentations at international academic conferences are conducted in English as well [5,6]. This reality highlights the importance of equipping students with strong English-language skills specific to technical disciplines. Long-term teaching experience in the Technical English of Mechanical Engineering has revealed that students often face notable challenges in translating academic literature, writing technical documents, and accurately interpreting professional terminology. These challenges can limit their ability to fully engage with international research and to apply advanced technical concepts effectively.

An illustrative example can be found in graduates from the 24th, 25th, and 26th cohorts of the Mechanical Engineering program at Jianghan University. These students frequently encounter persistent difficulties in translating foreign-language technical texts for their graduation projects. Moreover, during the preparation of technical literature reviews, misunderstandings regarding specialized knowledge are common, indicating gaps not only in language proficiency but also in the integration of technical understanding.

To address these challenges, this study designs a flipped classroom approach tailored for practical-oriented Mechanical Engineering instruction, specifically within the curriculum of Technical English of Mechanical Engineering. The approach emphasizes active learning, collaborative problem-solving, and applied translation exercises, enabling students to engage with technical content in a more interactive and context-driven manner. By integrating theory, practice, and guided analysis, this instructional reform seeks to enhance students' proficiency in technical English, improve their ability to comprehend and communicate specialized knowledge, and provide a replicable model for curriculum reform in technical language education [7].

2. Problems in Instruction for the Technical English of Mechanical Engineering

2.1. The Decoupling between the Theoretical Instruction and Its Practical Application in Engineering

According to the teaching syllabus of the Technical English of Mechanical Engineering at Jianghan University, this curriculum primarily aims to develop students' reading proficiency in original European and American technical literature. It emphasizes not only the core principles and foundational knowledge of mechanical manufacturing but also the latest advancements and emerging trends in modern manufacturing technology. The curriculum is designed to equip students with the skills to accurately understand specialized terminology, technical expressions, and grammatical structures used in contemporary Euro-American technical literature, enabling them to access cutting-edge research and professional knowledge in the field [8].

However, in actual teaching practice, the curriculum tends to overemphasize the details of language mechanics and disciplinary theory while paying comparatively less attention to the practical application of Technical English within the context of mechanical engineering projects. This focus on theoretical knowledge often leads to a gap between students' understanding of technical texts and their ability to apply these concepts in real-world engineering tasks. As a result, students may demonstrate proficiency in interpreting terminology and grammar but face challenges in using Technical English effectively for engineering design, technical documentation, and professional communication. Addressing this gap requires instructional strategies that integrate both linguistic competence and practical engineering application, ensuring that students can translate theoretical knowledge into actionable skills in mechanical engineering practice.

2.2. Need for Enhanced Systematic and Modular Organization of the Teaching Content

The curriculum is structured into six primary knowledge units: Advanced Engineering Materials, Lathe and Turning, Jigs and Fixtures, Manufacturing Technologies, Intelligent Manufacturing, and a comprehensive Summary and Abstract unit. Each of these units is closely connected to foundational disciplines, including CNC Technology, Robotics, Fundamentals of Mechanical Manufacturing, and Metallic Materials and Heat Treatment, forming an integrated knowledge network. However, the current delivery method generally follows a linear and compartmentalized approach, presenting each unit in isolation. This segmented instructional format can obscure the natural linkages between related concepts and processes, making it challenging for students to perceive the interdisciplinary connections inherent in mechanical engineering practices [9].

As a result, a notable pedagogical limitation emerges: the curriculum lacks a coherent modular system capable of reinforcing knowledge convergence and integration across multiple units. Without such a system, students may struggle to synthesize information from different modules, which can hinder their ability to apply Technical English in practical engineering contexts, such as interpreting technical literature, drafting reports, and communicating specialized procedures. Addressing this shortcoming requires an instructional design that emphasizes cross-unit coherence, integrates theoretical knowledge with practical application, and supports cumulative learning that reflects the interrelated nature of mechanical engineering disciplines [10].

2.3. Lack of Student Initiative in Classroom Participation

Students often exhibit a notable lack of initiative during the interactive components of classroom teaching. Very few students actively respond when instructors pose questions, which reduces the overall effectiveness of classroom engagement. This phenomenon can be attributed to the dual nature of the questions in the Technical English curriculum: they involve both mechanical engineering professional knowledge and English language skills. For one group of students, an insufficient grasp of foundational mechanical knowledge prevents them from recalling relevant concepts when faced with professional questions. Another group of students, who have weaker English proficiency, are reluctant to respond due to their limited confidence in language expression. Consequently, these factors collectively result in low student initiative and minimal participation during classroom interactions. This lack of active engagement not only affects the immediate learning outcomes but also hampers the development of practical skills, as students are unable to fully internalize the connections between theoretical concepts and their real-world applications in mechanical engineering. Therefore, enhancing student participation and fostering proactive learning behaviors are essential challenges that must be addressed to improve the effectiveness of Technical English instruction.

3. A Practice-Driven Mode for Flipped Classrooms in Mechanical Engineering Curriculum Titled Technical English

To address the three challenges identified in previous sections, our teaching research group has designed an instructional strategy that integrates practical engineering project knowledge directly into the Technical English curriculum. The core pedagogical approach adopts a flipped classroom model, aiming to shift students from passive recipients of information to active participants and facilitators of their own learning. In this model, students engage in pre-class preparation through reading, case studies, and guided exercises, allowing classroom time to focus on discussion, problem-solving, and the co-construction of knowledge. By emphasizing hands-on application and collaborative learning, this approach encourages students to actively connect technical English concepts with real-world mechanical engineering scenarios, thereby strengthening both language proficiency and professional competence. The practice-driven model also provides structured opportunities for students to reflect on their learning, clarify misconceptions, and internalize complex technical terminology, ultimately promoting a higher level of engagement, self-efficacy, and applied learning outcomes.

3.1. Adopting a Practice-Embedded Pedagogical Strategy

The practical learning component in the Mechanical Engineering curriculum is implemented through two main formats: discipline-specific project design and professional internships in Mechanical Engineering. The Technical English course is generally scheduled in the seventh academic semester, following the completion of most core practical courses. Consequently, when students engage with the Technical English curriculum, they already possess experiential knowledge from prior hands-on projects, which fosters relational thinking. This relational thinking enables students to effectively integrate Technical English linguistic elements-including specialized vocabulary, technical expressions, and domain-specific literature-into a coherent professional knowledge structure. Moreover, because the Technical English curriculum emphasizes current advancements and emerging trends in modern manufacturing technologies, embedding practice-based learning within the pedagogy allows students to connect language acquisition directly to real-world mechanical engineering applications and interdisciplinary technological integration. Such a practice-embedded approach not only enhances comprehension of complex technical content but also strengthens students' capacity to apply professional English in authentic engineering contexts, thereby bridging the gap between language proficiency and practical expertise.

3.2. Integrating the Flipped Classroom Model into Technical English Curriculum

To stimulate students' intrinsic motivation for learning, a flipped classroom model is implemented in the Technical English curriculum, informed by research and discussions within our teaching research group. Following a practice-oriented teaching syllabus, relevant specialized knowledge from preceding practical courses is identified and structured for pre-class preparation. During this phase, students are expected to independently locate, analyze, and critically evaluate related technical literature, developing both research and autonomous learning skills. In the classroom phase, students collaboratively refine their understanding of the specialized knowledge, applying domain-specific English skills such as technical reading, interpretation of terminology, and contextual analysis. The instructor then provides a comprehensive synthesis, reviewing technical terminology, analytical reading techniques, translation strategies, and professional writing based on the literature examined. This integrative process not only consolidates students' English proficiency in the mechanical engineering domain but also reinforces their comprehension of practical technical concepts, creating a meaningful learning experience that resonates with students and enhances their engagement in the subject matter.

3.3. Building an Evaluation System for Evaluating the Educational Effectiveness of Flipped Classrooms

Based on the pedagogical objectives outlined in the teaching syllabus, our teaching research group established a comprehensive evaluation system to assess the effectiveness of the flipped classroom model. A dual-target, anonymous survey instrument was developed for both instructors and students, designed to measure multiple dimensions including instructional delivery quality, alignment of curricular content, and levels of learner engagement. Following the collection and analysis of survey data, the operational details of the flipped classroom were iteratively adjusted and refined through collaborative workshops involving instructors and selected students. This iterative process ensures continuous improvement of the teaching model, enhances the relevance of course content, and strengthens student participation and practical application of Technical English in mechanical engineering contexts.

4. A Case Study in Practice-Embedded Technical English Instruction in Mechanical Engineering

To enhance students' motivation and engagement in the Technical English curriculum, a practice-embedded case study was designed within a flipped classroom model for Mechanical Engineering. This approach integrates domain-specific knowledge from practical engineering projects with English language learning, enabling students to actively apply linguistic skills to professional contexts.

4.1. Preparation Phase for the Class

At the beginning of each teaching cycle, the instructor delivers a preparatory lecture introducing and consolidating relevant Technical English vocabulary, expressions, and literature associated with the Production Line Course Design. The content covers core technical areas, including Robotics Programming, Machining Methodologies, and automated systems, providing students with a structured framework to systematically recall and organize Technical English knowledge within their professional discipline. Students are then divided into groups aligned with the teams used in the Production Line Course Design. Each group member is responsible for identifying and summarizing technical challenges in their project using English, and a detailed presentation script is compiled by the group leader to prepare for the subsequent in-class flipped phase.

4.2. Classroom Role Reversal Phase

During the in-class phase, group leaders deliver technical presentations in English, detailing their Production Line Course Design projects. These presentations cover engineering specifics such as part manufacturing, tooling, CNC operations, automated conveyance, inspection protocols, and integration of robotics. Students analyze curriculum materials and relevant literature, linking technical knowledge with English-language application. The presentations are followed by plenary discussions involving all groups and interactions with the instructor, allowing for clarification, debate, and consolidation of knowledge. The class monitor and study coordinator document the discussions and compile an English-language manuscript summarizing all key points and technical deliberations.

4.3. Instructor Review of Knowledge Points

Following the classroom presentations, the instructor systematically reviews Technical English terminology and relevant academic references related to the Production Line Course Design. This review ensures that students receive authoritative guidance on technical documentation, standardized linguistic usage, and professional conventions, solidifying their understanding of both technical content and language application.

4.4. After-Class Learning Phase

After class, students engage in peer-interactive learning, guided by topics and advanced technical details provided by the instructor. Using collaborative methods, students produce technical briefs in English, which integrate discussion outcomes and detailed explanations of advanced mechanical technologies. This phase reinforces independent research skills, critical analysis, and application of Technical English in practical contexts, enhancing students' professional competency and linguistic proficiency.

4.5. Evaluation and Analysis of Instructional Effectiveness

To measure the effectiveness of the flipped classroom model, a comprehensive evaluation instrument was employed, assessing student performance across pre-class, in-class, and post-class phases. Key metrics include engagement, understanding of technical content, and application of domain-specific English skills. Upon completion of the course, a teaching seminar is held involving instructors and selected students to review results, identify areas for improvement, and guide future curriculum development. This iterative evaluation process supports continuous optimization of teaching methods and strengthens the integration of Technical English with practical Mechanical Engineering knowledge.

5. Conclusions

From both pedagogical and learning perspectives, Technical English instruction in Mechanical Engineering continues to face three persistent challenges: (1) the decoupling between theoretical instruction and practical application in engineering, which limits students' ability to effectively apply learned knowledge in real-world scenarios; (2) the need for a more systematic and modular organization of teaching content to ensure coherent progression and stronger integration of interdisciplinary knowledge; and (3) the lack of student initiative and active engagement during classroom participation, which reduces the overall effectiveness of learning outcomes.

To address these challenges, a practice-driven instructional model has been constructed for the Technical English curriculum in Mechanical Engineering, employing a flipped classroom approach that emphasizes active learning, practical application, and systematic content delivery. This model is built on three key aspects: (1) adopting a practice-embedded pedagogical strategy that connects the curriculum to ongoing engineering projects and domain-specific tasks, enabling students to integrate language learning with professional knowledge; (2) integrating the flipped classroom methodology into the curriculum to promote student-centered learning, encourage peer interaction, and enhance engagement in both pre-class preparation and in-class activities; and (3) establishing a comprehensive evaluation system to assess the educational effectiveness of the flipped classroom, which includes measuring student learning outcomes, participation, and the integration of Technical English knowledge with professional engineering skills.

Overall, this approach provides a structured and interactive framework for cultivating students' technical language proficiency, professional knowledge application, and problem-solving capabilities, thereby contributing to the improvement of the quality and effectiveness of Technical English instruction in Mechanical Engineering.

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