https://doi.org/10.53964/jmer.2025002

https://www.innovationforever.com

Journal of
Modern Educational Research

ISSN 2790-3192 (Online)

Open Access

Research Article

Research on the Construction and Teaching Application of the STEP Engineering Education Model in Cultivating Excellent Engineers

Siyao Hong[1]

[1]Minzu University of China, School of Information Engineering, Beijing, China

[*]**Correspondence to: Siyao Hong,** Minzu University of China, School of Information Engineering, 27 South Zhongguancun Avenue, Beijing, 100080, China; Email: 3420626476@qq.com

Received: December 13, 2024 **Revised:** December 20, 2024 **Accepted:** December 24, 2024 **Published:** January 24, 2025

Abstract

Objective: To address the urgent demand for high-level engineering talents in the new era, and in response to engineering education reform trends and accreditation requirements, this paper focuses on the educational philosophies of world-class universities, particularly drawing from the globally recognized CDIO (Conceive, Design, Implement, Operate) framework. Based on the characteristics and practical experiences of a university's engineering education, we propose the STEP education model (i.e., Software, Theory, Experiment, Project) to achieve systematic enhancement in engineering education and effectively cultivate the comprehensive abilities of engineers.

Methods: The STEP model is structured around project-driven learning, seamless integration of theoretical and experimental teaching, and a curriculum structure supported by software tools. It aims to enhance students' learning outcomes through innovative teaching approaches, including science-education integration, virtual-real fusion, and competition-driven learning.

Results: Practical applications of the STEP education model in several course systems at the university demonstrate its effectiveness in enhancing students' engineering practice abilities and innovative thinking.

Conclusion: Providing strong support for the cultivation of excellent engineering talent, the STEP education model has proven effective in enhancing students' engineering practice abilities and innovative thinking, which are essential for meeting the demands of the new era and the trends in engineering education reform and accreditation requirements.

Keywords: excellent engineer; engineering education; STEP education model; construction; teaching application

Citation: Hong S, Research on the Construction and Teaching Application of the STEP Engineering Education Model in Cultivating Excellent Engineers. *J Mod Educ Res*, 2025; 4: 2. DOI: 10.53964/jmer.2025002.

1 INTRODUCTION

In the current era of rapid technological advancement and industrial transformation worldwide, competition among nations has increasingly evolved into a race for talent reserves and technological innovation[1]. The 2021 Central Talent Work Conference explicitly highlighted that excellent engineers are a critical force within the national strategic talent system[2], emphasizing the need to build a team of engineers who are "loyal, dedicated, highly capable in technological innovation, and adept at addressing complex engineering challenges" to support China's goal of achieving technological self-reliance and high-level innovative development. However, Chinese universities still face several persistent challenges in cultivating excellent engineers: First, theoretical teaching often remains at the level of "knowledge transmission," while experimental teaching is frequently limited to "repetitive verification"[3]. Second, a disconnect exists between theoretical and experimental teaching, and the curriculum design lacks practical application, with little organic connection to scientific research and actual engineering needs[4]. Third, classroom content lacks the application of real engineering cases, failing to fully inspire students' enthusiasm for autonomous learning[5]. These issues significantly undermine the effectiveness of engineering education, resulting in deficiencies in students' innovative awareness and practical abilities, which are major obstacles to the cultivation of excellent engineers.

In recent years, advanced engineering education concepts such as Conceive, Design, Implement, Operate (CDIO) have gradually become guiding principles for global universities in engineering talent cultivation[6,7]. Some domestic universities have also begun exploring innovative teaching methods, such as experiential, research-based, and project-driven approaches, to enhance students' engineering practice abilities and problem-solving skills[8,9]. To meet the demands for nurturing innovative talent in the new era, this paper draws from international educational philosophies, such as CDIO, and combines them with the university's unique characteristics and practical experiences in engineering education. We propose a STEP education model, which, through the organic integration of four modules—Software, Theory, Experiment, and Project—seeks to promote application across related disciplines and curricula. This model aims to comprehensively enhance students' engineering literacy, optimize course effectiveness, and provide new approaches for the continuous improvement of engineering education.

2 MATERIALS AND METHODS

2.1 Concept and Connotation of STEP

The goal of cultivating excellent engineers is to enhance college students' scientific literacy, technological innovation capabilities, and practical skills in solving complex engineering problems. This process relies on an engineering education system centered on innovation, integration, and comprehensive process[10]. The STEP education model focuses on the cultivation of excellent engineers, closely aligning the general principles of engineering education with the specific conditions of the nation and universities. STEP represents the organic combination of four elements: Software, Theory, Experiment, and Project. The university has been exploring the STEP education model and has developed a system for cultivating excellent engineers centered on project-driven learning. In this system, theoretical and experimental teaching complement each other, supported by software tools, forming a comprehensive practice and exploration from curriculum systems to teaching models and support mechanisms. The following figure illustrates the construction plan of STEP (Figure 1).

There are both differences and similarities between STEP and the CDIO educational philosophy. CDIO is based on product and production processes, emphasizing systematic decomposition across stages from R&D to operations, creating a vertically structured curriculum system based on the product realization process. In contrast, STEP promotes engineering education through horizontal integration of methods and tools. Specifically, STEP and CDIO have the following commonalities and distinctions: (1) Goal Consistency: Both STEP and CDIO support engineering accreditation, emphasizing a student-centered teaching philosophy and a curriculum system that aligns with talent cultivation goals. (2) Integrated Education Philosophy: Both emphasize project-based learning and comprehensive process integration, aiming to establish an effectively integrated talent cultivation system. (3) Process Management and Quality Assurance: STEP and CDIO place importance on educational process management and rely on internal quality assurance systems. Both faculty and students must invest adequate time, effort, and resources. While CDIO leans more towards the macro level, STEP is broadly applicable at both the macro level of curriculum system design and the micro level of individual course or course cluster implementation[11].

2.2 Construction Plan

2.2.1 Curriculum System Development

Building a curriculum system for cultivating excellent engineers is the core task of the STEP model, with a focus on achieving the organic integration of theory and experiment teaching under project-driven learning. By incorporating advanced software tools, a unified teaching design and practical system are created to maximize the effectiveness of various educational elements.

2.2.2 Project-Driven Approach

The STEP model centers on a project-driven approach, emphasizing that real projects are used to link and deepen students' integrated mastery of theory, experiments, and software tools. Project-driven teaching is not merely project-based learning but involves using projects as carriers of course knowledge and verification platforms for practical application through the establishment of a knowledge system[12]. STEP's project-driven teaching depends on task-oriented practical activities, requiring students to approach knowledge acquisition with a focus on solving actual problems, thereby building a systematic knowledge structure.

https://doi.org/10.53964/jmer.2025002

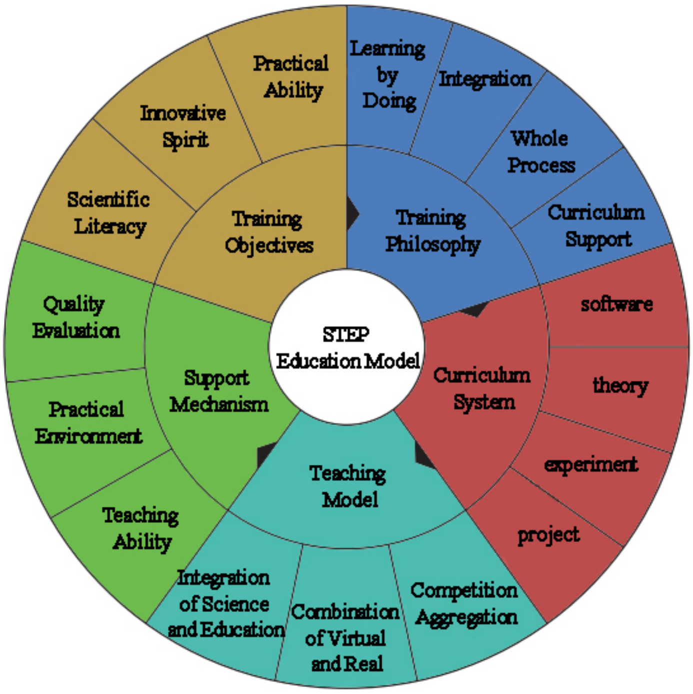

Figure 1. Construction Plan of STEP.

In the STEP model, project-driven learning is not limited to treating projects as standalone teaching activities; instead, projects are systematically regarded as core elements in students' knowledge structure building. Through project-driven learning, the conceptual knowledge from theoretical instruction transforms from fragmented information into a knowledge framework centered on project tasks, enabling students to profoundly understand the integration of theory, experimentation, and software tools in real engineering applications. By completing these projects, students develop team collaboration, innovation awareness, knowledge-sharing, and independent learning skills, thereby strengthening their comprehensive abilities to tackle complex issues. Project design is crucial for the successful implementation of the STEP model, with project selection following a "Core Principle" and "Five Principles," as detailed below in Table 1.

2.2.3 Coordination of Theoretical and Experimental Teaching

In the STEP education model, the coordinated development of theoretical and experimental teaching is an essential part of cultivating excellent engineers. Theoretical teaching not only includes four levels—general education, disciplinary courses, specialized courses, and integrated courses—but also emphasizes course progression and systematic knowledge construction. Experimental teaching, on the other hand, is divided into four levels: foundational, specialized, research-oriented, and interdisciplinary, guiding students gradually from applying basic knowledge to solving complex problems. Foundational and specialized experimental projects primarily develop students' abilities to apply professional knowledge to solve real-world problems, while research-oriented and interdisciplinary experimental projects aim to stimulate students' innovation capabilities and interdisciplinary integration skills, preparing them to tackle complex systemic issues. At the same time, experimental teaching achieves coordination with theoretical teaching through the combination of four approaches: teacher guidance with student self-practice, in-class with extracurricular activities, virtual simulation with hands-on practice, and exam assessment with process evaluation. Details are provided in Table 2 below.

By establishing several core course groups, the integration of theory and experimentation is strengthened, becoming a key to the systematic implementation of the STEP curriculum. This process aligns with the trends of interdisciplinary and knowledge integration, promoting comprehensive reforms across various disciplines around key course groups, breaking down the barriers between theory and experimentation, and achieving effective teaching synergy.

2.2.4 Support of Software Tools

In modern engineering and scientific education, proficiency in relevant software tools has become an essential skill. The use of virtual simulation software, in particular, has been shown to significantly enhance students' practical abilities and deepen their understanding of theoretical knowledge. The STEP education system emphasizes the in-depth use of software tools in the teaching process, enhancing their role in both theoretical learning and experimental operations, thereby promoting the transition of students from "understanding" to "application." The significance of software tools is outlined in Table 3 below.

https://doi.org/10.53964/jmer.2025002

Table 1. Summary of Project Selection and Design Principles

Module	Element	Description
Project Design Core	Student-Centered[13]	Focus on students' needs and learning interests during project design, ensuring student autonomy in project selection and learning, promoting knowledge application and skill enhancement through real tasks.
Five Major Principles of Project Design	Holistic, Realistic, Relevant, Adaptive, Cutting-Edge	Projects should ensure systematic knowledge building, stem from real engineering problems, effectively combine theory and experimentation, align with course characteristics, and represent advanced technology, comprehensively supporting students' skills development and knowledge application.

Table 2. Summary of the Coordinated Development of Theoretical and Experimental Teaching

Module	Element	Description
Theoretical Teaching Structure	General Education Courses	Cultivate students' humanistic literacy and scientific spirit through broad knowledge education, enhancing critical thinking abilities.
	Disciplinary Courses	Build a solid foundation in mathematics and physics, providing support for subsequent academic research and learning development.
	Specialized Courses	Guide students in exploring cutting-edge professional knowledge and engage in systematic professional training, with modular course design for flexibility.
	Integrated Courses	Integrate system knowledge in specific professional directions, fostering interdisciplinary integration skills to adapt to the complexity of modern engineering.
Experimental Project Levels	Foundational	Develop students' ability to apply foundational knowledge to solve real-world problems.
	Specialized	Enhance students' practical application of professional knowledge and improve hands-on operational skills.
	Research-Oriented	Stimulate students' research innovation awareness and foster complex problem-solving skills.
	Interdisciplinary	Promote interdisciplinary integration, developing skills to adapt to the complexity of modern engineering.
Experimental Teaching Methods	Teacher Guidance and Self-Practice	Teachers guide and motivate students to explore actively, encouraging independent practice to enhance learning outcomes.
	Combination of In-Class and Extracurricular	Deepen theoretical learning through extracurricular practice, achieving comprehensive improvement in learning outcomes.
	Virtual Simulation and Hands-On Practice	Use modern technology to enhance practical abilities and improve intuitive understanding of knowledge.
	Combination of Exam and Process Evaluation	Emphasize performance and progress throughout the learning process, ensuring comprehensive assessment of students' abilities and qualities.

2.3 Teaching Model

2.3.1 Integration of Science and Education

In the STEP education model, the integration of science and education is an important strategy for achieving engineering education goals, with curriculum design as the foundation and projects as the core for realizing objectives. Through carefully designed teaching projects, instructors not only help students develop scientific thinking and research methods but also effectively integrate research outcomes into teaching to cultivate students' abilities to solve engineering practice problems using modern tools. By offering "Engineering+" courses, introducing master lectures, and implementing new classroom teaching methods, the STEP education model effectively promotes the combination of scientific education and engineering practice, providing an excellent platform for the comprehensive development of students. Details are provided in Table 4 below.

2.3.2 Combination of Virtual and Reality

With the rapid development of new-generation information technologies such as mobile internet, big data, and cloud computing, university teaching models are undergoing profound changes[14,15]. The combined virtual and reality teaching model not only enhances classroom engagement but also improves students' self-directed learning abilities, effectively raising the overall effectiveness of the STEP education model.

The core of the virtual-reality combined model lies in using a blend of virtual and real methods to efficiently accomplish teaching tasks, taking into account specific teaching objectives and content requirements, as well as the characteristics of the course and implementation environment. On a macro level, building a virtual-reality combined teaching platform is essential, including the introduction of cloud classrooms and Massive Open Online Courses, promoting the construction of flipped classrooms, creating a comprehensive electronic course resource library, and encouraging students to engage in independent learning outside the classroom. This facilitates better interaction

Table 3. Explanation of the Significance of Software Tools

Module	Element	Description
Importance of Software Tools	Support for Theoretical and Experimental Teaching	Emphasizes the core role of software tools in teaching, transforming them from "supplementary" aids to key tools in theoretical learning and experimental application, enabling students to progress from understanding to practical application.
Value of Software Application	Project-Driven and Practical Application	Through simulation design, parameter setting, and data analysis, students gain application skills within projects, enhancing their problem-solving abilities in real-world contexts.
Integration of Courses and Tools	Collaboration of Theoretical Teaching and Simulation	Uses software tools to visualize abstract theoretical knowledge, such as in courses like mathematical modeling and mechanical design, where numerical simulation and virtual experimentation deepen understanding and apply course knowledge in experimental settings.
Support Resources	Software Tool Library and Technical Support	Establishes a tool library encompassing various courses, providing support tools from foundational to advanced levels, along with online tutorials and practical demonstrations, ensuring students have effective guidance and resources at every stage of learning.

Table 4. Summary of Methods for Science and Education Integration

Module	Element	Description
Curriculum Design	“Engineering+” Courses	Encourages instructors to develop experimental projects related to research projects, allowing students to learn in real engineering environments, thereby enhancing engineering thinking and innovation skills, facilitating the transition from theoretical learning to practical application.
Academic Exchange	Introduction of Master Lectures	Invites leading scholars as guest lecturers, exposing students to cutting-edge academic achievements, broadening academic horizons, inspiring curiosity and innovative spirit, and fostering research abilities through academic exchanges.
Teaching Methods	New Classroom Teaching Methods	Adopts heuristic, discussion-based, research-oriented, and project-based teaching approaches, creating an experience-centered classroom culture where students are encouraged to actively participate, enhancing their critical thinking and teamwork skills.

and hands-on practice during class, meeting students' individualized learning needs. On a micro level, integrating relevant software tools into the course system is a crucial step in achieving a virtual-reality combination. Through virtual simulation, data analysis, and evaluation methods, students gain a more intuitive and authentic learning experience, enhancing their understanding and practical skills. This new learning approach not only improves students' learning efficiency but also strengthens their ability to solve real engineering problems.

2.3.3 Competition Aggregation

Integrating competition activities into the curriculum system is an innovative teaching model that helps students gain comprehensive mastery of theoretical knowledge application and enhance their practical skills[16]. The university has established a three-tier linkage mechanism of “Alumni-Teacher-Student,” “Enterprise-School-Base,” and “Creativity-Innovation-Entrepreneurship,” forming a complete closed loop driven by competitions that supports course learning, practical training, and student development. This model achieves broad coverage of competition activities in the student training process, allowing students not only to gain in-depth understanding of course knowledge but also to improve their innovation and practical abilities through the challenges of competition. In the competition aggregation model, students are required to integrate course theories, experimental techniques, and innovative thinking in real situations to address practical problems. Through team collaboration, students conduct research, design, and produce competition entries, as well as write analysis reports and project completion papers, systematically developing a series of core skills from literature searching and self-directed learning to data analysis and real-world problem-solving. This multidimensional learning model greatly enhances students’ professional competence and cultivates their teamwork and innovation capabilities.

4 RESULTS AND DISCUSSION

STEP demonstrates broad applicability at both the macro level of curriculum system construction and the micro level of single course or course group development. The following typical case are discussed in detail with regards to STEP teaching practice in the traditional Mechanical Engineering curriculum system.

As a prominent engineering field of most universities,

https://doi.org/10.53964/jmer.2025002

Table 5. Summary of Software Tool Support

Category	Software Tools
Design	Adobe Photoshop, Adobe Illustrator, 3D Studio Max, Key Shot, Rhino
Manufacturing	SolidWorks/Inventor, CAD/CAXA, Cura, Unigraphics NX, Marc, Moldflow/Moldex, Mastercam
Control	LabVIEW, Vc6.0, MATLAB, AMESim, Visual Studio, MySQL/Access, Simulink
Analysis	Ansys, Adames, Patran, Nastran

the Mechanical Engineering major requires students to integrate multidisciplinary knowledge in materials science, mechanics, sensor technology, dynamics, control theory, and computer science for systematic design and development. However, in traditional teaching modes, there are common issues such as an overemphasis on theoretical learning, insufficient practical operation opportunities, and inadequate integration of theory and practice, which leads to deficiencies in students' systematic practical innovation abilities[17-19]. In response to the international higher education concepts of "Return to Engineering"[20] and "Big Engineering View"[21], the Mechanical Engineering major has established a talent cultivation goal centered on students mastering the "typical mechatronic product realization process" and actively explores and practices the STEP concept.

The Mechanical Engineering curriculum system based on the STEP concept is as follows: (1) Theoretical Teaching System: This system consists of general foundation courses, disciplinary foundation courses, professional foundation courses, and core professional courses, ensuring a broad knowledge base for students. (2) Experimental Teaching System: The experimental part is structured around characteristic foundational, comprehensive professional, scientific research innovation, and interdisciplinary open experiments. Through these experiments, students can deepen their understanding of theoretical knowledge in practical settings.

For the design and manufacturing of typical mechatronic products, the core courses are designed as follows: (1) General Theory Course: Courses such as "Introduction to Mechanical Engineering" help students build an overall understanding of the design and manufacturing of typical mechatronic products. (2) Design Courses: By learning the concepts and structural design process of typical mechanical systems, students acquire system design skills in subsequent mechatronic experimental courses, fostering their practical abilities in mechatronic control and hardware design. (3) Manufacturing Courses: This includes learning typical mechanical manufacturing processes and techniques, improving students' operational abilities in actual production. (4) Professional Comprehensive Practice: Through production internships and comprehensive professional practice, students master system design and manufacturing processes related to their professional direction, enhancing their technical innovation abilities and problem-solving skills for complex engineering issues, thus laying a solid foundation for cultivating outstanding engineers.

In teaching, the Mechanical Engineering major combines three types of project-driven teaching, organically embedding projects into courses: (1) Course Foundation Projects: These projects are based on practical applications within the course, supporting specific course modules to promote coherence and systematicity in the knowledge framework. (2) Research Training Projects: By integrating high-quality experimental resources, relevant projects are designed for different course groups, encouraging students to apply their specialized knowledge to solve comprehensive practical problems. (3) Comprehensive Innovation Projects: Focused on cutting-edge theories and high-level research outcomes in the discipline, projects related to high-level innovation and entrepreneurship competitions, graduation projects, and comprehensive professional practice are set up to fully embody the "complete mechanical product realization process" and promote the interdisciplinary integration of knowledge.

In terms of software tool support, the Mechanical Engineering major has summarized a comprehensive tool system, consisting of four major categories and over 20 software tools, as detailed in Table 5 below.

Through the above practices, the Mechanical Engineering major has not only enhanced students' theoretical and practical abilities but also laid a solid foundation for their future careers. This case demonstrates the effective application of STEP in engineering education, providing valuable insights for the reform and development of other professional courses.

5 CONCLUSION

Based on advanced educational concepts such as CDIO from both domestic and international sources, and combined with the distinctive features of our engineering education, some universities have introduced the widely applicable STEP model to support the cultivation of outstanding engineers. Since its implementation, this model has shown positive results in various aspects, providing a valuable reference for the training of STEM talents and the reform of engineering education. The STEP model emphasizes a close integration of theory and practice, driving innovation and updating in course content, while strengthening students' comprehensive abilities and practical experience. Through this model, students not only acquire solid theoretical knowledge but also develop problem-solving skills and teamwork in project practice. This lays a solid foundation for cultivating high-quality engineering and technical talents capable of meeting the demands of future society.

However, certain key issues still require attention in the implementation of STEP. For instance, the applicability of STEP in foundational theoretical courses needs further exploration and validation, and finding ways to better integrate this model into such courses is a future objective. Additionally, experimental teaching and project design within courses need to be more closely aligned with teaching objectives and content to ensure seamless integration between theoretical knowledge, practical experience, and relevant software tools. This will help enhance teaching effectiveness and further support students' all-round development. In summary, with the development of the research and application of the STEP model, more and more outstanding engineers will be educated and serve our society.

Acknowledgements
Not applicable.

Conflicts of Interest
The author declared no conflict of interest.

Data Availability
All data generated or analyzed during this study are included in this published article and its supplementary information files.

Copyright and Permissions
Copyright © 2025 The Author(s). Published by Innovation Forever Publishing Group Limited. This open-access article is licensed under a Creative Commons Attribution 4.0 International License (https://creativecommons.org/licenses/by/4.0), which permits unrestricted use, sharing, adaptation, distribution, and reproduction in any medium, provided the original work is properly cited.

Author Contribution
The author contributed to the manuscript and approved the final version.

Abbreviation List
CDIO: Conceive, Design, Implement, Operate

References
[1] Wang W, Cai Y. Technology-driven, talent empowerment, and demand-oriented: Three key dimensions of China's digital government construction - Based on the analysis of the electronic governance development index [In Chinese]. *Xing Zheng Lun Tan*, 2022; 29: 58-66.
[2] Liu Q, Wang Y, Fan L. Analysis and countermeasures of the cultivation of outstanding engineers in China [In Chinese]. *Guo Jia Jiao Yu Xing Zheng Xue Yuan Xue Bao*, 2024, 317: 44-52, 95.
[3] Wang J, Cui Y. Construction of the National Academy for Outstanding Engineers: Summary, comparison, and innovative suggestions [In Chinese]. *Xue Wei Yu Yan Jiu Sheng Jiao Yu*, 2024: 1-9.
[4] He J, Qin A, Wang L et al. Exploration of the implementation path for the reengineering of outstanding engineer training elements [In Chinese]. *Xue Wei Yu Yan Jiu Sheng Jiao Yu*, 2024: 61-68.
[5] Tkhagapsoyev KG, Yakhutlov MM, Islamova OV et al. To the strategy of training an engineer in quality management. 2020 International Conference Quality Management, Transport and Information Security, Information Technologies (IT&QM&IS). *IEEE*, 2020: 543-546.
[6] Peng Y, Shen T, Tang J et al. Research on the Innovative Training System for Outstanding Communication Engineers Based on CDIO — Taking the Communication Engineering Major of Kunming University of Science and Technology as an Example [In Chinese]. *Yun Nan Min Zu Da Xue Xue Bao (Zi Ran Ke Xue Ban)*, 2020, 29:140-144.
[7] Grit Z. Presentation of the advanced training program: 'specialized engineer / specialized planner / specialized construction supervisor in block pavement construction'. 2021; 87:27.
[8] Chen Y. Research on the Cultivation of Outstanding Engineers in the Field of New Energy under the CDIO Concept - Taking Xinyu University as an Example [In Chinese]. Xin Yu Xue Yuan Xue Bao, 2019; 24: 113-116.
[9] Leslie LJ, Gorman PC, Junaid S. Conceive-design-implement-operate (cdio) as an effective learning framework for embedding professional skills. *Int J Eng Educ*, 2021; 37: 1289-1299.
[10] Fu L, Yang G, Ma X et al. Construction of the Ideological and Political Education System for Outstanding Engineers in the New Era [In Chinese]. *Xue Wei Yu Yan Jiu Sheng Jiao Yu*, 2024:67-74.
[11] Yu J, Guo W, Chen D. The STEP Teaching Model for Engineering Education [In Chinese]. *Gao Deng Gong Cheng Jiao Yu Yan Jiu*, 2017: 73-77.
[12] Li Z, Yu C, Dong L. Project-driven Engineering Education Talent Cultivation Model: Practices and Enlightenments from European and American Universities [In Chinese]. *Gao Deng Jian Zhu Jiao Yu*, 2024; 33: 25-35.
[13] Li J, Wang F, Zhou Y. Exploration of the Flipped Classroom Practice in Actuarial Professional Experiment Courses [In Chinese]. *Gao Deng Gong Cheng Jiao Yu Yan Jiu*, 2019: 198-200.
[14] Wang J, Guan B. Research on the Reform and Practical Path of Ethnic Traditional Sports Teaching Model in Colleges and Universities under the Background of "Internet Plus" [In Chinese]. *Wu Shu Yan Jiu*, 2024; 9: 95-97.
[15] Jiang Q, Li Y, Qian S. Research on the Construction of Precise Teaching Model in Universities Based on Big Data [In Chinese]. *Gao Jiao Tan Suo*, 2020: 31-35.

https://doi.org/10.53964/jmer.2025002

[16] Cosden IA, McHenry K, Katz DS. Research software engineers: Career entry points and training gap. *Comput Sci Eng*, 2022; 24: 14-21.

[17] Ban Q, Yi B, Zhang H et al. Exploration of the Reform of Blended Teaching Model under the Background of Engineering Education Professional Certification [In Chinese]. *Da Xue Jiao Yu*, 2024: 68-72.

[18] Zhang C, Peng B, Cheng H et al. Exploration of the Reform Model of Traditional Engineering Practice Teaching in Colleges and Universities - Construction and Practice of the Light Chemical Engineering Practice Teaching System to Enhance Students' Engineering and Innovative Abilities [In Chinese]. *Pi Ge Ke Xue Yu Gong Cheng*, 2023; 33: 97-103.

[19] Wang C, Li Z, Gao H et al. Design of Project-based EDA Course Ideological and Political Teaching Reform under the Background of Engineering Education Professional Certification [In Chinese]. *Da Xue Jiao Yu*, 2024: 92-95.

[20] Ma T, Feng J. Returning to Engineering Practice and Reform of Engineering Education Model [In Chinese]. *Gao Jiao Fa Zhan Yu Ping Gu*, 2018, 34: 9-16.

[21] Yue Y, Jin X, Guo J et al. Teaching Reform and Practice of Mechanical Basic Course Cluster Facing the Concept of Large-scale Engineering [In Chinese]. *Nong Ye Gong Cheng*, 2024; 14: 125-132.