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ORIGINAL ARTICLE

Exploring a new model of undergraduate vocational education

Futao Huang*

Research Institute for Higher Education, Hiroshima University, Higashi-Hiroshima 739-8512, Hiroshima Prefecture, Japan

ABSTRACT

In modern society, the demand for high-level technical and skilled talents is increasing, necessitating that university students not only acquire theoretical knowledge but also develop practical operational abilities and professional literacy. However, traditional educational models often fail to cultivate these competencies effectively. This study explored a new undergraduate vocational and technical education model designed to bridge the gap between theory and practice. The proposed model emphasizes industry-academia collaboration, interdisciplinary integration, competence-based education, and certification alignment to enhance students' employability and adaptability. Through a comparative analysis of global best practices, including examples from Germany, Japan, and China, the study identified key strategies for developing a comprehensive vocational education framework. The findings highlight the importance of practical training, flexible curriculum structures, and robust evaluation systems in fostering high-quality skilled professionals who meet the evolving demands of the modern workforce.

Key words: undergraduate vocational education, competence-based learning, industry-academia collaboration, practical training

INTRODUCTION

In modern society, the demand for high-level technical and skilled talents is increasingly growing, requiring university students to possess not only theoretical knowledge but also practical operational abilities and professional literacy. However, traditional educational models and teaching methods often appear insufficient in cultivating these abilities (Raby & Valeau, 2024; Sabet *et al.*, 2024). Therefore, developing a new undergraduate vocational and technical education model has become particularly important to better adapt to the rapid development of technology and to actively respond to the globalization trend of higher education (Chinedu *et al.*, 2015).

In recent years, national policy levels have continuously emphasized the enhancement of higher education quality and the cultivation of vocationally skilled talents to strengthen China's competitiveness in the global higher education and industrial fields. For example, the National Medium- and Long-Term Educational Reform and Development Plan (2010-2020) proposed strategic goals and policy measures for developing vocational education, emphasizing the importance of strengthening the alignment of vocational education with industry, improving education quality, and enhancing service levels (Xinhua News Agency, 2010). The Vocational Education Reform Implementation Plan (2019) clarified specific tasks and objectives, such as expanding the scale of vocational education, improving education quality, and promoting industry-academia integration (Ministry of Education, 2020). The Action Plan for Improving Vocational Education Quality and Excellence (2020-

***Corresponding Author:**
Futao Huang, Research Institute for Higher Education, Hiroshima University, 1-2-2 Kagamiyama, Higashi-Hiroshima 739-8512, Hiroshima Prefecture, Japan. Email: huangfutao@gmail.com; https://orcid.org/0000-0003-1322-7784

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2023) further proposed policy measures in aspects such as enhancing vocational education quality, optimizing curriculum design, and advancing teacher team development (State Council, 2019). The revised Vocational Education Law of the People's Republic of China (2022 revision) explicitly defined the basic principles, goals, and management system of vocational education at the legal level, providing legal guarantees for the development of vocational education (Ministry of Education, 2022).

The aforementioned policies and planning documents provide guidance and support for the development of higher vocational education in China, aiming to promote the close integration of higher vocational education with socioeconomic development, cultivate more high-quality skilled talents, and drive national economic transformation, upgrading, and sustainable development. Local governments have also formulated specific vocational education development plans and policy documents according to national policies and local conditions, including specific measures in investment planning, project construction, talent cultivation, and other areas.

Internationally, Japan, South Korea, and other East Asian countries have many experiences in vocational education development that are worth referencing. For example, Japan has continuously promoted the development of vocational education and skills training and has improved the level of vocational and technical education by revising relevant laws and issuing policy documents (Ministry of Education, Culture, Sports, Science and Technology, 2017). Through the 1995 Framework Act on Vocational Education and Training and Vision for Vocational Education and Training 2020-2030, South Korea formulated clear strategies and goals for vocational education development, promoting the integration of vocational education with academic education. Additionally, other countries and regions have actively promoted the development of vocational education and improved its quality and employment competitiveness through various policies and measures (Choi, 2020; UNESCO, 2016).

The foregoing shows that promoting the development of high-level vocational education is not only an important way to cultivate high-skilled talents but also an important support for promoting economic development and social progress. By improving undergraduate vocational education policies, strengthening the alignment of vocational education with industries, and enhancing the quality and service level of vocational education, modern society's demand for highly skilled talents can be better met, thereby promoting sustainable socioeconomic development.

From the perspective of cultivating high-level technical and vocational and technical talents talents to meet the demand for such talents in modern society, the existing undergraduate education models generally have several critical limitations. For instance, liberal education emphasizes humanistic literacy and civic responsibility but usually does not involve the cultivation of specific vocational skills (Maddock, 2021). Professional education effectively cultivates specific vocational skills but often overly focuses on theory, neglecting integration with modern vocational practice (Wilding, 2024). General education provides foundational knowledge but is often broad and lacks depth. Traditional vocational technical education courses cultivate practical skills but generally do not offer theoretical knowledge or teach vocational design elements (Adler-Kassner, 2014). Competence-based education (CBE) attempts to combine the advantages of vocational education and general education to cultivate students' comprehensive abilities, but balancing theoretical learning and practical application often appears challenging to implement (Naranjo, 2022).

To address the shortcomings of existing educational models, this paper proposes an undergraduate vocational technical education model based on practical teaching and learning methods, aiming to cultivate students' vocational skills, practical operational abilities, and professional literacy. This model can not only provide students with learning opportunities at the undergraduate level but also allow them to receive vocational training, enhancing their professional literacy and technical abilities. More importantly, the proposed model can better meet the country's demand for highly skilled talents, help improve the overall level of China's higher education, enhance the country's influence and competitiveness in the international vocational education field, and elevate the country's status in global technological innovation.

This paper examines the development and challenges of undergraduate vocational and technical education and proposes a systematic vocational technical education model to improve students' vocational skills and practical application abilities. It first reviews domestic and international research findings, analyzes the development status and challenges of vocational education under the support of national policies, and cites relevant scholars' studies to explore the concepts, development models, and status of vocational education in the education system while analyzing the development trends of vocational education in various countries. It also raises relevant research questions. Next, it discusses the fundamental characteristics of the proposed undergraduate vocational technical education model, emphasizing the integration of practice and theory, a balanced curriculum structure, diversified teaching

methods, and comprehensive evaluation systems. It proposes specific implementation pathways both inside and outside universities, including foundational curriculum design, vocational skills courses, and industry collaboration internships. It further elaborates on the relationships between the proposed undergraduate vocational technical education model and vocational education as well as CBE. Finally, it summarizes the study's findings, offers insights for higher education research and policymaking, provides recommendations for institutional innovation in talent cultivation, and points out the research limitations and directions for future studies.

LITERATURE REVIEW

Prior research in China

The development of undergraduate vocational and technical education is an important strategic task for meeting the needs of socioeconomic structural transformation, optimizing the structure of higher education, and building a modern vocational education system. Undergraduate vocational and technical education in China is currently at an exploratory stage, and it is crucial to clarify its developmental direction and pathways.

Ma (2015) pointed out that undergraduate vocational and technical education is a type of undergraduate education built upon the foundation of secondary and tertiary vocational education, and that its goal is to cultivate high-level technical application-oriented talents by systematically improving students' vocational skills and comprehensive qualities through teaching. Three pathways were proposed for the development of undergraduate vocational and technical education: relying on undergraduate education resources, integrating the advantageous resources of tertiary vocational education, and utilizing advantageous resources from emerging industries to establish modern corporate universities and implement undergraduate vocational qualification education.

Furthermore, to optimize the development environment for undergraduate vocational and technical education, the following external support systems should be established: promulgating relevant laws and regulations, investing in education funding, ensuring government management efficiency, and guiding public opinion.

Based on a comparative analysis of the similarities and differences in the core elements of talent cultivation models between undergraduate vocational education, regular undergraduate education, and higher vocational education at the associate degree level, Duan (2015) proposed that the educational philosophy of undergraduate vocational education should embody the dual attributes of "higher education" and "vocational education". The cultivation goals should target high-level technical application-oriented talents, and the curriculum system should embody "competence-based" principles. Simultaneously, by drawing on the experiences of U.S. community colleges, German universities of applied sciences, and Taiwan's undergraduate vocational education in terms of institutional positioning, cultivation goals, major settings, curriculum systems, faculty development, and practical training guarantees, among others, scientific models for talent cultivation in China's undergraduate vocational education can be constructed. These include establishing educational philosophies aligned with trends in higher education reform and development; cultivating high-level technical application-oriented talents; setting market- and employment-oriented majors; building a curriculum system focused on cultivating applied technical capabilities; establishing a government-led, institution-centered, and enterprise-supported practical model, and building a diversified evaluation system.

Zhao (2023) noted that the development of the vocational education curriculum in China has gone through stages, from parallel theory and practice (Curriculum 1.0) to theory serving practice (Curriculum 2.0), and further to theory and practice integration (Curriculum 3.0). Future curriculum development (Curriculum 4.0) needs to focus on the characteristics and laws of digitalization and "work-based learning".

Zhou (2023) further suggested that China should improve its relevant laws, regulations, and vocational qualification certification systems, increase its education funding, and build an employment guarantee system to promote the high-quality development of undergraduate vocational and technical education. Meanwhile, undergraduate vocational institutions should optimize talent cultivation models, improve their talent cultivation systems, address their shortcomings in professional development, scientifically refine their curriculum systems, and fully promote the development of undergraduate vocational education.

Although prior studies have provided specific pathways and support systems for the development of undergraduate vocational education, several issues remain. For example, the vocational education quality evaluation system urgently needs improvement, requiring a more scientific and comprehensive evaluation system to measure the development level of students' vocational abilities. Zhao (2023) proposed establishing a scientific evaluation concept for vocational education emphasizing the assessment of vocational cognitive and action capabilities to avoid the phenomenon of "one exam determining a lifetime".

Overseas research

Globally, developmental trends in vocational and technical education demonstrate that countries are increasingly focusing on cultivating high-quality talents with practical operational skills and professional literacy. Cameron and O'Hanlon-Rose (2011) found that global technological advancements and demographic changes impose new demands on technical and vocational education and training (TVET), requiring educators and graduates to possess global competitiveness. Maclean and Pavlova (2013) proposed that integrating TVET into higher education is a significant global development trend in vocational and technical education, emphasizing the close connection between vocational education and academic education. In a case study in South Africa, Sebola (2022) highlighted that to transform TVET colleges into institutions of higher education, the capability standards of students and staff must meet higher education standards. This high demand for vocational education standards and quality reflects the importance and influence of vocational education within the global higher education system. In recent years, Japan has made significant progress in the development of undergraduate vocational and technical education. Many scholars believe that this initiative aims to reform vocational education so that it can better meet the needs of Japanese society and industries, bridging the gap between theoretical academic knowledge and practical industrial requirements while aligning with international trends set by the Bologna Declaration (Hu, 2022; Inage, 2020; Kaneko, 2019).

Despite the progress in undergraduate vocational education domestically and internationally, several challenges remain. First, the vocational education quality evaluation system urgently needs improvement. The current evaluation system requires greater scientific rigor and comprehensiveness in measuring students' vocational ability development levels. Second, the integration of vocational education and general education requires further exploration to ensure that the former will play a role within the higher education system. Lastly, a more comprehensive and systematic undergraduate vocational education model must be constructed to meet the developmental demands of modern societies and economies.

Based on the above literature review, the following major research questions were formulated: (1) How can a systematic undergraduate vocational and technical education model be designed and implemented to comprehensively enhance students' vocational skills and practical application abilities. (2) What teaching methods and strategies are most effective in cultivating undergraduate students' vocational skills and practical application abilities.

CHARACTERISTICS OF THE NEW MODEL

Based on actual cases in Germany and Japan, as well as the reviewed literature, the core characteristics of undergraduate vocational and technical education models are outlined below.

Educational philosophy and goals

Undergraduate vocational and technical education models emphasize not only cultivating students' practical operational abilities and vocational skills but also developing students' capacity for independent practice in modern vocational environments. Contemporary vocational education theories stress the unity of teaching and practice, while further emphasizing interdisciplinary practical methods in actual education (Choy *et al.*, 2018; Farran & Nunez, 2024). The philosophy of vocational and technical education includes the following key points.

Integration of vocational training and education

Students are not just recipients of knowledge but active participants in the learning process, which is a practice process. For example, Hochschule Esslingen (HE) and Hochschule Heilbronn (HHN) in Germany emphasize cultivating students' practical abilities through real-world projects and collaborations with enterprises (Childs, 2022; Yu, 2023).

Alignment with industry needs and technologies

Teaching content must be based on the latest industry demands and technological developments, and teachers should incorporate their practical experiences in these into their teaching. For instance, the Tokyo Professional University of Health Sciences (TPU; 2023) in Japan has increasingly emphasized the close integration with the latest medical technologies and industry standards in its curriculum development.

Interdisciplinary competencies

Through multidisciplinary learning and practice, students improve their comprehensive qualities and adaptability. HE and HHN foster students' interdisciplinary competencies through interdisciplinary courses and projects.

Integration with vocational certificates

The curriculum and teaching content should align with the requirements of relevant vocational certificates, enabling students to obtain industry-recognized qualifications upon graduation. For example, TPU emphasizes that students must meet the essential subjects for the national qualification exams upon graduation and offers interdisciplinary education to expand their knowledge base and comprehensive qualities.

Basic structure and content

The proposed undergraduate vocational and technical

education model systematically cultivates students' vocational skills and practical application abilities through both internal and external university teaching and practice activities.

Within universities

Foundational and professional courses: In classroom-based education, students build a solid theoretical foundation under the guidance of instructors. For instance, the foundational courses at HE and HHN include mathematics, physics, computer science, and electrical engineering, with advanced studies in areas such as electrical engineering and control technology following in later stages.

Vocational skills training: The courses offer not only theoretical knowledge but also specific vocational skills training, such as Computer-Aided Design (CAD) drafting in engineering and clinical nursing techniques in nursing programs. Such courses equip students with skills directly applicable to the workplace.

Comprehensive practical training: Simulated real-world environments allow students to practice skills in a hands-on manner. For instance, engineering students may engage in production operations within campus-based simulation factories, while nursing students may perform nursing tasks in simulated hospital wards. TPU students practice nursing skills in simulated wards, effectively translating the theoretical knowledge they have gained into practical skills.

Vocational certification courses: To enhance students' vocational competitiveness, vocational technical education models include vocational certification courses. These courses provide students with the opportunity to acquire industry-recognized certifications while mastering professional knowledge and skills. For example, information technology (IT) students can take Cisco Certified Network Associate training courses to obtain industry-recognized credentials.

As suggested above, in recent years, Japan has placed significant emphasis on developing high-level vocational and technical education. According to a 2023 report by Japan's MEXT (Ministry of Education, Culture, Sports, Science and Technology, 2023), professional universities established since 2019 have provided students with unique opportunities to acquire both theoretical knowledge and practical skills. The key features include the following.

Extensive practical training: Over one-third of the credits required for graduation from four-year professional universities are devoted to practical training and skills development. Internships during their studies, gaining essential advanced "practical skills".

Balance between theory and practice: Teaching is conducted by experts proficient in theoretical knowledge and professionals with rich industry experience, ensuring the close integration of theory and practice. Thus, students gain a solid theoretical foundation while applying what they have learned in practice.

Small-class teaching: Professional universities emphasize small-class teaching, with fewer than 40 students per class, allowing for personalized and interactive learning. This approach helps instructors monitor each student's progress and provide tailored guidance.

Enterprise internships: A distinguishing feature of professional universities is their emphasis on extended enterprise internship durations. For example, students spend over 600 h on internships during their four-year program, which helps them gain practical experience and enhance their employability.

Interdisciplinary learning: Professional universities encourage students to pursue knowledge beyond their primary fields. For example, engineering students may take management courses to enhance their managerial capabilities.

Flexible learning paths: Professional universities offer flexible academic structures, allowing students to switch learning stages between semesters. Working professionals can have their work experience recognized as part of their accumulated learning time, further demonstrating flexibility and practicality.

Diverse student backgrounds: Professional universities actively admit students with diverse backgrounds, including high school graduates, working professionals, and transfer students from other institutions. Selection standards consider practical work experience, qualifications, and skill assessments to ensure diversity and fairness.

Quality evaluation and accreditation: Professional universities' accreditation evaluations include specialized assessments tailored to each field to ensure continuous improvement of education quality.

Beyond universities

Vocational and technical education emphasizes resource sharing, practice orientation, interdisciplinary integration, and innovation-driven approaches in collaboration with external entities, such as enterprises. Implementation strategies typically include joint projects, internships, joint laboratories, lectures and workshops, innovation competitions, and entrepreneurial support (Powell & Solga, 2010). Typical examples are given below.

Enterprise collaboration and internships: Partnerships

with enterprises allow students to complete internships in companies and gain real-world work experience. For example, HE and HHN collaborate with companies to provide practical opportunities for their students.

Practice projects: Collaborative practice projects help students gain hands-on experience in actual professional settings, such as real design and construction projects for engineering students.

Integration with vocational certifications: Collaborations ensure that students' skills and knowledge meet vocational certification requirements, facilitating success in certification exams. For example, TPU partners with local health centers to offer internships and training aligned with national qualification exams.

Implementation approaches and methods

The proposed undergraduate vocational and technical education model provides various specific implementation approaches and methods, including the following.

Internal to universities

Comprehensive implementation: University-wide programs focus on problem-solving and practical skills development. For example, more than 30 undergraduate vocational colleges officially approved by the Ministry of Education in China can largely refer to this educational model to implement undergraduate vocational talent training activities.

College-level implementation: Vocational projects specific to secondary colleges within universities are offered. For example, in some institutions where certain programs have been upgraded to the undergraduate level, many programs still belong to the associate degree level. These higher vocational colleges can implement this educational model in certain faculties.

Course-level implementation: Courses are designed to cultivate basic vocational skills, including programs that can help students develop vocational competencies and skills.

Intentional professionalism training: Students' professional literacy is consciously cultivated, and their practical skills are enhanced in various undergraduate courses.

External to universities

Enterprise internships: By collaborating with enterprises to provide internship opportunities and practical projects, students can learn and train in real work environments, enhancing their professional skills and practical application abilities.

Collaborative projects: Universities collaborate with enterprises to design and implement projects, enabling students to engage in real professional tasks and gain authentic work experience.

Internship plans: Internship programs are jointly developed with enterprises to ensure that students acquire practical professional skills during their internships and gain industry recognition.

Innovation competitions and entrepreneurship support: By participating in innovation competitions and entrepreneurship support programs, students can apply their knowledge to solving real-world problems, fostering their innovative thinking and entrepreneurial abilities.

Evaluation systems and methods

Successful implementation requires robust evaluation systems the focus on the following.

Stakeholder participation: Multiple stakeholders, including enterprises, students, teachers, and education administrators, play a crucial role in ensuring the comprehensiveness and diversity of the evaluation system. For example, enterprises can provide feedback based on real work environments, students can reflect on the practicality and adaptability of courses, teachers can assess the effectiveness of teaching methods, and education administrators can conduct macro-level evaluations from policy and management perspectives.

Developmental assessment: Evaluation should focus on students' development and progress throughout the learning process rather than solely on final exam results. For example, regular formative assessments can help track students' learning progress and identify existing challenges, allowing for timely adjustments to teaching content and methods to support students' overall development.

Comprehensive and diverse evaluations: These evaluations encompass multiple aspects, including theoretical knowledge, practical skills, and professional literacy. For example, the assessment of nursing programs may include theoretical exams, clinical skill operations, patient communication abilities, and professional ethics evaluations.

Ability and professionalism assessments: Assessments of competencies and professional literacy focus on evaluating students' practical skills and professional qualities. For example, in engineering programs, assessments can be conducted through various methods, such as project design, laboratory experiments, teamwork, and professional ethics evaluations.

Long-term outcomes: These focus on students' career development after graduation to assess the long-term effectiveness of the educational model. For example, by tracking graduates' employment statuses, career paths, and job satisfaction, the actual impact of the educational model can be evaluated, leading to improvements and optimizations in the educational system.

Direct and indirect evidence: This involves conducting evaluations by combining direct observations with indirect data, such as employment rates and enterprise feedback. For example, assessing educational effectiveness through employer feedback and students' employment outcomes ensures that the educational model aligns with market demands (Beywl & Speer, 2004;Mohd Salleh & Sulaiman, 2015).

Summary of core characteristics

The key principles of the proposed undergraduate vocational and technical education model are as follows.

Philosophy and goals: Integration of practice and theory is emphasized, ensuring that the course design and teaching content are closely aligned with the latest industry demands and technological developments. This approach fosters students' interdisciplinary competencies and aligns with the requirements for professional certifications.

Curriculum structure: Foundational theory courses and professional skills courses are balanced, ensuring that practical training and internships account for a significant proportion of the total course credits. The curriculum should be flexible, offering interdisciplinary learning opportunities and integrating with professional certification requirements.

Teaching methods: A small-class teaching model is adopted, instructors with extensive practical experience are employed, enterprises are collaborated with to provide internships and practical opportunities, teaching methods are diversified, and interaction and hands-on learning are emphasized.

Evaluation: A diversified evaluation approach with continuous formative assessments and a multi-stakeholder evaluation system is implemented. This ensures a comprehensive assessment of students' overall competencies and practical skills, aligning with professional certification standards.

By adhering to the aforementioned principles, the proposed undergraduate vocational and technical education model can better meet modern vocational needs and cultivate high-quality talents.

RELATIONSHIP BETWEEN UNDERGRADUATE VOCATIONAL EDUCATION, PROFESSIONAL EDUCATION, AND CBE

Correlation between undergraduate vocational education and professional education

Undergraduate vocational education closely aligns with professional education in terms of its educational philosophy and objectives. Both aim to cultivate students' skills and competencies within specific professional fields, emphasizing the integration of theory and practice. However, vocational education focuses more on hands-on application and operational capabilities. For instance, in engineering, vocational education integrates laboratory courses and enterprise internships to enable students to master skills such as mechanical design, electronic circuitry, and programming. This focus ensures that students can perform effectively in real-world tasks post-graduation. Similarly, professional education incorporates extensive application-focused curricula in fields such as nursing, accounting, and architecture, which require practical experience as a core component. These programs align with vocational education's goal of producing talents capable of making immediate contributions to their professional fields.

The synergy between vocational and professional education lies in their shared objective of enhancing students' theoretical understanding and practical skills. By combining the theoretical rigor of professional education with the practicality of vocational training, undergraduate vocational education models provide a comprehensive framework that enhances students' holistic development, employability, and competitiveness in the workforce.

To further expand the correlation between vocational and professional education, vocational education can benefit from the rich theoretical depth of professional education. Embedding modules, such as advanced research methods or innovative technologies, in vocational curricula ensures that students are prepared to take on leadership roles in their respective industries. Similarly, professional education can draw from the highly practical and industry-focused methodologies of vocational education to enhance students' real-world readiness (Huang, 2016).

Correlation between undergraduate vocational education and CBE

Undergraduate vocational education and CBE share significant overlap, primarily in their focus on real-world applicability and skills development (Huang, 2012). Both aim to bridge the gap between educational content and workplace demands, ensuring that students are equipped to handle task-specific challenges.

CBE centers on cultivating the ability to perform specific tasks within a professional environment, emphasizing measurable competencies, practical applications, and real-world problem-solving. Vocational education adopts similar principles by structuring curricula that revolve around practical tasks and scenarios. For instance, in IT, vocational programs often include project-based learning and coding exercises that enable students to validate and enhance their technical and analytical skills.

A critical strength of CBE is its evaluation framework, which prioritizes hands-on assessments and project deliverables over traditional examinations. This aligns seamlessly with vocational education, whose evaluation methods increasingly emphasize practical performance and tangible outcomes. By integrating CBE principles, vocational education enhances students' engagement and innovation, fostering an environment in which creativity and practical application thrive.

To expand the synergy between undergraduate vocational education models and CBE models, the former can incorporate adaptive learning technologies inspired by CBE, such as artificial intelligence (AI)-driven feedback systems that provide real-time assessments of student performance. These technologies not only enhance learning outcomes but also align vocational training with modern industry expectations. Moreover, CBE's emphasis on continuous improvement can help vocational programs establish dynamic curricula that evolve alongside technological advancements (Huang, 2014).

Comparative analysis of the three models

Although vocational education, professional education, and CBE share common goals, they exhibit distinct differences in educational objectives, curriculum design, and evaluation methods. These differences provide unique advantages that can be harnessed through integration.

Educational objectives

Professional education: Focuses on cultivating academically grounded professionals with strong theoretical foundations and research capabilities and emphasizes innovation and contributions to academic knowledge.

CBE: Aims to equip students with task-specific skills and the ability to excel in workplace scenarios and prioritizes job readiness and measurable performance metrics.

Vocational education: Strives to produce application-oriented professionals with robust technical skills and practical knowledge and balances theory and practice to prepare students for immediate workforce participation.

Curriculum design

Professional education: Features a predominantly theoretical structure, with supplementary practical components, such as laboratory work or internships.

CBE: Centers on modular, task-oriented curricula designed around industry-specific competencies and emphasizes flexibility and personalization.

Vocational education: Combines theoretical courses with extensive practical training, including internships, simulations, and project-based learning, and ensures that content aligns with industry demands.

Evaluation methods

Professional education: Relies on traditional assessments, such as exams, theses, and research projects.

CBE: Employs real-world tasks and competency certifications to evaluate student performance.

Vocational education: Utilizes a hybrid approach, combining theoretical assessments, project evaluations, and practical skill tests to ensure comprehensive student preparation.

In conclusion, the proposed undergraduate vocational and technical education model has similarities with both the professional education model and the CBE model in terms of educational objectives, curriculum design, and evaluation methods, while also exhibiting significant differences. By integrating elements of the professional education model, undergraduate vocational and technical education ensures the systematic acquisition of theoretical knowledge while enhancing the practicality of hands-on skills, providing students with comprehensive vocational training. At the same time, the incorporation of the CBE model places greater emphasis on developing and assessing students' practical abilities, ensuring that they are equipped to perform specific tasks in professional settings.

It is important to emphasize that the core characteristics of the proposed undergraduate vocational and technical education model are comprehensiveness and practicality. By integrating the theoretical depth of professional education with the practice-oriented approach of CBE, the model not only enhances educational quality and students' career adaptability but also cultivates a large number of highly skilled applied professionals for society.

In future educational reforms, further strengthening the integration of undergraduate vocational and technical education with professional education and CBE will contribute to the diversification of higher education,

meeting the evolving needs of society and providing a solid talent foundation for socioeconomic development.

Undoubtedly, the aforementioned comprehensive educational model is particularly significant in the era of globalization and digitalization. As technology advances rapidly and occupational demands continue to evolve, the undergraduate vocational and technical education model must constantly adapt to new challenges. Through continuous innovation and reform, it can maintain its essential role in the higher education system. By continuously improving curriculum design, teaching methods, and evaluation approaches to ensure both scientific rigor and practical relevance, undergraduate vocational and technical education will provide students with high-quality education services and cultivate highly skilled professionals who can meet the demands of the times.

DISCUSSION

The findings of the present study highlight the need for a systematic and integrated approach to undergraduate vocational education that combines theoretical knowledge with practical skills. By analyzing vocational, professional, and CBE models, the study emphasized the alignment of education with industry needs, technological advancements, and the demands of modern society.

Bridging theory and practice

One of the core strengths of the proposed model is its emphasis on bridging the gap between academic theory and practical application. Traditional vocational education often prioritizes hands-on skills but lacks the theoretical depth required for innovation and advanced problem-solving. Conversely, professional education is deeply rooted in academic theory but may fail to equip students with practical skills for immediate application in the workplace. The integration of CBE into this model addresses these deficiencies by providing a structured framework that emphasizes measurable outcomes, interdisciplinary learning, and project-based teaching. For example, in the engineering sector, integrating CAD drafting with courses on design principles allows students to develop both theoretical understanding and practical expertise. Similarly, nursing programs can combine clinical theory with hands-on training in simulated environments. Through the incorporation of interdisciplinary project work, students not only learn to solve technical problems but also develop teamwork and communication skills essential for modern workplaces.

Enhancing employability through collaboration

The present study also underscored the importance of collaboration between educational institutions and industries. Effective partnerships enable the design of curricula that reflect real-world demands, ensuring that students are prepared to take on specific roles upon their graduation. Internship programs, project-based learning, and the alignment of courses with vocational certification requirements create a strong foundation for employability. However, the success of these initiatives depends on consistent feedback from industry partners and the flexibility of institutions to adapt to evolving technological and market trends (Otache, 2022).

An example of successful industry collaboration can be seen in Germany's HHN, where students participate in long-term internships with industry leaders such as Bosch and Daimler. These internships expose students to cutting-edge practices and technologies, enhancing their readiness for employment. Similarly, Japan's Professional University integrates certification courses that align with national and international standards, ensuring that graduates are not only employable but also competitive in the global job market.

Adapting to technological change

The rapid pace of digital transformation necessitates the inclusion of technology in vocational education. The proposed model integrates digital tools and platforms, such as virtual simulations, AI-driven assessments, and online collaborative environments, to enhance learning outcomes. By familiarizing students with industry-standard tools and techniques, this approach ensures that they are well prepared for the demands of the modern workforce (Beer & Mulder, 2020;Maclean & Lai, 2011). For instance, incorporating virtual reality into medical training allows nursing students to practice emergency response scenarios in a safe and controlled environment. Similarly, AI-powered platforms can personalize learning experiences by identifying individual strengths and weaknesses, enabling targeted skills development. These technologies not only enhance learning efficiency but also prepare students for the digital tools they will encounter in their careers.

Addressing challenges in implementation

Despite its potential, the implementation of the proposed integrated model is not without challenges. Limited resources, institutional resistance to change, and disparities in regional industrial development can hinder progress. Moreover, the emphasis on interdisciplinary education and innovative teaching methods requires significant investment in faculty development and curriculum redesign (Kovalchuk *et al.*, 2022; Mutohhari *et al.*, 2021). Addressing these challenges will require the creation of a supportive ecosystem for vocational education through concerted efforts by policymakers, educators, and industry leaders.

Policy support is crucial in overcoming the aforementioned barriers. Governments can provide funding for infrastructure development, faculty training, and technology integration. For example, China's recent reforms in vocational education include substantial investments in building state-of-the-art training facilities and incentivizing industry partnerships. Additionally, institutions must adopt flexible governance structures that encourage innovation and adaptability, fostering an environment in which new models can thrive.

Promoting lifelong learning

Another critical aspect of the proposed model is its emphasis on lifelong learning. In today's fast-evolving job market, continuous skills development is essential for maintaining employability. The integration of modular courses, stackable certifications, and pathways for advanced education within the vocational model ensures that learners can continually upgrade their skills. For example, graduates from undergraduate vocational programs can seamlessly transition to advanced diploma courses or specialized certifications in their fields. Institutions can collaborate with professional organizations to offer ongoing training programs, ensuring that alumni remain competitive throughout their careers. This approach not only benefits individuals but also strengthens the overall workforce by addressing skill gaps and fostering innovation.

CONCLUSION

This paper introduces a systematic model for undergraduate vocational education that enhances students' practical skills, professional literacy, and adaptability to modern workforce demands. By integrating interdisciplinary learning, project-based teaching, and CBE, the model fosters well-rounded, skilled professionals ready for dynamic work environments.

The key contributions of the proposed model include bridging the gap between theory and practice by ensuring that students acquire both academic knowledge and hands-on experience through integrated curricula. The emphasis on assessing student learning through practical tasks and project outcomes rather than traditional exams aligns learning outcomes with industry expectations, providing a more accurate measure of graduates' job readiness. Additionally, the model highlights the importance of sustained industry partnerships to develop forward-looking curricula that incorporate the latest industry trends and technologies, ensuring that graduates remain competitive in both local and global job markets.

To support the successful implementation of the proposed model, policymakers should establish standardized competency frameworks, allocate resources for industry-academia collaborations, and provide financial incentives, such as subsidies for employer-sponsored apprenticeships and grants for technology adoption. Universities should forge stronger ties with industries through dual-degree programs, joint research initiatives, and shared training facilities to create seamless education-to-employment pathways. Educators must be equipped with innovative teaching methods, including small-class instruction, digital learning tools, and interdisciplinary teaching. Incentives for faculty engagement in industry projects can further enhance teaching effectiveness.

Given the evolving nature of vocational education, further research should focus on assessing both cognitive and practical competencies through longitudinal studies to provide a holistic view of student performance. The integration of digital tools, such as AI-driven learning platforms and work-based simulations, should be explored to enhance student engagement and adaptability. Additionally, promoting international collaboration through joint research projects and student exchange programs can facilitate the global integration of vocational education and enrich learning experiences.

The proposed model has significant implications for the future of higher education. By closing the gap between academic learning and practical application, it ensures that vocational education remains relevant in a knowledge-driven economy. Its emphasis on lifelong learning and adaptability prepares graduates for diverse career paths in an era of technological transformation. As globalization reshapes industries, aligning vocational education with broader educational frameworks is essential to developing a resilient and innovative workforce.

In conclusion, the systematic undergraduate vocational education model presented in this study offers a practical and future-oriented approach to modern education challenges. By integrating theoretical knowledge with industry-driven practice, enhancing industry collaboration, and fostering lifelong learning, the model provides a robust framework for developing highly skilled professionals. Sustained research, innovation, and cross-sector collaboration are essential in ensuring that vocational education remains a cornerstone of workforce development in an evolving global landscape.

DECLARATIONS

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Futao Huang is the Associate Editors-in-Chief of the journal. The article was subject to the journal's standard procedures, with peer review handled independently of the editor and the affiliated research groups.

Data availability statement

All data have been included in this paper.

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