Practical Curriculum Development in TVET: Integrating Taylorism and Connectivism for Operational Skill Enhancement

Lizhi Tao
Mahasarakham University
Shenzhen Institute of Technology

Ruannakarn Prasert
(Corresponding Author)
Mahasarakham University

Chano Jiraporn
Mahasarakham University

Wang Ran
Mahasarakham University

With the continuous development of the global economy and the adjustment of industrial structure, there is a growing demand for high-quality skilled talents with practical operational skills. This study aims to explore how to integrate Taylorism and Connectivism in the field of Technical and Vocational Education and Training (TVET) to enhance the effectiveness of operational skill cultivation. In the first phase of the research, we focused on the operational skill of escalator troubleshooting, gaining in-depth insights into the current situation in this field. Subsequently, we proposed and implemented an innovative curriculum development framework (BTCC), which fully utilizes the practical orientation of Taylorism and the interactive learning philosophy of Connectivism. This framework focuses on developing a course to enhance the operational skills of escalator troubleshooting. Finally, validated in an actual TVET environment, the research results, referred to as the Innovative Practical Course (ETSC), show that the new course significantly improves students' proficiency in escalator troubleshooting skills and promotes active learning and collaboration in practice. This study provides practical and adaptable escalator troubleshooting course development experience for vocational colleges, offering a feasible approach to address the challenges in cultivating related operational skills.

Keywords: Technical and Vocational Education and Training (TVET), curriculum development model, Taylorism, Connectivism, operational skills

INTRODUCTION

With the continuous development of the global economy and rapid advancements in technology, the role of Technical and Vocational Education and Training (TVET) has become increasingly crucial. This is especially true in China, where education is divided into General Education and TVET, both holding the same educational status (The State Council of the People's Republic of China, 2019) . In this era of transformation, vocational education needs to adapt to the technological requirements of emerging industries, ensuring that students are well-equipped to handle practical work in specific professional fields.

Operational skills, as the core of vocational education, are essential for cultivating students' practical abilities and enhancing their competitiveness in the job market (Li Pei, 2021). However, traditional education models often focus on imparting theoretical knowledge, neglecting the cultivation of practical operational skills to some extent. Students face challenges in obtaining sufficient hands-on experience during their learning process, leading to potential difficulties when confronted with real-world work situations (Jiebing Zhu et al, 2023). Therefore, the integration of practical operational skill development in vocational education is an urgent issue that needs to be addressed. In this context, this study aims to propose and implement an innovative curriculum development framework by integrating Taylorism and Connectivism. This framework aims to enhance the development of practical courses in vocational institutions, meeting the pressing need for cultivating operational skills in vocational education.

In the background of exploring how to better integrate Taylorism and Connectivism, we will investigate the following questions: How can a new curriculum development framework improve the cultivation of operational skills in vocational education and training? How to balance the practice-oriented nature of Taylorism and the interactive learning philosophy of Connectivism to better meet students' learning needs and societal expectations for practical operational skills?

The objective of this research is to propose and implement a novel curriculum development framework by integrating Taylorism and Connectivism to promote the cultivation of operational skills in vocational education and training. By investigating the current operational skills of Chinese vocational college students, we will focus on the engineering field, specifically on the operational ability of escalator troubleshooting, to validate the effectiveness of the new framework. This study aims to provide vocational colleges with practical and adaptable experiences in course development, addressing the challenges in cultivating operational skills in the field of vocational education.

LITERATURE REVIEW

Development Trends in Technical and Vocational Education and Training (TVET)

Technical and Vocational Education and Training (TVET), as a crucial platform for cultivating practical operational skills, has been a focus of attention in education (Bakare et al., 2018). Globally, TVET has become an integral part of the education system. In the backdrop of evolving technology and global industrial structural changes, vocational education needs to emphasize students' practical operational skills more to better adapt to future occupational demands (Davies, 2019) (Wang Xing, 2020).

Research on Operational Skill Cultivation

In the five categories of learning outcomes, Gagne (1965) proposed motor skills, emphasizing the ability to control muscles in performing tasks (Lamri, J. et al., 2021). Feng Zhongliang (2010) classified motor skills into tool-manipulating motor skills and body movement motor skills, simplifying them into operational skills and body movement skills based on whether they require manipulating tools. Although motor skills find widespread applications in fields such as sports, healthcare, military training, and performing arts, there is relatively limited research in the vocational education engineering and technology education domain (Hao Qiujing et al., 2019). In vocational education, operational skills highlight students' practical abilities required in specific occupational fields. This includes mechanical skills, laboratory operations, technical maintenance, and other aspects, combining theoretical knowledge to provide students with comprehensive vocational competence (Wu Renheng et al., 2010).

However, there exists ambiguity in defining operational skills in vocational education. In some literature, operational skills are considered synonymous with motor skills (Jiang Dayuan, 2016), although they share the same theoretical foundation, their emphasis differs. To better study operational skills in different fields, it is necessary to combine the foundational theories of motor skills with learning objectives in the respective professional domains to propose a more specific and measurable definition of operational skills. Additionally, vocational education faces the challenge of how to better incorporate operational skills into curriculum design. Due to the diversity of operational skills in different fields, assessing and quantifying students' operational skills is also a problem that needs to be addressed.

The cultivation of operational skills involves extensive practical practices in disciplinary areas. To comprehensively understand and evaluate students' developmental stages of operational skills at different levels, Simpson proposed the seven-level theory of motor skills. This theory includes receptive action (Perception), preparatory action (Set), guided response (Guided Response), mechanism (Mechanism), complex overt response (Complex Overt Response), adaptation (Adaptation), and origination (Origination) (Simpson Thomas et al., 2021). Simpson's seven-level theory provides a powerful framework for in-depth research into the different developmental stages of operational skills in vocational education students.

Moreover, the measurement and assessment of operational skills take various forms. Depending on the timing of implementation, measurement methods can be classified into outcome measurement and process measurement (Du Meilian, 2014). Outcome measurement primarily focuses on evaluating the results or performance of actual operations, while process measurement emphasizes the evaluation of the process and its characteristics, including the functioning mechanisms of the nervous system, the working principles of the muscular system, and the movement characteristics of limbs or joints. In the TVET field, the measurement of actual operational skills often emphasizes the assessment of operational outcomes due to the diversity of specific measurement methods in different professional domains.

In previous studies, discussions on the cultivation of operational skills mainly focused on various industries and fields. For example, in the engineering field, Johnson et al. (2017) effectively enhanced students' practical operational skills by implementing project-oriented practical courses (Johnson B. et al., 2017). Similarly, in the medical field, Smith's (2019) research indicated that simulated practice significantly influenced the cultivation of students' practical skills and their ability to respond to emergencies (O'Connor Paul et al., 2023). However, these studies often focused on specific domains, lacking specific support for course design, theoretical teaching methods, and learning context theory. By integrating Taylor's curriculum goal theory, Connectivism, and the seven-step theory of skill acquisition, these issues can be better addressed, providing more effective guidance for the cultivation and promotion of operational skills.

Curriculum Development Theories

To ensure that the curriculum better aligns with the actual employment needs, students need to gain experience in real work scenarios. Research on practical courses in vocational colleges focuses on how to better integrate practical experience.

In the development of practical courses in engineering in vocational colleges, choosing an appropriate curriculum development model is crucial for improving students' operational skills. Currently, there are various curriculum development models to choose from. Models such as the ADDIE model, which provides a systematic design process, Problem-Based Learning (PBL) model, which cultivates problem-solving skills and teamwork through problem-driven learning, the SAM model, emphasizing iterative design and implementation, and Constructivist model, focusing on students constructing knowledge through practical experience, are available (Hong Songzhou, 2019). However, these models face some challenges in the TVET field, particularly in the development of practical courses to enhance operational skills. These challenges include insufficient matching of course objectives, low student enthusiasm for learning, and the lack of scientific and regularity in skill mastery (Hong Songzhou, 2019).

Smith (2018) pointed out that Taylor's practical-oriented concept is widely applicable in the development of TVET practical courses (O'Connor Paul et al., 2023). By incorporating actual work tasks into course design, students can better understand and apply the knowledge they acquire. Taylor's curriculum goal theory includes explicit learning objectives, organized learning activities, assessment of learning outcomes, and adjustment of teaching methods (Tyler, R. W, 2013). Applying Taylor's practical theory and curriculum goal theory can lead to the better development of vocational education practical courses, thereby more effectively cultivating students' operational skills. However, this theory tends to overlook teacher and student themes, so integrating Connectivism during the course implementation process, focusing on real-time feedback and socialization in learning, can help consider diverse factors in the teaching process, emphasizing student agency and teacher guidance.

Connectivism in Educational Philosophy

In the article "Connectivism: A Learning Theory for the Digital Age," Siemens systematically points out that the concept of Connectivism emphasizes that learning is no longer an individual isolated activity but is achieved through the process of connecting specialized nodes and information sources (Siemens, G., 2004). Learners acquire and construct knowledge and skills by establishing and reinforcing these connections. This philosophy provides a new perspective and method for building personalized learning networks, promoting information acquisition and sharing, driving socialization in learning, adapting to digital learning environments, and integrating practical skills.

In the TVET field, the concept of Connectivism is expected to bring new insights into the cultivation of practical operational skills. By constructing learning networks, students can more flexibly acquire and share knowledge related to practical operational skills. The Connectivism philosophy also helps adapt to digital learning environments, providing students with more personalized learning opportunities. In this study, we will explore how to integrate the Connectivism philosophy to better drive the development and implementation of TVET practical courses.

In summary, there is a research gap in the development and validation of practical courses to enhance operational skills in the TVET field. Therefore, this study will conduct the following research: firstly, investigate the level of operational skills in Chinese vocational colleges (using "Elevator Fault Diagnosis and Repair Ability" in the engineering field as an example). Then, integrate the seven-level theory of operational skills, Taylor's theory, and Connectivism to develop a new curriculum development model, aiming to better promote and adapt to the development of TVET practical courses, thereby improving students' operational skills. Finally, to validate the practical effects of the new curriculum development framework, we will use the practical course "General Fault Diagnosis and Repair of Elevators" in the engineering field as an example, verifying the process and implementation effects of course development. This study aims to provide an innovative curriculum development framework for TVET, better meeting the needs of students and society for the cultivation of practical operational skills.

RESEARCH METHODS

Phase One: Survey of Escalator Fault Diagnosis and Repair Operational Skills Among Chinese Vocational College Elevator Engineering Students

Population: The population includes third-year students who have completed relevant courses in escalator operation in 12 Chinese vocational colleges offering elevator engineering technology programs, totaling 621 individuals.

Sample: The selected sample with the cluster random sampling technique from each college, a total of 248 individuals. the sample calculation formula is

$$n = \frac{N}{\mathbf{1} + N(\boldsymbol{e})^2} \tag{1}$$

n means sample size; *N* means Population size, *N*=40; *e* means margin of error, here *e* = 0.05 (Yamane,1973).

The specific population and sample statistics for the current stage are shown in the table below.

TABLE 1
DESCRIPTIVE STATISTICS OF THIRD-YEAR STUDENTS IN ELEVATOR ENGINEERING TECHNOLOGY MAJOR IN CHINESE VOCATIONAL COLLEGES

School Name	Location	Population (P)	Sample (S)	Rounded Percentage (%)
Shenzhen Technician College	Guangdong	40	16	6.45
Guangzhou Electromechanical Technician College	Guangdong	41	17	6.85
Yunnan Electronic Information Advanced Technical School	Yunnan	99	39	15.73
Zhejiang Construction Technician College	Zhejiang	62	25	10.08
Tianjin Labor Protection Technician College	Hebei	40	16	6.45
Xi’an Technician College	Shaanxi	38	15	6.05
Guangxi Electromechanical Technician College	Guangxi	42	17	6.85
Jiangsu Yancheng Technician College	Jiangsu	73	29	11.69
Guangxi Industrial Technician College	Guangxi	30	12	4.84
Kaifeng Technician College	Henan	30	12	4.84
Tianjin Electromechanical Craft Technician College	Hebei	45	18	7.26
Henan Chemical Technician College	Henan	80	32	12.9

Instrument: Create a questionnaire on escalator operation skills, following these steps:

(1) The researcher studies the concept and components of escalator operation skills and determines the definition of the term.

(2) The researcher designs a comprehensive 51-item questionnaire assessing practical skills in three key areas: tool and equipment use, analysis and repair of escalator failures, and escalator inspection, maintenance, and upkeep. Participants rate their proficiency on a scale of 1 to 5, where 1 indicates minimal practicality, 2 suggests low practicality, 3 signifies moderate practicality, 4 represents high practicality, and 5 denotes the utmost practicality. The detailed breakdown of the questionnaire items is outlined below:

TABLE 2
THE NUMBER OF QUESTIONS AND THEIR DISTRIBUTION OF THE ESCALATOR TROUBLESHOOTING OPERATION SKILL

Content	Design NO. of items	Actual NO. of items
Correct Use of Tools and Equipment	17	13
Accurate Analysis and Identification of Escalator Malfunctions, and Taking Appropriate Measures for Repair	17	14
Conducting Escalator Inspection, Maintenance, and Upkeep	17	14
Total	51	41

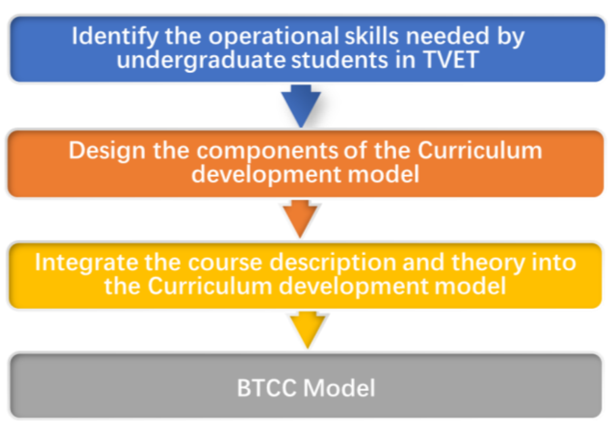
(3) The researcher submitted the created questionnaire to 5 experts for review and judged the content validity by the consistency index (IOC).
(4) Researchers can select appropriate items with an Index of Concordance (IOC) of 0.50 or higher (Sirichhai Kanchanawasi, 2010). In this study, the IOC ranged from 0.80 to 1.00.
(5) The researchers used the prepared questionnaires for a trial with student samples (Try out) and selected 25 students from Shenzhen Technician College for test research.
(6) The researcher analyzed the discriminative power (r_{xy}) of each questionnaire and selected items with values ranging from 0.20 to 1.00 (Boontham Kitpreedabsurung, 2010). So, the discriminative power of the questionnaire was from 0.50 to 0.96.
(7) Reliability analysis. The reliability was analyzed using the Cronbach's alpha coefficient and equaled to 0.98, which is higher than the 0.80 (Streiner and Norman, 1995).
(8) Publish the complete questionnaire for further data collection.

Data Analysis: Use the SPSS program to calculate the mean ($\bar{X}$) and standard deviation (S.D.). Evaluate overall performance based on the scores from student testing. Interpretation of scores: 91% and above - far above average, 71% to 90% - above average, 51% to 70% - average, 11% to 50% - below average, 10% and below - far below average.

Phase Two: Construction and Validation of the BTCC Course Development Model

Based on Taylor's theory and Connectivism, construct the course development (BTCC for short) model and develop it in the order shown in Figure 1. Subsequently, based on the BTCC course development model, using the ETSC course as an example, the model and course will be validated through the following steps:

FIGURE 1
DEVELOPMENT OF THE BTCC MODEL



Select five experts to assess the quality of the course development model and the use of guidelines. Then, evaluate the quality of the course outline. The criteria for selecting experts are: a) Over 10 years of vocational education teaching experience; b) Master's degree; c) Expertise in the following areas: curriculum and instruction, engineering technology, and education.

Tools: Design assessment forms to separately evaluate the appropriateness of the BTCC model and the appropriateness of the ETSC outline, and provide usage guidelines.

The evaluation of the BTCC model is divided into two parts: 1) Appropriateness of the BTCC model; 2) Compliance of each component of the BTCC model. In addition, the assessment of the usage guidelines for the BTCC model is divided into three parts: 1) How to use the BTCC model; 2) Appropriateness of the ETSC course outline; 3) Appropriateness of the lesson plans. The evaluation forms are designed using the Likert five-point scale, with scores as follows: 5 = very appropriate; 4 = appropriate; 3 = neutral; 2 = inappropriate; 1 = least appropriate.

Data Analysis: Use the SPSS program to calculate the mean ($\bar{X}$) and standard deviation (S.D.) and analyze the scores given by the experts.

Phase Three: Innovative ETSC Course Practice

Population and sample: Population is 40 third-year students majoring in elevator engineering technology at Shenzhen Technician College with two classes. According to the principles of cluster random sampling, selecting one class from two classes by randomness, then the sample is 20 students to participate in the experimental group teaching, including 18 male students and 2 female students.

Instrument: Escalator Operation Skills Scale (same as in the first phase).

Experimental Group Teaching: Implement the new innovative course teaching in the experimental group, encouraging cooperation and interaction among students in the classroom. Teachers can organize group discussions or project collaborations, guiding students to share experiences and solve real-world problems. Corresponding teaching materials and cases should be closely related to actual work, aiming to cultivate students' practical operational abilities.

Data Analysis: By comparing students' performance on different evaluation indicators before and after, statistically analyze the data results of the impact of the newly developed course on students' operational skills. Use t-tests to validate the significance of the results.

RESULTS

Phase One: Survey of Escalator Operation Skills of Vocational College Students Majoring in Elevator Engineering Technology

The results of this stage are shown in Table 3. According to the percentiles provided by Watson & Glaser (1991), the average score is 46.72, with a standard deviation of 3.84, falling within the 11th to 30th percentiles, interpreted as "below average."

TABLE 3
TOTAL SCORES OF THE TEST OF OPERATION SKILLS FOR STUDENTS MAJORING IN ELEVATOR ENGINEERING TECHNOLOGY IN CHINESE VOCATIONAL COLLEGES (n=248)

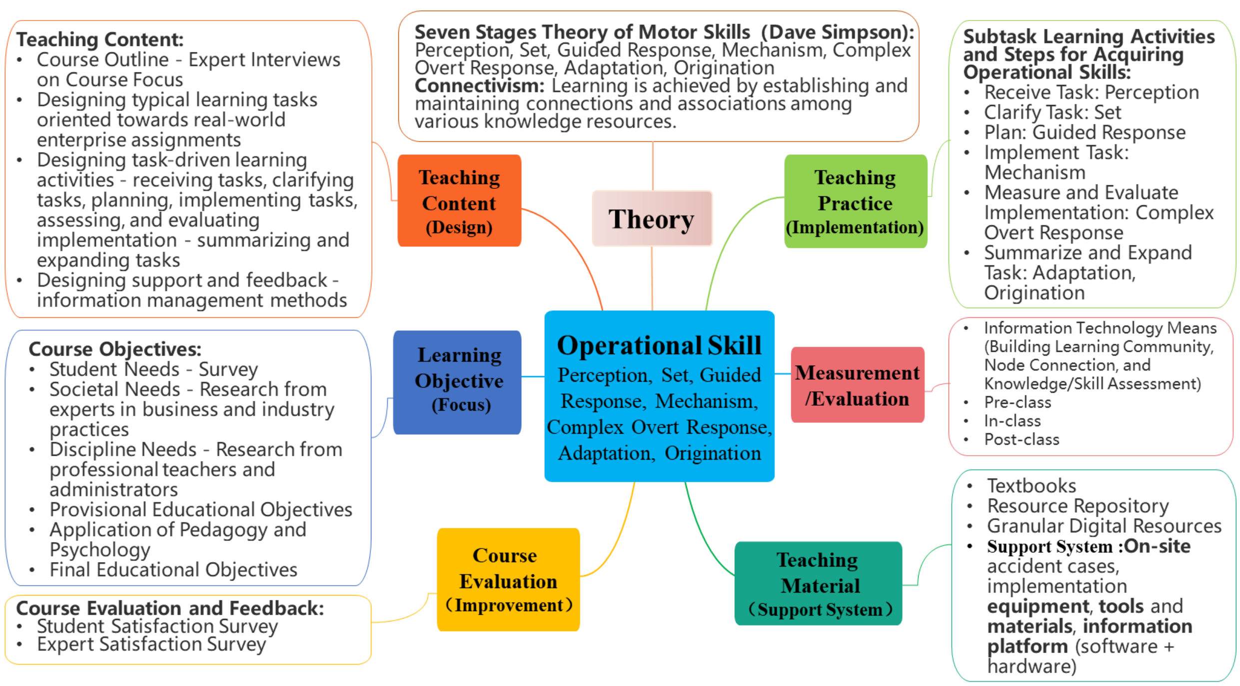
			(n=248)
Operational skills test score	Mean	Standard Deviation	Level of operational skills
	46.72	3.84	Below Average

Note. **p<.05.

Phase Two: Construction and Validation of the BTCC Course Development Model Based on Taylor's Theory and Connectivism

Based on the results of the first stage, we developed the BTCC model, which aims to improve the operational skills of vocational college students. Figure 2 shows the different components of the course development model (BTCC model), which integrates Taylor's theory and Connectivism, including instructional goals, instructional content, instructional practices, instructional measurement and evaluation, instructional resources, and course assessment. The components of the BTCC model are adapted from the previous research of Taylor et al. (2016).

FIGURE 2
BLENDED TAYLOR THEORY AND CONNECTIVISM IN CURRICULUM DEVELOPMENT (BTCC) MODEL



Component 1: Focused on Instructional Goals

The instructional goals of this course framework utilize the practical orientation of Taylor's theory. This involves in-depth research into the specific expectations of industry practitioners, vocational college administrators, and students regarding practical operational skills. Educational and psychological analyses are then integrated to form the final instructional goals, aiming to cultivate students' operational skills. Therefore, the development of course goals is based on Taylor's theory.

Course Goal for "General Escalator Troubleshooting" Course:

Through research, the course goals focus on cultivating students' operational skills and practical abilities in the field of "General Escalator Troubleshooting." The course aims to enable students to master the basic knowledge and operational skills of escalator troubleshooting. Specific goals include:

- Mastery of the use of common tools and equipment for escalator troubleshooting.
- Independent completion of common escalator fault troubleshooting.
- Independent completion of common escalator fault maintenance.

Component 2: Selection of Instructional Content

The instructional outline is designed through focused interviews with educational experts to increase practical elements. Using Taylor's theory, tasks are broken down into simple steps, and operational processes are standardized. Additionally, an information management platform is used to establish a learning network between students and teachers, students and students, and students and resources.

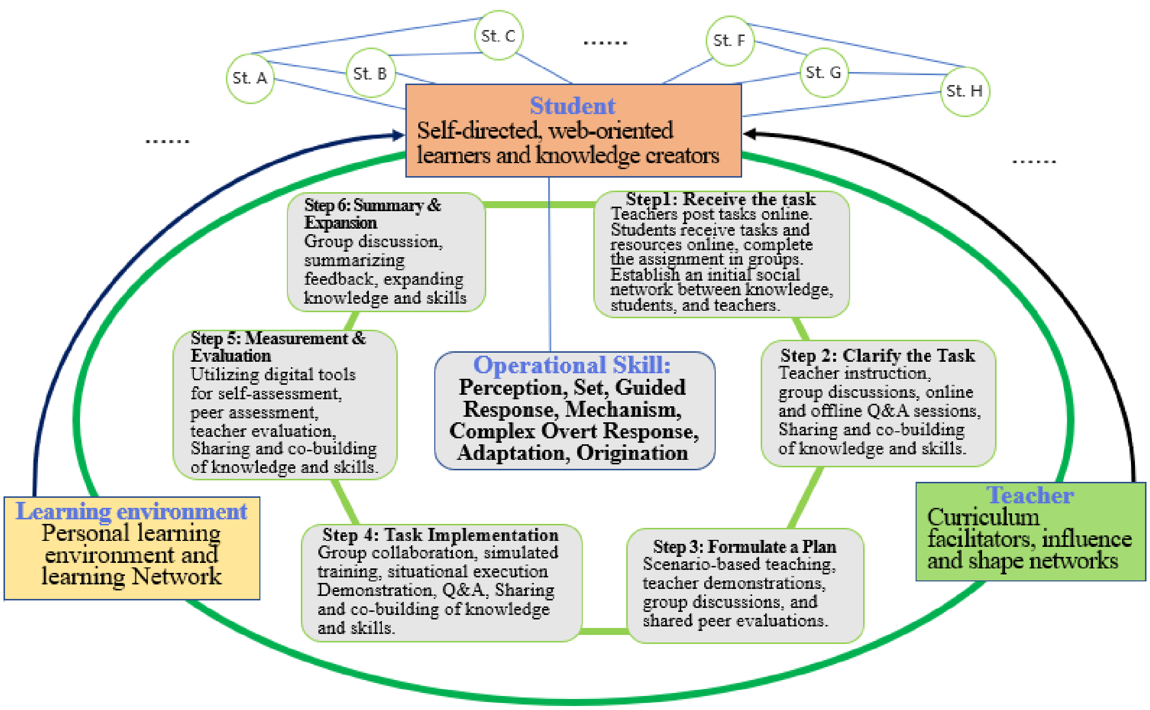
Instructional Content for the "General Escalator Troubleshooting" Course:

The instructional tasks for the course are divided into three typical work tasks: general escalator troubleshooting, troubleshooting for escalator step sagging faults, and troubleshooting for escalator handrail jitter faults. Each task's instructional activities include the receipt, clarification, planning, implementation, evaluation, and summary feedback of the task, to be completed by groups of 3-5 students.

Component 3: Designing Instructional Practices

The core of the course development model is instructional practices or activities. Based on the learning goals and instructional content, practical learning activities are designed in groups, allowing students to gain experience in practical operations. This study provides a continuous step-by-step demonstration of how to acquire operational skills using the BTCC framework, as shown in Figure 3. It primarily includes six stages based on practical tasks: receiving tasks, clarifying tasks, planning, implementing tasks, measuring and evaluating implementation, and summarizing and expanding (Jiang Dayuan, 2016).

FIGURE 3
TEACHING PRACTICE STEPS OF THE BTCC MODEL



During the implementation of teaching, the first step is to build a personalized learning network for learners. This network includes the individual learner, teachers, industry experts, resource repositories, etc. Students, in the form of groups, connect to nodes and information sources in the relevant professional field through digital technology and online resources while querying and completing online tasks assigned by teachers, facilitating the acquisition of knowledge and skills. Secondly, it promotes information retrieval and sharing. In teaching activities, students gain a better understanding of the practical aspects of the professional field by connecting to real industry information and practical experience. Moreover, students share information and results learned and practiced in real-time both online and offline. Finally, it fosters social learning and integrates operational skills. Additionally, students can gain broader learning support and experience sharing in practical operations, case studies, etc., through connections with peers, mentors, and professional practitioners, achieving the integration and connection of knowledge and skills. The specific stages of instructional activities and steps for acquiring operational skills are as follows:

- **Stage 1: Receiving Tasks — Operational Skill: Perception.** Connectivism emphasizes that learners, when faced with new information, receive tasks through channels such as networks and social media. Learners can obtain information about tasks through online platforms, social networks, email, etc., such as Blaemor Cloud Class, MOOC, LinkedIn Learning, WeChat, Facebook, etc. Students, through this stage, initially construct personal knowledge networks, and through online teacher Q&A sessions and group discussions, they preliminarily build social networks. Finally, students achieve the Perception of operational skills through completing the task reception assessment.
- **Stage 2: Clarifying Tasks — Operational Skill: Set.** Teachers explain and demonstrate the basic principles, operational techniques, and tool usage for escalator maintenance. Learners understand the goals and requirements of the task through classroom teaching, accessing online resources, participating in online discussions, and interacting with classmates and teachers. In the process of sharing and constructing knowledge in the network, learners achieve the Set of operational skills.
- **Stage 3: Planning — Operational Skill: Guided Response.** Learners, guided by the main points of the teacher's lecture on planning, use the network and digital tools to formulate learning plans. This includes selecting appropriate online resources, using learning management systems, participating in collaborative tools, and using social media for collaborative learning. Learners can search and share relevant information about the task in the network. Teachers guide and review the task plans of each group, share the results, and achieve the Guided Response of operational skills.
- **Section 4: Task Implementation — Mechanism+Complex Overt Response.** In accordance with Taylor's theory, this phase involves breaking down tasks into simple steps and standardizing the operational process to enable students to master elevator maintenance skills progressively from basic to complex. Simultaneously, the primary operational task is subdivided into 2-5 smaller tasks, progressing from virtual simulations to practical operations. These tasks focus on the manipulation of components, parts, and the entire elevator system, gradually enhancing operational skills. Additionally, practical abilities and problem-solving skills are cultivated through teacher demonstrations, guidance, group discussions, and collaborative projects. The objective is to elevate the students' operational skills from the Mechanism stage to Complex Overt Response. During this stage, students fully utilize online collaboration tools and digital platforms for practical learning activities, including participation in virtual practices and simulation training, aiming to acquire hands-on skills and real-world experience. Students collaborate with their peers in online activities, working together to accomplish assigned tasks.
- **Section 5: Measurement and Evaluation of Implementation — Adaptation.** Learners employ digital tools and online platforms for self-assessment, peer assessment, teacher evaluation, and expert reviews. This encompasses online quizzes, assignment submissions, peer reviews, teacher assessments, and expert critiques as digital evaluation methods. During this stage, students measure and evaluate the results of their implementation, adjusting their approach and internalizing the steps and techniques of operational skills to achieve Adaptation. The focus is on ensuring flexibility and adaptability in applying operational skills based on real-world scenarios.
- **Section 6: Summary and Expansion — Origination of Operational Skills.** Teachers organize group discussions to stimulate collaboration, interaction, and the sharing of experiences to address real-world problems. Through class summaries and reports, the analysis of implementation experiences and operational essentials is conducted. Post-lesson activities involve extending tasks further. The internet serves as a source for feedback and additional information, continually expanding individual knowledge networks. Learners may share experiences through online discussions and social media, summarizing the outcomes of tasks and seeking opportunities for further in-depth learning. The final stage involves expanding practical assessments to originate operational skills.

In each phase, emphasis is placed on learners obtaining information, building connections, and sharing experiences in the digital environment. This underscores that, in the digital era, learning is a social, distributed process where learners acquire knowledge and skills through connections and networks (Fred Kraus, 2020).

Component 4: Establishing Task Measurement and Evaluation Mechanism

Feedback and Evaluation: At each stage, attention is given to learners acquiring information, establishing connections, and sharing experiences in the network. Feedback nodes are constructed to provide timely feedback and evaluation of operations, allowing students to view results and improve learning methods promptly.

Course Evaluation Methods:

- Theoretical Knowledge Exam: Assessing theoretical knowledge of escalator fault diagnosis and repair learned during the course.
- Operational Demonstration and Practice Assessment: Students are required to perform practical escalator fault diagnosis and repair demonstrations, with assessment based on the operational process and results.
- Project Reports and Group Discussion Assessment: Students are required to write project reports or participate in group discussions, assessing their performance in solving practical problems and cooperation skills.

Component 5: Teaching Resources

Based on the selected instructional content, appropriate teaching materials and resources can be chosen to support teaching, such as:

- "Escalator General Fault Diagnosis and Repair" Manual: Detailed introduction of escalator fault classification, fault analysis, and repair methods.
- "Escalator Fault Maintenance Technology" Guide: Provides guidance on escalator fault diagnosis and repair techniques.
- "Elevator Operation and Maintenance" Textbook: Provides basic information on escalator structure, working principles, electrical control principles, etc.
- "GB16899-2023 Safety Code for the Manufacture and Installation of Escalators and Moving Walks": National standard providing technical specifications and indicators, serving as a basis for practical assessments.
- Granular Digital Resources: Provides granular resources for each specific concept, theme, skill, or information unit, including various electronic documents, videos, audios, and images

Component 6: Teaching Feedback and Course Improvement

Firstly, using connectivism theory, an information network is constructed, assessment nodes are set according to the Simpson's seven levels and Taylor's curriculum assessment theories at the pre-, mid-, and post-teaching stages to monitor teaching dynamics in real-time. Feedback and communication with students are conducted to understand their learning progress and needs, adjust teaching methods promptly, and enhance teaching effectiveness. Additionally, educational administrators can track course progress through the information platform, matching teaching segments to support course implementation.

Secondly, by conducting surveys on student and expert satisfaction with course teaching, the overall course design is adjusted and optimized.

Through the course design described above, combined with the teaching methods of Taylor's theory and connectivism, the escalator fault diagnosis and repair course is designed as a teaching process that combines theory and practice. It aims to cultivate students' operational skills and practical abilities, enabling them to master the basic knowledge and operational skills of escalator maintenance. Simultaneously, through diverse assessment methods, comprehensive assessment of students' learning outcomes is conducted, promoting students' learning improvement and improving teaching quality. The expert validation of this framework was highly positive, with an average score of 4.83 and a standard deviation of

0.54, indicating excellent performance in practice. Experts highlighted the “good organization and thorough review of relevant literature,” emphasizing the model’s well-documented research process and clear conceptualization, making it convenient to construct and evaluate in real educational environments. Some experts noted that the introduction of this model is a breakthrough, recognizing it as an important development for teaching professionals.

Phase 3: Innovative ETSC Course Practice

The results of this phase, as shown in Table 4, indicate that according to the percentile provided by Watson & Glaser (1991), the descriptive statistics of students’ pre-test and post-test scores are as follows: the mean of the pre-test score is 16.72, with a standard deviation of 3.84, falling within the 11th to 30th percentile, interpreted as “below average.” The mean of the post-test score is 83.41, with a standard deviation of 4.93, falling within the 71st to 90th percentile, interpreted as “above average.” This shows that after the course intervention, the post-test average score increased by 36.69 compared to the pre-test, indicating a positive change in students’ practical skills and a significant improvement in escalator operational skills.

TABLE 4
TOTAL SCORE OF SHENZHEN TECHNICIAN COLLEGE ELEVATOR MAJOR STUDENTS’ OPERATIONAL SKILLS TEST

Operational skills test score	n	Mean	Standard Deviation	Level of operational skills
Pre-test	20	46.72	3.84	Below Average
Post-test	20	83.41	4.93	Above Average

Note. **p<.05.

Further statistical analysis indicates that the pre-test and post-test data, as determined by the Shapiro-Wilk test, show a normal distribution (pre-test: $W = 0.98$, $p = 0.21$; post-test: $W = 0.97$, $p = 0.14$). As the pre-test and post-test data are paired, a paired-sample t-test was used to compare the differences in the means of the two groups. The results show that, at a significance level of $\alpha = 0.05$, there is a significant difference in the means of the pre-test and post-test data ($t(df) = 35.2$, $p < 0.001$), indicating that the course intervention had a significant impact on students’ operational skills.

CONCLUSION AND DISCUSSION

This study delves into the three stages of development of the Blended Taylorism and Connectivism Curriculum (BTCC) model, focusing on enhancing the operational skills of students, particularly those in engineering disciplines at vocational colleges. Recognizing the pivotal importance of operational skills in the field of engineering, the development of this curriculum model has progressed incrementally.

In the first phase of the research, a survey on elevator operational skills was designed, and vocational college students majoring in elevator engineering technology in China were surveyed. The results indicated that the scores of vocational college students in elevator operational skills were below the average. This discrepancy was attributed to potential issues in practical courses in China, such as a disconnect between theoretical knowledge and practical application, an overemphasis on lecturing at the expense of practical training, and an inadequately designed pathway for skill acquisition. This finding aligns with previous research by Smith et al. (2018), Jones and Wang (2019), Brown (2020), and Taylor et al. (2021) (Department of Internal Medicine et al., 2019; Jinzhi Zhang, 2018; Zhao Binjie et al., 2023), emphasizing the necessity of strong operational skills for successful engineering professionals. The absence of contradictory findings in the existing literature further validates the rationale and feasibility of the operational skills questionnaire design, with potential applications in the development of similar surveys in other engineering domains.

Therefore, the theoretical underpinnings and research findings of this study support the consensus that vocational college students lack operational skills. In response to this issue, the researchers developed the BTCC development model.

The second phase of the study involved expert validation, with five experts unanimously deeming the six fundamental components of the model as “highly appropriate” for enhancing students’ operational skills. The experts’ endorsement of the BTCC model can be explained by their understanding and acknowledgment of its purpose, necessity, and practicality in enhancing operational skills. Additionally, the model integrates components widely accepted in curriculum models, as proposed by Taylor et al. (2009), and incorporates the systematic development of Connectivism and Simpson’s seven-level theory of operational skills (Groccia, 1997; Joyce et al., 2009) (Wu Renheng et al., 2010).

Moreover, experts found the curriculum development model highly suitable due to its concise explanation and presentation of the background and basic principles of the model. The research also clarified the urgency and necessity of developing this model.

The BTCC curriculum development model exhibits the following characteristics:

Practical Orientation: Aligned with Taylorist principles, this design ensures that the curriculum closely revolves around practical tasks associated with real-world work. By incorporating actual work scenarios into course design, students can apply and consolidate their operational skills in simulated environments, better preparing them for future professional challenges (Tyler, R. W, 2013).

Interdisciplinary Approach: Breaking down disciplinary barriers by incorporating knowledge from different subject areas, the BTCC model integrates task decomposition from Taylorism (Tyler, R. W, 2013). Through the construction of a Connectivism learning community, students have the opportunity for interdisciplinary communication and learning.

Personalized Learning: The BTCC model provides diverse learning resources and methods, allowing students to choose learning paths that align with their individual interests and characteristics. For example, support systems include case studies of equipment malfunctions, making the model applicable to real work environments and familiarizing students with situations they may encounter in future workplaces. Additionally, granular digital resources are tailored to teaching goals, breaking down course contexts, knowledge points, and skill points into smaller components such as documents, videos, audio, and images (Mepham A, et al., 2017). Each component represents a specific concept, theme, skill, or information unit, enabling students to gradually build their knowledge structures and skill sets by continuously accessing, processing, and connecting these granules. Learners can choose and organize learning resources based on their needs and interests, fostering a conducive environment for personalized learning. Moreover, the assessment and feedback principles of Taylor’s theory ensure that the effectiveness of personalized learning is promptly evaluated and adjusted (Tyler, R. W, 2013).

Interactivity and Collaboration: The BTCC model emphasizes the social aspect of learners by constructing a learning community through online platforms, facilitating interaction and collaboration among students. Various activities within the model, such as group cooperation, scenario introductions, case studies of malfunctions, simulated training, role-playing, and brainstorming discussions, promote the mastery of operational skills through cooperation and communication. This approach enhances both collaborative and teamwork skills.

Continuous Assessment and Feedback: Integrating Taylor’s theory principles of pre-class, in-class, and post-class assessments (Tyler, R. W, 2013), the BTCC model ensures that students receive timely and effective evaluation and feedback throughout the entire learning process. The connected learning environment of constructivism provides real-time updates on student learning status, enabling teachers to assess and provide feedback more effectively, thereby adjusting teaching methods and resources. Students can also proactively adjust their learning methods based on periodic assessment results.

Application and Learner’s Role: A prominent feature of the BTCC model is its dual focus on teaching goals and learners. The course elements are developed based on Taylor’s curriculum goal theory, and in the teaching process, teachers play an active facilitator role by building a learning network that supports learning. Students become the central figures in the learning process, and learning transitions from an internalized individual activity to a social one (Estrada Marta et al., 2022). Learners can acquire information through various channels, actively construct knowledge and understanding, and thereby better master operational skills.

Challenge to Traditional Classroom Culture: The BTCC model, presented through the teaching practice process, aligns the sequence and steps of completing actual work tasks, allowing any interested teacher to easily use the model. However, this model may challenge traditional Chinese classroom culture by transforming learning from an individualized internal activity to a social one. Students acquire information through various channels, actively participating in knowledge construction, making operational skills an integral part of the learning community. This is of significant importance for cultivating students' ability to adapt to future work environments.

The third stage of the research indicates that students' escalator operational skills significantly improved in the post-test after participating in the newly developed ETSC course, further supporting the research hypothesis. This positive outcome aligns with the overall goal of enhancing students' operational skills required for entering the workforce.

Despite being considered highly suitable and receiving high praise from experts and students, along with empirical evidence proving its effectiveness, the BTCC model still has some limitations:

Firstly, the model's design primarily targets vocational college students, emphasizing learner initiative and contextuality. Therefore, in the course development process, there is a need to focus more on designing challenging and meaningful learning tasks to inspire learners' active participation, cooperation, and exploration. From a teacher's perspective, playing the role of a "guide on the side" and preparing relevant materials to support the construction and operation of the learning network may require more time and effort.

Secondly, the sample size in the course practice research is relatively small and limited to specific educational backgrounds. Therefore, future research should aim to expand the sample size and validate the model in more diverse educational environments to further confirm the universality of the BTCC model. This could involve conducting research in different types of schools and majors, designing control and experimental groups to obtain more comprehensive and reliable research results.

Additionally, the construction of granular digital resources needs to consider a well-organized structure and clear standards to ensure that learners can effectively locate, understand, and utilize these granules. The ways and tools used to connect these granules are also crucial in promoting meaningful learning associations.

In conclusion, through an in-depth exploration of the Blended Taylorism and Connectivism in Curriculum Construction (BTCC) model, this study examined the development and implementation of the model across three stages, assessing its effectiveness in enhancing operational skills for vocational college students. The research results indicate significant achievements in design principles, implementation effectiveness, and student feedback. The high recognition from experts and students, coupled with empirical evidence demonstrating its effectiveness in improving students' operational skills, provides a solid foundation for the application of this model in vocational education. This study contributes valuable experiences and insights for the cultivation of operational skills in vocational college students, serving as a valuable reference for future educational research and practice.

RECOMMENDATION

However, we recognize that continuous improvement and adaptation to different educational environments are necessary when developing practical courses using the BTCC model. Therefore, to better promote and apply the model, the following recommendations are proposed:

1. Thorough Examination of Teaching Practices: Before utilizing the model to develop practical courses, teachers should meticulously study the teaching practices associated with the BTCC model. This understanding is crucial for its effective application in teaching, as it forms the core of the model.
2. Expand Applicability: In the future dissemination of practical courses, considering the application of the BTCC model in various types and levels of schools is advisable. This may

involve validating its applicability in higher education institutions, secondary schools, and even broader vocational training institutions.

3. Continuous Model Improvement: Continuously enhance and optimize the BTCC model based on practical application experiences and feedback. This could involve updating learning resources, adjusting task designs, and providing more flexible learning paths to accommodate the diverse needs and backgrounds of students.
4. Teacher Training and Support: To facilitate the wider adoption and implementation of the BTCC model, it is recommended to provide relevant teacher training and support. This may include training teachers to become facilitators of learning networks and offering additional teaching resources and tools for both teachers and students.
5. It would be beneficial to emphasize the importance of ongoing communication between teachers and researchers to ensure the continued success and relevance of the BTCC model in various educational settings.

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REFERENCES

Bakare, S.F., Latib, A.A., Inti, M.M., & Saud, M.S. (2018). Enhancing employability in technical and vocational education through non-technical skills development. *Advanced Science Letters*, (1), 9–11.

Du, M. (2014). Learning needs assessment and learning objectives setting for clinical teaching skills in respiratory therapy. In *2014 International Respiratory Therapy Symposium and the Eighth Cross-Strait Respiratory Therapy Forum Proceedings* (pp. 26–32). Kaohsiung Chang Gung Memorial Hospital Respiratory Therapy Department.

Estrada, M., Monferrer Rodríguez, D., & Sánchez, A. (2022). The impact of COVID-19 on university students and competences in education for sustainable development: Emotional intelligence, resilience and engagement. *Journal of Cleaner Production*, (P2), 135057–135057.

Hao, Q., & Gu, X. (2019). Current Application of Bloom's Goal Teaching Method in Nursing Teaching. *Tianjin Nursing*, (2), 241–244.

Hong, S. (2019). Construction of the School DIER curriculum development model from the perspective of systems science. *Modern Primary and Secondary Education*, (02), 29–33. doi:10.16165/j.cnki.22-1096/g4.2019.02.007

Jiang, D. (2016). Distinction between technology and skill. *Research on Higher Engineering Education*, (04), 71–82.

Jinzhi, Z. (2018). Discussion on how to create higher vocational education practice-based teaching systems adapted to vocational skills competitions. *Open Journal of Social Sciences*, (2), 95–101.

Johnson, B., & Ulseth, R. (2017). Student Experience for the development of professional competencies in a project-based learning curriculum. *International Journal of Engineering Education*, (3), 1031–1047.

Kraus, F. (2020). A new species of Lobulia (Squamata: Scincidae) from Papua New Guinea. *Zootaxa*, (2), 201–214.

Lamri, J., & Lubart, T. (2021). Creativity and Its relationships with 21st century skills in job performance. *Kindai Management Review*, *9*, 75–91.
Li, P. (2021). *A Study on the Application of Texture, Harmony, and Melody in Piano Improvisational Accompaniment* [Master's thesis, Nanchang University]. Retrieved from https://link.cnki.net/doi/10.27232/d.cnki.gnchu.2021.002502
Mepham, A., Besant, J.D., Weinstein, A.W., Burgess, I.B., Sargent, E.H., & Kelley, S.O. (2017). Power-free, digital and programmable dispensing of picoliter droplets using a Digit Chip. *Lab on a Chip*, (8), 1505–1514.
O'Connor, P., Reid, A., Mongan, O., Egan, C., Reid McDermott, B., Augusthinose, P.P., & Byrne, D. (2023). An assessment of the simulated performance of basic clinical procedures by junior doctors during the first year of clinical practice. *BMC Medical Education*, (1), 565–565.
Siemens, G. (2004). Elearnspace. Connectivism: A learning theory for the digital age. *Elearnspace.org*, pp. 14–16.
Simpson, T., Ellison, P., Tyler, R., & Carnegie, E.M.D. (2021). Optimising children's foundational movement skills and movement assessment batteries: The OPTIMAL theory. *Journal of Sport Exercise Psychology*, pp. S47–S47.
Tyler, R.W. (2013). *Basic Principles of Curriculum and Instruction*. University of Chicago Press.
Vaughn, V.M., Saint, S., Krein, S.L., Forman, J., Meddings, J., Ameling, J.M., . . . Chopra, V. (2018). Characteristics of healthcare organisations struggling to improve quality: Results from a systematic review of qualitative studies. *BMJ Quality & Safety*, (1), 74–84.
Wang, S. (2023). Exploration of undergraduate vocational education in China: Process, experience and strategy. *Journal of Education and Training Studies*, (4), 83–98.
Wang, X. (2020). Realistic dilemmas, target positioning, and path breakthroughs in the talent training of undergraduate vocational education. *Vocational and Technical Education*, (34), 6–11.
Wu, R., Yang, G., & Wan, S. (2010). New advances in the research of western operation skills theory. *Educational Academic Monthly*, (8), 90–94, 101. doi: 10.16477/j.cnki.issn1674-2311.2010.08.029
Zhao, B., Xie, Y., & Li, Z. (2023). Teaching practice of BIM technology course based on the "learning through competitions, teaching through competitions" model. *Western Quality Education*, (21), 143–147. doi: 10.16681/j.cnki.wcqe.202321035
Zhu, J., & Wang, D. (2023). Research on curriculum reform of environmental art and design majors in higher vocational education based on school enterprise cooperation. *Advances in Vocational and Technical Education*, (8).