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# The Practical Path of Training Field Engineers in Vocational Education—An Nvivo Analysis of 10 Typical Cases in Secondary Vocational Schools

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This study adopts a qualitative research approach, utilizing Nvivo 12.0 software to analyze typical cases of field engineer training implemented over several years in 10 secondary vocational schools in Dongguan. The research explores practical pathways for training field engineers and develops a training model. It identifies seven key dimensions with 20 primary and secondary indicators: comprehensive and in-depth school-enterprise collaboration, optimized curriculum and teaching design, continuous innovation in practice-based training, improved evaluation and management systems, strengthened resource allocation and support, promotion of intelligent technology application, and innovation in talent cultivation models.

*Keywords:* field engineer training, school-enterprise collaboration, training model, Nvivo analysis, typical cases

## Introduction

To implement the directives of the Central Talent Work Conference and the National Vocational Education Conference, the Ministry of Education, along with four other departments, jointly issued the *Notice on the Implementation of the Special Training Program for Field Engineers in Vocational Education* (Document No. [2022] 2). The goal is to cultivate high-quality technical and skilled talent that aligns with emerging technologies, industries, and models through industry-education integration and school-enterprise collaboration.

As a manufacturing powerhouse in Guangdong Province, Dongguan has made remarkable progress in training field engineers. In 2024, it became the first in the province to launch a special training program, selecting

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10 public secondary vocational schools to establish "Field Engineer Special Classes". These classes focus on training highly skilled talent to meet the demands of emerging industries. By adopting a "work-study alternation and integration of education and training" approach, schools and enterprises have jointly built field engineer training centers. A systematic training pathway has been developed, integrating secondary and higher vocational education with undergraduate programs, supported by dual-track teaching teams. Additionally, an evaluation mechanism oriented toward job-specific competencies has been established, creating a distinct Dongguan model for training field engineers (Yangcheng Evening News, 2024; Southcn.com, 2024).

This study systematically examines the practical pathways and outcomes of field engineer training based on typical cases from 10 secondary vocational schools in Dongguan. A qualitative research approach was adopted, combining case studies and NVivo coding. Through three-level coding in grounded theory, key concepts were identified to construct a theoretical training framework. The study summarizes Dongguan's successes and challenges, offering recommendations for improvement and providing valuable insights for other regions.

## Research Process

### Textual Keyword Frequency Analysis of Case Studies

This study utilized natural language processing (NLP) techniques to perform keyword frequency analysis on 10 typical case study texts, totaling approximately 41,000 words. This method allowed for a quick understanding of content and themes, extraction of keywords, and identification of hidden patterns and regularities within the text. After importing these texts into NVivo software and performing data cleaning, a total of 1,911 keywords were identified. Analysis was conducted based on a byte-length standard of two characters.

The keyword frequency analysis revealed the most frequently occurring terms, including "training" (431 occurrences, 2.35%), "field" (330 occurrences, 1.80%), "school" (314 occurrences, 1.71%), "engineer" (289 occurrences, 1.58%), and "enterprise" (229 occurrences, 1.25%). Other high-frequency keywords included "student", "talent", "professional" and "technology", reflecting the core content and themes of the texts.

### Three-Level Coding of Case Texts

This study utilized NVivo software to perform a combination of automated and manual coding, employing the grounded theory methodology to conduct three levels of coding.

**Open Coding.** This study employed NVivo software to perform a combination of automated and manual coding, using the grounded theory methodology to conduct three-level coding of the case texts. At the stage of open coding, the collected case materials were meticulously deconstructed to identify preliminary concepts and categories. Automated coding of the 10 typical case studies using NVivo software produced the following open coding results: "field" (10 cases, 167 occurrences; numbers in parentheses indicate the number of cases coded and coding frequency, respectively), "training" (10, 145), "engineer" (10, 129), "talent" (10, 129), "enterprise" (10, 121), "technology" (10, 110), "curriculum" (10, 102), "teaching" (10, 101), "school" (10, 100), "project" (10, 97), "professional" (10, 94), "ability" (10, 92), "position" (10, 77), "industry" (10, 75), "skills" (10, 73), "vocational" (10, 69), "education" (10, 68), "practice" (10, 68), "student" (10, 68), "collaboration" (10, 67), "development" (10, 59), "demand" (10, 53), "resources" (10, 52), "model" (10, 46), "innovation" (10, 46), "system" (10, 46), "automotive" (3, 46), "talent training" (10, 44), "design" (9, 44), "intelligence" (6, 43), "process" (10, 40), "learning" (10, 40), "evaluation" (9, 39), "issues" (10, 39), "engineering" (8, 37), "management" (8, 36), "plan" (9, 35), "education" (10, 34), "quality" (10, 33), and "company" (10, 33). A total of 33 key concepts were identified.

The research team further optimized the initial 33 open codes through manual refinement, classifying and tagging the relevant data into 15 categories (A1–A15): "educational institutions and projects, training content, training targets, school-enterprise collaboration, practice and innovation, evaluation and assessment, objectives and outcomes, curriculum design and resources, challenges and countermeasures, teaching methods, student management, technology application, market demand, resource allocation, and policy support." This process identified a total of 477 reference points. Additionally, several key concepts such as "school-enterprise collaboration", "curriculum design", and "practical teaching" were extracted from the codes.

**Axial Coding.** The process of axial coding began with the identification of core categories. In this stage, a central category was first selected as the axis, around which the relationships among other categories were explored and analyzed. The next step involved examining the connections among various categories, including causal relationships, chronological sequences, and semantic links, to uncover their underlying interrelations. Finally, a relational model was constructed to visually represent these connections through diagrams or models, clarifying and concretizing the associations between different components. This process transformed the research data from loose concepts into an organized and structured whole, laying the foundation for selective coding and theoretical framework construction.

A total of seven axial coding categories (AA1–AA7) were identified: "school-enterprise collaboration, curriculum and teaching design, practice and innovation, evaluation and management, resource allocation and support, technology and intelligentization, talent cultivation and career development."

## Findings from High-Frequency Keyword Analysis

The high-frequency keyword analysis of 10 schools in Dongguan revealed the current state and key characteristics of field engineer training. First, the frequent appearance of "training" (2.35%) and "field" (1.80%) highlights the emphasis on cultivating field engineers. For example, Dongguan Textile and Garment School has improved students' practical skills and competitiveness through its "three-stage education and work-study alternation" model.

School-enterprise collaboration is crucial in field engineer training, as reflected in the high frequency of "school" (1.71%) and "enterprise" (1.25%), underscoring the importance of this partnership. Dongguan Automotive Technology School, in collaboration with BAIC (Guangzhou), established an "in-factory school" training center to equip students with the latest technical standards for new energy vehicles, enhancing their professional competencies.

The frequent occurrence of "engineer" (1.58%), "professional" (0.94%), and "technology" (0.93%) underscores the professional and technical demands of training. For instance, Dongguan Polytechnic School partnered with Huawei to establish specialized training classes to deliver high-quality technical talent to the industry.

Field engineer training also focuses on the skill development of "students" (1.08%). Dongguan Electronic Technology School, for example, enhances students' practical and problem-solving abilities through professional programs like drone technology. Additionally, the frequent appearance of "practice" (0.48%) and "innovation" (0.43%) highlights the emphasis on hands-on practice and fostering innovation capabilities. Dongguan Light Industry School leverages its "AI + project-based practical training" platform to continuously enhance students' overall competencies.

In summary, these schools have significantly improved students' professional skills and employment competitiveness through diverse training methods, strong school-enterprise collaborations, and hands-on training platforms.

## Research Findings from Three-Level Coding

Building upon the keyword frequency analysis and the three-level coding process, the research team preliminarily constructed a training model for field engineers. Through the categorization and analysis of 33 open codes and 433 reference points within the seven axial coding categories, the study further examined the implementation pathways and distinct characteristics of field engineer training.

### Comprehensive and In-Depth School-Enterprise Integration

In field engineer training, school-enterprise collaboration demonstrates a high degree of closeness. High-frequency keywords such as "collaboration", "enterprise" and "project" reflect the deep involvement of enterprises in training programs. Models like "smart + projects" and work-study alternation have enhanced students' skills, with enterprise mentors providing continuous guidance during practical training, as seen in the collaboration between Dongguan Information Technology School and Dayan Automation. Flexible collaboration models include projects, special classes, and practical training bases. For instance, Dongguan Automotive Technology School collaborates with BAIC (Guangzhou), enabling students to engage in project-based learning. School-enterprise partnerships span curriculum design, teaching implementation, and student evaluation, with long-term agreements ensuring stability, such as the joint training model between Dongguan Polytechnic School and Huawei. Enterprise involvement ensures alignment between teaching content and industry demands while driving students' practical abilities and innovative thinking, comprehensively enhancing their professional skills and market adaptability.

### Optimized Curriculum and Teaching Design

Curriculum design and teaching play a pivotal role in field engineer training. Keywords such as "curriculum", "teaching" and "professional" appear frequently, emphasizing the importance of building a robust curriculum system. Scientifically designed curricula ensure students acquire systematic knowledge and skills, as seen in Dongguan Economic and Trade School's collaboration with enterprises to develop market-relevant courses, and Dongguan Polytechnic School's creation of core curricula meeting industry standards. A combination of theoretical and practical teaching fosters comprehensive competencies in students. Diverse teaching models and rich content are also critical. For example, Dongguan Light Industry School leverages its "AI + project-based practical training" platform to enhance problem-solving abilities. Teaching teams composed of school and enterprise personnel ensure professionalism and practicality. Programs are tailored to meet industry trends, focusing on emerging technology skills, as demonstrated by the courses at Dongguan Electronic Technology School and Dongguan Automotive Technology School. A curriculum system that balances scientific rigor with practical relevance is continuously optimized through collaboration and market research, ensuring students' competitiveness in the job market.

### Continuous Innovation in Practice-Based Training

Practice and innovation are distinct features of field engineer training, emphasizing hands-on skills and innovative capacity. Training pathways focus on problem-solving abilities, such as the "in-factory school" program at Dongguan Automotive Technology School, which enhances students' practical skills in new energy vehicle manufacturing through enterprise collaboration. Similarly, project-driven teaching in Dongguan Polytechnic School's Huawei-specialized classes strengthens students' AI-related technical skills. Practical teaching, supported by real-world projects, transforms theoretical knowledge into applicable skills, as seen in Dongguan Light Industry School's "AI + project-based practical training" platform. Innovative teaching and assessment methods are also integral. For instance, Dongguan Information Technology School employs a project-driven model in collaboration with enterprises to enhance students' creativity and professional literacy. The integration of practice and innovation in teaching not only strengthens students' vocational competencies but also boosts their competitiveness in the job market.

**Improved Evaluation and Management Systems**

Evaluation and management play crucial roles in field engineer training. High-frequency keywords like "evaluation" and "management" highlight the importance of assessing vocational competencies and managing training processes. A scientific evaluation system ensures that students meet professional standards. For example, Dongguan Light Industry School employs a diversified intelligent evaluation system, and Dongguan Information Technology School has developed a comprehensive teaching quality evaluation framework. Diverse assessment methods also enhance vocational skills. Dongguan Automotive Technology School uses varied assessment techniques to ensure students' proficiency in new energy vehicle practices, while Dongguan Economic and Trade School collaborates with enterprises to establish standardized outcome evaluations, improving students' employability. Effective management systems, such as Dongguan Electronic Technology School's structured management protocols, ensure the smooth operation of teaching and practical training. Overall, a robust evaluation and management system ensures the development of students' professional skills, learning outcomes, and vocational literacy.

**Strengthened Resource Allocation and Support**

Resource allocation and policy support are critical to field engineer training. Efficient resource allocation, such as Dongguan Light Industry School's optimization of practical training resources, enhances students' hands-on skills. Similarly, Dongguan Information Technology School's detailed resource plans ensure efficient utilization, improving teaching quality and practical outcomes. Policy support serves as a strong backbone for training. For example, Dongguan Economic and Trade School leverages government policies for necessary funding and resources, optimizing course design and practical training to align with market demands. Overall, effective resource allocation and strong policy backing provide a solid foundation for field engineer training, ensuring students have access to optimal learning and practical environments.

**Promotion of Intelligent Technology Application**

Technology and intelligentization play key roles in field engineer training, as reflected by high-frequency keywords such as "technology" and "intelligent". The application of advanced technologies equips students with cutting-edge skills. Examples include Dongguan Polytechnic School's AI courses in partnership with Huawei and Dongguan Mechanical and Electrical Engineering School's industrial robotics programs, which foster students' intelligent manufacturing capabilities. The integration of intelligent technologies, such as Dongguan Light Industry School's practical training platform and Dongguan Electronic Technology School's drone projects, strengthens students' technical proficiency. Additionally, the development of technical services is emphasized. Dongguan Information Technology School collaborates with Dayan Automation to enhance students' awareness of technical services, while Dongguan Automotive Technology School incorporates frontier trends in new energy vehicle courses. The extensive application of new technologies and intelligent teaching models significantly improves students' vocational skills and employability.

**Innovative Talent Development Models**

Talent cultivation and career development are essential in field engineer training. Systematic training plans, developed through enterprise collaboration and industry-standard curricula, enhance students' professional skills. Examples include the AI training programs co-designed by Dongguan Polytechnic School and Huawei and the new energy vehicle training initiatives at Dongguan Automotive Technology School. Innovative talent development models emphasize adaptability to market demands and technological changes. For instance, Dongguan Textile and Garment School's "three-stage education" model and Dongguan Electronic Technology School's specialized classes improve students' practical and adaptive abilities. Diversified vocational training, such as enterprise mentors stationed at schools and platforms like Dongguan Light Industry School's "AI + project-based practical training", enhance operational skills and innovation capacity, ultimately boosting employment rates. Overall, systematic training programs, innovative models, and diversified projects strengthen students' vocational competencies and competitive advantages in career development.

This study analyzed the implementation pathways and outcomes of field engineer training across seven aspects: school-enterprise collaboration, curriculum design, practical teaching, evaluation systems, resource allocation, technology application, and talent cultivation, based on cases from 10 secondary vocational schools in Dongguan. The findings indicate that optimizing collaboration, curriculum systems, and resource support has significantly improved students' vocational skills and employability, providing new pathways and models for vocational education. However, the limited sample scope excludes diverse school types. Future research should expand the sample size, include comparisons among different school types, and adopt diverse data collection methods to enhance the universality and scientific validity of the findings.

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