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Research on the Personalized Growth Path for "Dual-Qualified" Teachers in Higher Vocational Colleges Empowered by Big Data

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Abstract: *This study confronts the persistent challenges of homogeneity and imprecision in the professional development of "dual-qualified" teachers within higher vocational education. We investigate how big data can serve as a catalyst for genuinely personalized growth by introducing a framework built upon a cycle of data collection, analysis, diagnostic evaluation, and tailored path recommendations. By drawing on multi-source data to create a detailed competency profile for each educator, our model pinpoints specific skill deficits and dynamically generates corresponding development tasks. A pilot case study demonstrated the model's potential to ignite teachers' intrinsic motivation for advancement. However, the practical application also surfaced formidable hurdles, including the difficulty of acquiring comprehensive data, a palpable crisis of trust, and steep technical barriers. We conclude that while big data is a powerful lever for personalization, its ultimate success is contingent not only on technical and logistical solutions but, more critically, on establishing an incentive-compatible governance system that rebuilds trust. This requires a pedagogical shift: guiding teachers from being passive training recipients to becoming proactive architects of their own professional journey.*

Keywords: *"Dual-Qualified" Teacher; Teacher Professional Development; Higher Vocational Education; Big Data*

1. Introduction

China is increasingly recognizing the strategic importance of higher vocational education. This emphasis comes as part of its national strategy to accelerate the development of new quality productive forces. The goal is to become a leading manufacturing power. It serves as the primary training ground for high-caliber technical and skilled professionals. The cornerstone supporting this grand vision is undoubtedly a team of "dual-qualified" teachers who are well-structured, technically proficient, and possess both theoretical knowledge and practical skills. In line with the newly revised Vocational Education Law of the People's Republic of China and the explicit requirements of the "Double High-level Plan," strengthening the ranks of "dual-qualified" teachers is no longer an option but an imperative crucial to the core competitiveness of vocational education.

Big data's analytical power offers a direct path to overcoming this challenge. The core mechanism involves building a unique competency profile for each teacher by analyzing diverse data points—from classroom performance and research activity to training records and industry practice. This fundamentally changes the game, replacing subjective hunches with objective, data-backed diagnostics. With this clarity, the system can identify exact developmental needs and generate truly personalized growth plans and resources. It marks a decisive move away from outdated, uniform management styles and toward a dynamic model of "precision empowerment."

Therefore, this study focuses on constructing a big data-driven framework for the personalized growth of "dual-qualified" teachers. We will systematically elaborate on its theoretical foundations and design an operational closed loop that includes data modeling, diagnostic analysis, and intelligent recommendation. The aim is to provide a scientific and efficient solution for innovating faculty development in vocational colleges in this new era, thereby injecting powerful momentum into the quality-focused development of China's vocational education.

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2. Building a Theoretical Framework for Big Data-Empowered Personalized Growth

To achieve personalized empowerment for "dual-qualified" teachers, our research constructs a three-tiered, closed-loop theoretical framework. This framework is grounded in the Competency Model, Data-Driven Decision-Making, and Adult Learning Theory.

2.1 Theoretical Foundations

▪ Competency Model. This serves as the structural basis for building teacher competency profiles. It defines the dimensions of ability to be measured, ensuring the profile is both scientific and comprehensive [1].

▪ Data-Driven Decision-Making (DDDM) . As the guiding philosophy of the framework, DDDM emphasizes that all developmental recommendations and path planning must stem from the analysis of objective data, rather than subjective assumptions.

▪ Adult Learning Theory[2]. This provides the psychological basis for path design. It respects teachers as adult learners, acknowledging their autonomy, experience, and problem-centered orientation, which ensures that recommended paths can spark their intrinsic motivation.

2.2 Constructing a Digital Competency Profile for "Dual-Qualified" Teachers

A digital competency profileis the prerequisite for personalization [3] . The profile designed in this study comprises four key competency dimensions and their corresponding data sources:

▪ Theoretical Teaching Ability[4]. Data sources include course schedules from the academic affairs system, student evaluation data, interaction records from online teaching platforms, feedback from teaching supervisors, teaching competition awards, and records of quality course development, encompassing both structured and unstructured data.

▪ Industry Practice Ability[5]. We draw data from the HR system's records of industry practice duration and positions, levels of professional qualification certificates obtained, results from guiding students in skill competitions, participation in industry standard development, and the contract value and completion status of enterprise-commissioned projects.

▪ Technological R&D and Social Service Ability[6]. Data sources consist of records of published papers and patent applications from the research management system, data on the approval and completion of vertical research projects, and records of technical consulting and training services provided to communities and enterprises.

▪ Personal Development and Potential. This dimension utilizes data from records of participation in various training programs, career development plans submitted by teachers, peer evaluations, and self-efficacy assessment questionnaires.

2.3 The Model for Generating and Empowering Personalized Growth Paths

2.3.1 Data Collection and Integration Layer

Its core task is to break down "data silos." By establishing a campus-level data middle platform or data warehouse, this layer cleanses, aggregates, and standardizes teacher-related data scattered across different business systems like academic affairs, HR, research, student affairs, and finance. This process forms a unified, teacher-centric database.

2.3.2 Data Analysis and Diagnosis Layer

This layer employs data mining algorithms for in-depth analysis of teacher data. For instance, we can use cluster analysis to categorize teachers into groups like "strong in theoretical teaching," "elite in industry practice," or "high-potential developer." Association rule analysis can reveal which training or practice activities most significantly enhance specific competencies. Most critically, this layer pinpoints a teacher's "strengths" and "weaknesses" by comparing their individual competency profile against a pre-set benchmark model of an "excellent dual-qualified teacher" or specific job requirement models.

2.3.3 Path Recommendation and Application Layer

The framework's operational core is a dynamic, closed-loop process that translates diagnostics into

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actionable growth. This process unfolds in the follow stages:

▪ Intelligent Path Generation. The system's algorithm analyzes competency gaps to assemble a custom "task package" [7] from a resource pool (courses, projects, conferences, etc.). For example, it would pair a theory-strong teacher with a hands-on industry project.

▪ Visualized Progress Tracking. A personal dashboard uses radar charts and growth curves to make progress tangible. It clearly displays a teacher's current standing, target goals, and the recommended path, providing immediate insight for both the individual and administration.

▪ Dynamic Feedback and Adaptation. Upon task completion, new data instantly updates the teacher's profile. The system then refines future recommendations, creating a self-improving cycle: Diagnose → Act → Reflect → Adapt [8].

3. Case Study and Analysis

3.1 Research Design

We selected College A as the subject for our case study. The college has a relatively strong IT infrastructure and an urgent need to develop its "dual-qualified" faculty. The study focused on three teachers at different career stages (junior, intermediate, and senior titles) from two professional clusters: new-generation information technology and intelligent manufacturing. Our research method combined "simulated system deployment with in-depth interviews." We used existing data to simulate the construction of teacher competency profiles and path recommendations, then conducted interviews with the teachers and their department heads to validate the framework's effectiveness.

3.2 Case Implementation Process

Let's take Teacher Zhang (intermediate title) from the intelligent manufacturing cluster as an example. The competency radar chart generated after integrating his data showed strong abilities in "theoretical teaching" and "guiding student competitions." However, it also revealed significant weaknesses in "front-line industry project experience" and "technology patent commercialization."

Based on this diagnosis, the system generated a personalized growth path with the following core tasks.

▪ Short-term (within 1 year):The teacher will participate in the "Intelligent Operation and Maintenance of Industrial Robots" advanced workshop hosted by partner company B. And he will apply for a college-level teaching reform project on the theme such as "Modular Redesign of the PLC Application Technology Course Based on Real-world Enterprise Projects."

▪ Mid-term (2-3 years):Young teacher will be assigned to Company B as replacement interns or visiting engineers, where they will engage in professionally relevant projects for a period of more than six months, gaining substantial hands-on experience. He will also collaborate with the company to co-develop curriculum resources and practical training modules.

3.3 Results, Analysis, and Discussion

This case study not only verified the basic feasibility of our theoretical framework but also, through in-depth interviews, uncovered the multi-faceted value, deep-seated challenges, and potential organizational changes that this big data-empowered model can bring about in practice.

3.3.1 Core Value Validation: From "Precision Empowerment" to "Motivational Spark"

The precision of the diagnosis and the targeted nature of the path received high praise. Teacher Zhang commented, "This plan is incredibly precise. It targets exactly the areas I've been wanting to improve but wasn't sure how to approach." This feedback directly confirms the effectiveness of the data profile in identifying an individual's genuine "competency gaps." It signifies a shift from the past's crude, "experience-driven, group-supply" training model to a refined, "data-driven, individually-tailored" empowerment model. The department head believed this approach would help "build a faculty structure with a reasonable talent echelon," indicating that the model also provides administrators with a scientific basis for optimizing faculty allocation at a macro level.

The framework does more than generate a to-do list; it sparks a desire to improve. Its secret lies in

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visualization. When teachers see their skills mapped on a radar chart, they don't just see data—they see themselves. This moment of clarity is transformative. It cuts through the fog of career anxiety and provides a clear, personal mission. The mindset shifts entirely, aligning perfectly with adult learning principles: problems become opportunities, and motivation comes from within. Teachers are no longer passive "trainees" in a program; they become the authors of their own growth story. This is the crucial transition from "I have to" to "I want to."

3.3.2 Unveiling Deeper Challenges: A Complex Balancing Act Between Data, Trust, and Technology

The implementation also exposed challenges more complex than anticipated. These issues are intertwined and form the main obstacles to widespread adoption.

- The "Last Mile" Problem of Data Acquisition. Quantifying the "quality" of unstructured data is difficult. In the case study, we found that while structured data (like teaching hours and awards) was relatively easy to collect, capturing the value of unstructured data crucial for "dual-qualified" teachers—such as the specific outcomes of "industry practice" and the actual contributions of "technical services"—was extremely challenging. For example, the system can record that a teacher spent six months in an enterprise, but it cannot automatically measure whether they were "deeply involved in core projects" or merely engaged in "marginal observational learning." This lack of "quality-level" information directly affects the accuracy of the profile and the relevance of the recommended path, representing a key barrier that future technical optimizations and institutional designs must overcome.

- The Fragility of Trust. A deep-seated anxiety about "data surveillance" exists. Some teachers' "data anxiety" was not just about privacy leaks but a fear that the data could be misused as the "ultimate evaluation tool." They worried that a system designed for "empowerment" could evolve into an all-encompassing "electronic overseer," with their data being used by administrators in zero-sum games like performance rankings and promotion selections. This lack of trust could lead teachers to "report only the good and hide the bad" or engage in "data embellishment," thereby contaminating the data source and undermining the entire system from its foundation. This reveals that institutional goodwill and transparency are the foremost prerequisites for the effective application of technology.

- The "Dual Barriers" of Capability and Cost. Technology and cost are not just financial issues; they represent a "capability gap" common in higher vocational colleges. Building and maintaining a data middle platform requires a professional IT team. Moreover, interpreting data, conducting precise diagnostics, and planning paths demand high levels of "data literacy" from administrators and teacher development staff. For many ordinary vocational colleges with a weak IT foundation, these constitute an insurmountable barrier, potentially widening the "digital divide" in faculty development between the "Double High-level" institutions and their peers.

4. Path Optimization and Strategic Recommendations

Based on the challenges identified in the case study—such as data acquisition, privacy and trust, and technical costs—we propose the following concrete and actionable strategies at the top-level design, institutional implementation, and individual teacher levels. These aim to ensure the personalized growth model empowered by big data can effectively transition from a "theoretical framework" to a "practical paradigm."

4.1 Institutional Management Level: Building an Incentive-Compatible Governance and Cultural System

The institution is the primary entity responsible for policy implementation. It must act synergistically in its systems [9], technology, and culture to alleviate teacher concerns and foster internal motivation.

- Establish a "Data Governance Committee" and Implement a "Sunshine Policy" to resolve the trust crisis. A committee led by college leadership should be formed, including representatives from HR, academic affairs, research, the IT center, department heads, and front-line teachers. The inclusion of teacher representatives is key to building trust.

- Use formal documents to clarify the scope of data collection, its purpose, anonymization rules, and a teacher's "right to know, access, and correct" their data. Developmental data (like competency

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profiles) and evaluative data (like annual performance reviews) should be physically and functionally separated. It must be explicitly stated that profile analysis results are only for path recommendation and resource matching and cannot be used as a direct basis for negative evaluations or penalties. This is essential to eradicate teachers' "data anxiety."

▪ Link personalized development plans to resource allocation. A teacher's "personalized annual development plan," generated in the system and confirmed by their department, should be a significant factor when they apply for training funds, overseas visits, or project funding. This gives proactive planners priority access to development opportunities.

▪ Create special awards for "Competency Breakthroughs." Teachers who successfully bridge key competency gaps through system-recommended tasks (e.g., securing their first industry-funded project or guiding students to win a national competition for the first time) should receive special rewards or bonus points in promotion reviews. This makes the benefits of data empowerment "visible and tangible."

▪ Cultivate "data stories" and role models. The institution should regularly identify and publicize cases of teachers who have achieved significant growth through their personalized paths. Visualizing and narrating their "growth stories" with data can create a powerful demonstration effect, encouraging all teachers to shift from being "bystanders" to "participants."

4.2 Individual Teacher Level: A Leap in Consciousness and Capability from Passive Adaptation to Active Planning

Teachers are the ultimate users and beneficiaries of this model. They must be guided to eir data literacy and proactively embrace this change.

▪ Provide "one-on-one" profile interpretation and planning support. The Teacher Development Center or academic departments should establish a "Development Advisor" role. This role is not for management but for service.

▪ During the initial rollout, advisors should proactively invite each teacher for a one-on-one session to interpret their profile, help them understand their strengths and weaknesses, and collaboratively formulate their first personalized annual development plan. This initial phase of hands-on guidance is critical.

▪ Encourage teachers to form "Competency Growth Groups" spontaneously. Groups like a "Teaching Innovation Circle" or a "Patent Task Force" can share experiences, showcase achievements, and motivate each other within the system. This transforms isolated individual development into a community-based collective growth effort.

5. Conclusion and Outlook

This study confirms that a personalized growth model empowered by big data offers an effective path to overcoming the homogeneity dilemma in the training of "dual-qualified" teachers. By constructing teacher competency profiles, conducting precise diagnostics, and offering intelligent recommendations, this model enables "precision irrigation" for teacher development. It marks a fundamental shift in faculty development from traditional experience-based management to modern data-driven governance. We believe this provides a solution with both theoretical depth and practical value for building a high-quality "dual-qualified" teaching force.

While acknowledging the limitations of our current research in terms of sample size and data scope, future work should focus on deepening three dimensions: technology, empirical evidence, and ecosystem. First, we should integrate artificial intelligence to upgrade the system from "diagnostic" to "predictive" intelligence. Second, large-scale empirical studies should be conducted to quantify the model's ultimate impact on teaching effectiveness and student achievement. Third, we envision building an inter-institutional data-sharing platform to create a "new infrastructure" for talent development in China's vocational education. Such advancements will elevate data intelligence from an auxiliary tool to a strategic engine, laying a solid foundation for cultivating an innovative and adaptive teaching workforce capable of meeting the demands of future industrial development.

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