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Innovative Practice of Industry-Education Integration and Competition Empowerment in Data Visualization Courses

-- Taking Suqian University as an Example

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Abstract: Faced with the urgent demand for data talents amid the development of the digital economy and new engineering initiatives, this study is grounded in the application-oriented educational positioning of Suqian University and the talent needs of local pillar industries—including e-commerce, liquor-making, and smart city development in Suqian. It addresses core challenges: the disjunction between the teaching content of the "Data Visual Analysis" course and industrial demands, fragmented teaching resources, misalignment between the evaluation system and job requirements, and insufficient competitive motivation in practical sessions. Guided by the core concepts of industry-education integration, competency-based education, achievement-oriented teaching, and competition-driven learning, the study incorporates desensitized sales data from local leading enterprises (e.g., JD.com and Yanghe Co., Ltd.) to establish a visual case library, and constructs a six-in-one innovative teaching system encompassing school-enterprise data collaboration, project-driven teaching, competition empowered practice, blended teaching empowerment, multi-dimensional process assessment, and deep integration of ideological and political education. In practice, local desensitized industrial datasets are integrated, virtual simulation experiments and new-form teaching resources are developed, discipline competitions are deeply integrated with curriculum practice, a multi-dimensional competency evaluation model is adopted, and dynamic alignment is achieved between corporate job requirements and competition competency standards. Results indicate that the overall achievement rate of curriculum objectives post-reform reaches a high of 0.8939. Students' practical abilities, industrial adaptability, innovative awareness, and comprehensive professional literacy have been significantly improved. This study provides a replicable and promotable "Suqian Model" for the reform of data-related courses in local undergraduate universities featuring regional industry-education integration and academic competition empowerment.

Keywords: Data Visualization; Integration of Industry and Education; Subject Competition; Competition to Promote Learning; Teaching Reform; Blended Teaching.

1. Introduction

In recent years, big data and artificial intelligence technology have developed rapidly. Data visualization, as a core means of data understanding, decision support and information dissemination, has become a core course in data science and big data technology majors. The industry's demand for visualization talents not only focuses on tool skills such as Python, Matplotlib, and Pyecharts, but also emphasizes comprehensive qualities such as demand analysis, engineering practice, project management, data ethics, and innovative thinking. The development of local digital economy has increasingly prominent regional and job-based demands for visualization talents ([1]).

From the perspective of current domestic and international research, foreign studies on data visualization teaching and industry-education integration emerged earlier, forming a mature system in terms of technological application and teaching models. Liu et al. conducted a comprehensive review of the research progress in the field of high-dimensional data visualization in the past ten years and provided a modular research progress guide for data practitioners ([2]); European and American universities generally implement deep school-enterprise collaboration and project-based practical teaching, embedding real industrial scenarios and subject competition mechanisms into the entire course process, focusing on cultivating students' engineering practice and innovative problem-solving abilities. In the process of promoting the construction of new engineering disciplines in China, the teaching reform of data courses has become a prominent research topic. Jiang et al. have explored the implementation path of integrating subject competitions into the professional practical ability training system of data science and big data technology ([3]). Ding et al. have constructed a general education curriculum system for the introduction to big data in new engineering disciplines and carried out practice ([4]). Shen et al. have carried out innovative exploration of teaching systems for Python language courses in the era of artificial intelligence ([5]). Wei et al. analyzed the constraints of employment and entrepreneurship guidance in private vocational undergraduate colleges under the school-enterprise collaborative education model, and proposed improvement measures to provide reference for improving the effectiveness and efficiency of employment and entrepreneurship guidance in such colleges ([6]). Wu et al. proposed a trinity of industry-education through-training ideas of "skills cultivation - literacy improvement - value guidance", elaborated on the implementation process of education reform and gave suggestions for curriculum system optimization to cultivate data visualization talents that meet market demand ([7]). Lu et al. proposed targeted teaching reform ideas for data visualization courses under the background of industry-education integration ([8]). However, existing research predominantly centers on a single reform dimension. Furthermore, there is a dearth of studies exploring the synergy between industry-education integration and competition empowerment in local undergraduate colleges—particularly those closely aligned with regional pillar industries. Additionally, there is a lack of implementable and replicable regional practical models.

There are four core shortcomings in the current construction of data visualization courses in colleges and universities. Firstly, the course content is out of touch with regional industry needs, and there is a lack of integration of real projects and business scenarios in local pillar industries. Secondly, teaching resources are fragmented, with virtual data being the main focus, and students lack real industry data practice opportunities. Thirdly, the integration of industry and education is insufficient, enterprise participation is superficial, and the assessment system and job standards are misaligned; fourth, the practical link lacks the empowerment of subject competitions, and students' innovative thinking, teamwork, and complex problem-solving abilities are insufficiently cultivated.

In the context of the digital economy and the transformation and upgrading of local industries, carrying out industry-education integration and competition empowerment reforms in data visualization courses is not only a practical necessity to meet the urgent needs of industry talents and break the gap between learning and application, but also a theoretical necessity to improve the education system of data courses in local undergraduate colleges and improve the quality of talent training. Suqian University uses the "Data Visual Analysis" course as a reform carrier, based on local industry needs, introducing desensitized sales data from local leading companies such as JD.com and Yanghe Co., Ltd. to build a teaching case library, drawing on the core path of integrating subject competitions into practical ability training, and carrying out a two-wheel-driven teaching reform of "integration of industry and education + subject competitions" to solve the problems of "disconnection between learning and application, mismatch between supply and demand, and insufficient innovation", and explore a new model for regional education of data courses in local undergraduate colleges.

2. Theoretical Basis and Design Ideas of Curriculum Reform

2.1. Theoretical Support

1. Outcome-based education (OBE): reversely design course objectives, teaching content, and evaluation systems based on students' expected learning outcomes, focusing on five core competencies: problem analysis, tool use, program design, project management, and competition innovation, to meet the dual requirements of corporate positions and subject competitions.

2. Industry-education integration theory: promote the effective connection between the education chain and talent chain and Suqian's local industry chain and innovation chain, introduce desensitized industrial data from local enterprises into practical training and teaching, realize the integration of industry data into teaching materials, classrooms, and practical training, which is in line with the development path of industry-education integration in the construction of new engineering disciplines in local universities ([9].

3. Blended Learning Theory: integrates online self-directed learning, offline intensive hands-on training, virtual simulation supplementary teaching, and independent competition preparation. This approach addresses the constraints of limited learning time, uneven academic foundations among students, and insufficient practical training opportunities.

4. Use competitions to promote learning/teaching theory: relying on the competitive, practical, and comprehensive characteristics of subject competitions, competitions are used as an important carrier for cultivating practical abilities, stimulating students' learning initiative, and forcing innovation in teaching content and methods. The integration of competitions and education has become the core reform direction of practical teaching in data majors ([10]).

2.2. Reform Design Ideas

Guided by the competency demands of local industrial posts in Suqian and the proficiency standards for academic competitions, a reform framework of "one main line, five synergies and six enhancements" is formulated.

The first core line: regional industry-education integration and academic competition empowerment run through the whole curriculum.

Five synergies: schools and enterprises collaborate to provide data resources, collaboratively develop resources, collaboratively implement teaching, collaboratively conduct evaluation, and collaboratively guide competitions;

Sixth improvement: improve knowledge mastery, practical operation ability, project execution ability, innovative thinking ability, competition competitiveness, and professional quality.

3. Industry-Education Integration and Competition Empowered Curriculum Innovation Practice

3.1. Data Introduction and Competition Benchmarking: Reconstructing Course Objectives and Content Systems

By introducing desensitized sales data from local leading enterprises such as JD.com and Yanghe Co., Ltd., and in conjunction with the requirements of academic competitions including the Lanqiao Cup and the National College Student Data Visualization Competition, the course syllabus was revised, and five core course objectives were defined: mastering basic visualization theories and system design methods; proficiently applying visualization tools to complete real-world data development; possessing teamwork capabilities and engineering practice literacy; fostering data ethics and industrial service consciousness; and acquiring the competence to prepare for and participate in academic competitions.

Structured along the progressive path of Fundamentals → Competition Training → Advanced Learning → Comprehensive Application → Practical Project Practice, the teaching content is divided into five hierarchical modules. It deeply integrates desensitized sales data from local leading enterprises, real business scenarios and official competition problems, and underpins the development of an industrial data case repository and a standardized academic competition question bank. On this basis, a novel integrated teaching resource system has been established, consisting of loose-leaf teaching materials, online learning resources, enterprise data cases and authentic competition exercises. This system fully satisfies the core requirements for the construction and reform of data visualization course groups ([11]).

3.2. Four-Dimensional Teaching Model Innovation

1. Blended learning, virtual-real integration and competition preparation Integrate online micro-lectures, official competition problems and a competition preparation video resource library with offline practical operations and virtual simulation training for contest preparation. This mode enables complementary integration of personalized independent learning and centralized classroom teaching.

2. Dual-driving teaching of project-led and competition-oriented learning Authentic data cases from local enterprises and academic competition problems are simultaneously incorporated into classroom teaching. Whole-process training is implemented following the workflow of demand analysis → data processing → visual design → development and implementation → defense, with dual tutors providing one-stop guidance throughout the entire process.

3. Thematic teaching via competition case analysis typical official competition problems are selected to design 90-minute special thematic sessions. The complete teaching procedure covers competition problem introduction, task decomposition, hands-on training, effect optimization and summary reflection.

4. Dual-teacher collaboration, curriculum-certification integration and competition-based assessment. A teaching team consisting of on-campus professional teachers and competition instructors is established. The model facilitates the alignment between curriculum learning and professional certification in data visualization, and allows competition performance to offset corresponding course module credits.

3.3. Construction of the Six-level Progressive Practical Teaching System

Drawing on the core approach of embedding academic competitions into practical teaching, the original practical training system is optimized and upgraded into a six-stage progressive framework: Basic Experiment → Competition Training → Comprehensive Experiment → Virtual Simulation → Project Practice → Enterprise Internship. Practical tasks are designed hierarchically to accommodate students with varied learning foundations.

1. Basic experiment: consolidate tool operation skills and meet the basic requirements of the competition.

2. Competition training: integrate basic competition questions to stimulate interest in competition.

3. Comprehensive experiment: combined with advanced competition questions to improve comprehensive application capabilities.

4. Virtual simulation: simulate actual competition scenarios, break through the limitations of practical training conditions, and optimize practical teaching effects based on virtual simulation experimental design.

5. Project Practice: integrating real enterprise data cases with simulated academic competitions to foster students' systematic thinking and innovative competencies.

6. Enterprise internship: benchmark enterprises and competition standards, and experience the actual industrial environment.

3.4. Multi-process and Competition-oriented Assessment System

A multi-dimensional assessment system is established, consisting of formative process evaluation (50%), competition practice performance (20%), and final comprehensive examination (30%). A multidimensional competency radar chart model is adopted to align evaluation criteria with enterprise job requirements and official competition scoring rules.

1. Competition-based assessment instead of traditional examinations achievements and awards obtained in academic competitions can be directly recognized as full credits for the competition practice module.

2. Hierarchical differentiated evaluation basic and advanced practical tasks are set with corresponding graded scores, fully accommodating students at different learning levels.

3. To implement competition-aligned knowledge assessment, the final examination incorporates core concepts from official academic competition questions, achieving a seamless alignment between curriculum mastery and competition competency development.

3.5. Curriculum Ideology and Politics (IPE) and Teaching Team Development

Ideological and political education is deeply embedded in the entire teaching process by integrating the spirit of craftsmanship, data ethics, competition integrity, and teamwork awareness, so as to reinforce value guidance. For teaching team development, a model combining internal training, external recruitment, and interdisciplinary collaboration is adopted: faculty members are arranged to attend enterprise training programs and academic competition guidance training; relying on desensitized industrial data, they continuously optimize teaching cases, establish interdisciplinary teaching teams, and share industrial resources and competition-related materials.

4. Teaching Reform Effectiveness and Data Analysis

4.1. Analysis of Course Goal Attainment

Based on the scores of 53 students majoring in data science and big data technology in the class of 2023, the overall course achievement degree was 0.8939, much higher than the expected value of 0.7. All four major goals were achieved, proving that the reform effectively supports the implementation of the goal of ability cultivation.

4.2. Graduation Requirements Support Effectiveness

The course supports the five major index points of graduation requirements: problem analysis, designing solutions, using modern tools, project management, and innovative practice. The attainment levels are all at a high level and are highly consistent with local industrial positions and subject competition ability requirements.

4.3. Effectiveness of Student Ability Improvement

1. Improved industrial adaptability: graduates can quickly

adapt to local visualization positions, and the job adaptation cycle is greatly shortened.

2. Enhanced learning initiative: hierarchical practice and competition drive effectively alleviate student polarization, significantly improve learning participation, and the competition teaching integration model significantly improves students' practical and innovative abilities ([9]).

5. Existing Problems and Improvement Measures

5.1. Problems

1. Some students lack initiative in learning and their enthusiasm for competition preparation needs to be improved.
2. Weak ability to integrate visualization tools and lack of practical competition skills;
3. There is insufficient systematic thinking in projects and competitions, and the ability to integrate industry and business needs to be strengthened.
4. The depth of integration between industry, education and competition is insufficient, and resources of real enterprise data cases and competition questions are limited.
5. The phenomenon of student polarization still exists, and students with weak foundations are afraid of difficulties.

5.2. Improvement Measures

1. Strengthen process management: quantify classroom interactions and competition preparation tasks into daily results.
2. Focus on core skills: carry out special training on tools and drills on real competition questions to consolidate practical abilities.
3. Promote dual-driven learning: design mini industrial data cases and simple competition questions, and cultivate systematic thinking step by step.
4. Deepen integration reform: expand data cooperation enterprises, enrich the industrial data case library, and optimize the supply of teaching resources.

6. Conclusion

Driven by industry–education integration and academic competition empowerment, the data visual analysis course at Suqian University closely aligns with the talent demands of the local digital economy and pillar industries. By adopting desensitized sales data from local leading enterprises, the course reconstructs the curriculum system through competition benchmarking, dual-teacher collaborative instruction, project-and-competition dual-driven practice, multi-dimensional assessment, and curriculum ideological and political guidance. It effectively addresses four major bottlenecks in traditional teaching, and realizes the four-in-one integration of knowledge imparting, competency training, value guidance, and innovation empowerment.

Moving forward, the university will further deepen university-local data cooperation and competition-integrated teaching. It will dynamically update the industrial data case repository and supporting teaching resources, refine the teaching model and evaluation mechanism, and improve the integration mechanism between competition-based assessment and curriculum certification. This reform aims to cultivate high-quality application-oriented and innovative data talents for the development of the local digital economy, and provide a replicable and scalable practical model for the curriculum reform of data courses featuring industry–education integration and academic competition empowerment among local undergraduate universities.

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