

Research on Industrial Adaptation and Practical Transformation of Emerging Engineering and Business Disciplines in Local Universities in the Era of Big Data and AI

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Abstract: The deep integration of big data and artificial intelligence (AI) is empowering industrial upgrading, posing new interdisciplinary, data-driven, and practice-oriented demands on talent cultivation in emerging engineering and business disciplines at local universities. However, these institutions currently face challenges such as outdated curricula, impractical teaching detached from real-world scenarios, insufficient engineering practice and data literacy among faculty, and superficial industry-education integration. To address regional industrial needs, it is essential to shift curricula from knowledge-based to competency-oriented with dynamic updates, transition practical teaching from simulation-based to real project-driven approaches, transform faculty into “dual-qualified” professionals with both teaching and industry expertise, and establish a collaborative ecosystem involving governments, universities, and enterprises. Through multidimensional reforms, the alignment between talent development and local industries can be enhanced, providing high-quality human resources to support regional digital transformation.

Keywords: Big data; AI; Emerging engineering; Emerging business; Industry-education integration; Practical teaching

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1. Introduction

The rapid penetration of big data and AI is reshaping operational paradigms across industries, driving deep integration between digital technologies and the real economy. This fusion is propelling traditional industries toward intelligent, data-driven, and networked transformation. Consequently, the competency standards for talent in emerging engineering and business disciplines have fundamentally shifted, with interdisciplinary integration, data literacy, and practical problem-solving abilities becoming core competitive advantages. As primary providers of regional talent, local universities shoulder the critical mission of serving local industries and supporting digital transformation. However, the growing disconnect between traditional training models and the demands of the new industrial era has become increasingly apparent. Many universities still face challenges such as outdated curricula, virtualized practical teaching, faculty lacking frontline experience, and superficial industry-education collaboration, making it difficult to meet the urgent needs of small and

medium-sized enterprises (SMEs) for “plug-and-play” composite talent. To address these gaps, local universities must reform by restructuring curricula, innovating practical teaching models, strengthening faculty development, and improving industry-education collaboration mechanisms. Only by aligning education chains, talent chains, and industrial chains with regional industrial realities can they cultivate high-quality applied talent suited to the intelligent era^[1].

2. New demands on talent cultivation at local universities driven by industrial needs in the big data and AI era

2.1. Shifts in industrial demands for emerging engineering disciplines

The rapid proliferation of big data and AI has blurred traditional disciplinary boundaries in engineering, rendering single-technical expertise inadequate for industry development. Traditional fields like mechanical engineering, electronics, and materials science now require deep integration with data and algorithms, making interdisciplinary competencies essential. Technologies such as machine learning, industrial IoT, and digital twins are no longer elective but foundational tools for engineering students. Employers increasingly prioritize graduates with real-world project experience capable of directly engaging in tasks like intelligent production line management, data analysis, and system debugging.

2.2. Shifts in industrial demands for emerging business disciplines

Modern business operations have transitioned from experience-driven to data-driven models, with big data playing a pivotal role in precision marketing, supply chain optimization and risk management. Business professionals must now master not only domain knowledge but also the application logic of AI tools, enabling collaboration with intelligent systems. Emerging roles in fintech, digital operations, and intelligent finance demand composite talent proficient in both business fundamentals and data technologies, with cross-disciplinary resource integration capabilities. A pure business background is no longer sufficient to meet industry requirements.

2.3. Unique pressures faced by local universities

Local universities primarily serve regional industries dominated by SMEs, which exhibit varying digitalization levels but share urgent transformation needs. Unlike elite institutions, most graduates from local universities remain in their home regions for employment, prompting enterprises to demand “plug-and-play” talent with immediate practical skills. This reality places greater pressure on local universities to align curricula, practical teaching, and industry partnerships with market demands^[2].

3. Practical challenges in aligning emerging engineering and business disciplines with regional industries at local universities

3.1. Curricula lagging behind technological evolution

Current curricula at local universities fail to keep pace with rapid industrial technological advancements. Engineering programs still prioritize classical theories, with inadequate or superficial coverage of cutting-edge topics like data science and AI algorithms, leaving students ill-equipped with core skills. In business disciplines, traditional courses such as marketing and accounting dominate, while industry-relevant subjects like business analytics, data mining, and Python applications lack systematic design, resulting in knowledge structures misaligned with market needs. A common issue across disciplines is the disconnect between course content and enterprise toolchains; tools like Spark, Tableau, and AutoML were widely used in industry, but were rarely taught, forcing graduates to relearn skills on the job^[3].

3.2. Virtualized and repetitive practical teaching

Practical teaching suffers from virtualization and low-level repetition. Most laboratory projects remain verification- or

simulation-based, using simplified virtual scenarios lacking real industrial data and complex challenges, thus failing to develop problem-solving abilities. Industry-university collaborations often rest on surface-level activities like corporate visits or guest lectures, lacking substantive cooperation in curriculum co-development, joint research projects, or internship rotations. Limited funding and resources further hinder practical teaching quality, as outdated laboratory equipment and insufficient access to AI computing power or professional data platforms restrict the cultivation of operationally skilled talent.

3.3. Dual shortcomings in faculty engineering practice and data literacy

Faculty at local universities generally lack both engineering practice experience and data competencies. Many educators follow a “school-to-school” career path without exposure to frontline industry projects, making it difficult to guide students through AI/data-driven real-world challenges^[4]. Engineering faculty may possess technical expertise but lack familiarity with industrial contexts, while business faculty understand operational logic but struggle with data tools and analytics. Furthermore, insufficient institutional incentives and funding discourage faculty from engaging in industry practice or upgrading their professional skills.

3.4. Loose industry-education integration mechanisms and imbalanced benefit distribution

Current industry-education collaborations often remain superficial, characterized by loose mechanisms and unequal benefit sharing. Enterprises hesitate to engage deeply due to high internship costs, management risks, and unclear intellectual property boundaries. Local universities, lacking the capacity to solve industrial technical problems, struggle to attract long-term investments from leading firms. The absence of regional platforms for matching industry needs with educational resources further exacerbates misalignment between talent development and evolving job requirements, diminishing collaboration outcomes.

4. Practice transformation path guided by industry adaptation

4.1. Transition of the curriculum system: From “knowledge logic” to “competency logic + dynamic technological updates”

4.1.1. Design of new engineering curriculum modules

New engineering curricula should break away from traditional knowledge frameworks and reconstruct three-tier modules centered around competency logic. The foundational layer retains mathematics, physics, and programming courses while strengthening training in data processing and algorithmic thinking to solidify fundamental digital competencies. The core layer introduces compulsory courses such as machine learning, industrial data analysis, intelligent control, and the Internet of Things (IoT), enabling students to understand key technologies at the intersection of AI and industry. The extension layer collaborates with local leading industries to offer micro-specializations aligned with real-world directions like new energy and intelligent equipment, enhancing employability alignment.

4.1.2. Design of new business curriculum modules

New business curricula are structured around data, operations, and scenarios. The data literacy layer emphasizes advanced Excel analysis, SQL, data visualization, and Python fundamentals, increasing the application of digital tools. The business-plus-AI layer integrates content such as marketing analytics, risk control models, digital supply chains, and robotic process automation (RPA), achieving a close integration of business and intelligent technologies. The industry scenario layer leverages real anonymized data from local enterprises to build a case library, ensuring learning is closely aligned with practical applications.

4.1.3. Dynamic update mechanism

To keep curricula abreast of technological advancements, a regular update system should be established. A curriculum

committee comprising both university and enterprise representatives should be formed to review content quarterly, removing outdated knowledge and incorporating cutting-edge technologies. Additionally, credit substitution and micro-credential certification should be implemented to encourage students to take high-quality online courses across disciplines and institutions, fostering interdisciplinary learning and rapid skill updates to synchronize training with industry demands^[5].

4.2. Transformation of practical teaching models: From “simulated verification” to “real project-driven”

4.2.1. Deep integration of project-based learning (PBL)

Practical teaching should shift entirely from simulated verification to real project-driven learning. Engineering programs can directly collaborate with local small and medium-sized enterprises (SMEs), transforming practical technical challenges such as production line data collection, equipment fault identification, and predictive maintenance into course or graduation projects, enhancing students’ engineering capabilities through real-world problem-solving. Business programs can focus on tasks like market research, user profiling, sales forecasting, and operational optimization, producing actionable analytical reports for enterprises and ensuring practical applicability of learning.

4.2.2. Integration of virtual simulation with real data

Combining virtual simulation platforms with real industrial data creates efficient practical scenarios. Data experiment workshops can be established using open-source data from platforms like Kaggle and Tianchi, as well as anonymized enterprise data, providing students with high-quality training materials. Engineering programs can use digital twin platforms to simulate complex scenarios such as intelligent production lines and manufacturing processes, while business programs can employ digital sandboxes to model supply chain scheduling, financial decision-making, and marketing campaigns, achieving a high degree of alignment between virtual training and real business logic.

4.2.3. Innovation in university-enterprise collaborative education models

Deepening university-enterprise collaboration can be achieved through diverse approaches, such as establishing industry colleges with leading regional enterprises and jointly determining training programs. Segmented training models like “3 + 1” or “2 + 2” can be adopted to ensure seamless integration between campus learning and enterprise practice. Implementing enterprise micro-project bidding mechanisms, where engineers and university faculty serve as dual mentors, enhances the practicality of projects. Upgrading traditional internships to rotational on-the-job training lasting 2–4 weeks per position and incorporating it into compulsory credits significantly improves students’ job adaptability.

4.3. Reshaping faculty capabilities: Building a “dual-qualified and dual-competent” team

4.3.1. Integrating industry into education

Enhancing faculty practical capabilities hinges on integrating industry expertise. Schools can create positions such as part-time enterprise professors and industry mentors, with seasoned industry professionals undertaking practical course teaching, graduation project guidance, and special lectures, bringing real projects, technical standards, and workflows directly into the classroom. Regularly inviting enterprise algorithm engineers, operations experts, and data engineers to teach on campus, in collaboration with university faculty, ensures teaching content aligns with real enterprise needs, achieving seamless integration between classroom and industry^[6].

4.3.2. Institutionalizing faculty enterprise practice

To encourage faculty to engage with industry, enterprise practice must be institutionalized and mandatory. For example, young engineering and business faculty could be required to accumulate at least six months of enterprise internship experience every three years, directly linking this requirement to tenure review, job appointments, and performance

evaluations. Faculty should also be encouraged to actively collaborate with enterprises on horizontal research projects, participating in technical problem-solving, data analysis, and solution design, with project outcomes, technical services, and patent cases allowed to offset teaching workloads, motivating faculty to engage in enterprise projects.

4.3.3. School-based training and community building

Addressing gaps in faculty data literacy and AI application capabilities requires ongoing school-based specialized training. Regular workshops on “AI + Teaching” can focus on practical skills such as large model tool usage, data analysis software operation, and data visualization, assisting faculty in innovating teaching methods and knowledge systems. Establishing interdisciplinary teaching and research communities comprising engineering, business, and data science faculty can facilitate the joint development of real-world cases, project-based curricula, and improved teaching content based on regional industry needs, achieving capability complementarity and overall quality enhancement through collaboration.

4.4. Innovation in industry-education integration mechanisms: From “point-based cooperation” to “ecosystem co-construction”

4.4.1. Establishing a regional industry-education information platform

To overcome fragmented industry-education integration and achieve precise and efficient collaboration, a regional industry-education information platform led by the government and deeply involving universities and industrial parks is crucial. The platform’s core is a dynamically updated talent supply and demand database, which aggregates real-time core enterprise needs such as job vacancies, skill requirements, and recruitment plans on one side and synchronously records student capability profiles, university curricula, and training rhythms on the other. By regularly generating reports on skill demand trends and curriculum-job alignment assessments, universities can clearly identify adjustments in talent cultivation, while enterprises can precisely connect with suitable talent, fundamentally addressing information asymmetry between universities and enterprises and achieving a virtuous cycle of demand-based talent cultivation and precise employment.

4.4.2. Establishing a benefit-sharing mechanism

The enthusiasm of enterprises for industry-education integration stems from building a sustainable benefit-sharing ecosystem. When enterprises contribute real project cases, anonymized business data, or deeply participate in curriculum design, they should receive corresponding benefits in return, not only gaining priority access to graduates meeting job requirements but also enjoying customized talent delivery services from universities and relying on university faculty and resources for in-service employee skill enhancement training. Simultaneously, universities and enterprises can jointly apply for government industry-education integration special projects, competing for policy supports such as tax incentives and special subsidies to maximize cooperation benefits. This mutually beneficial model transforms enterprises from passive collaborators to active investors, providing long-term development momentum for industry-education integration.

4.4.3. Co-constructing industry technology research institutes or joint laboratories

Focusing on local leading industries and characteristic economies, such as intelligent manufacturing, agricultural product e-commerce, and regional cultural tourism digitalization, universities and enterprises can co-construct industry technology research institutes and joint laboratories to conduct practical applied technology research and problem-solving. Students can participate as assistant researchers in project R&D, data processing, and solution implementation, enhancing their professional capabilities in real research scenarios. This model integrates teaching, research, and industry services, forming a closed loop of “learning-research-practice-employment”, continuously supplying high-quality applied talent to local industries.

5. Conclusion

The in-depth application of big data and artificial intelligence presents new opportunities and challenges for the transformation and development of local universities. The construction of new engineering and new business programs can only truly achieve synchronization between talent cultivation and market demands by closely aligning with regional industrial structures and closely monitoring technological iteration trends. Facing real-world challenges such as outdated curricula, weak practical training, insufficient faculty, and separated industry-education integration, it is essential to adhere to industry adaptation as the core and drive comprehensive changes in educational philosophy, curriculum systems, practical models, and faculty structures. By constructing dynamically updated curriculum modules, implementing real project-driven practical teaching, building a dual-qualified and dual-competent faculty team, and establishing a regionalized industry-education integration ecosystem, barriers between universities and industries can be effectively bridged.

Disclosure statement

The author declares no conflict of interest.

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