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Enhancing the Practical Competence of Undergraduates in Big Data Majors at Local Application-Oriented Colleges and Universities through Competition-Based Learning: A Case Study of the *CP Group Market Survey and Analysis Competition*

Chengqiang Wang[1,a,*], Jianmin Gao[1,2]

[1]*School of Mathematics and Physics, Suqian University, Suqian, 223800, China*
[2]*School of Mathematics and Statistics, Qinghai Normal University, Xining, 810008, China*
[a]*chengqiangwang2022@foxmail.com*
**Corresponding author*

Abstract: *We examine here how refined competition-based learning approaches enhance the practical competence of Big Data undergraduates in local application-oriented universities. To address persistent challenges such as fragmented interdisciplinary skill acquisition, insufficient experiential learning, and limited exposure to real industry contexts, the study draws on teaching practice records, instructor reflections, expert consultations, and documentation from multiple iterations of the CP Group Market Survey and Analysis Competition. Using factor analysis, eleven instructional strategies are consolidated into three essential dimensions: Curriculum and competition integration, authentic industry practice orientation, and collaborative support mechanisms for talent cultivation. The findings show that competition-based learning significantly strengthens students' applied data analysis abilities, promotes interdisciplinary problem-solving, and improves the alignment between academic training and industry expectations. This offers a framework for implementing competition-driven pedagogical strategies and provides practical guidance for enhancing the development of practice-oriented Big Data professionals in local higher education institutions.*

Keywords: *Competition-based learning; Practical competence; Big data undergraduates; Application-oriented universities*

1. Introduction

In recent years, the Big Data major has developed rapidly worldwide, driven by advances in artificial intelligence, cloud computing, and large-scale data analytics. For instance, an increasing number of local application-oriented colleges and universities have established Big Data majors in recent years to meet rising industry demand. However, these institutions often encounter significant challenges in preparing students to become industry-ready professionals, particularly due to limited practical training resources and the rapid evolution of data-related technologies. In response to these difficulties, educators and researchers have proposed a range of strategies aimed at strengthening students' practical and application-oriented abilities. Among these approaches, competition-based learning has proven especially effective, as it provides authentic, scenario-driven tasks that enhance technical proficiency, teamwork, and problem-solving skills. Through competitions, *CP Group Market Survey and Analysis Competition*, for example, students engage in hands-on data collection, modeling, and analysis, thus bridging the gap between theory and practice. Against this backdrop, this paper uses the *CP Group Market Survey and Analysis Competition* as a case study to examine how competition-driven training can effectively enhance the practical competence of undergraduates in Big Data majors at local application-oriented institutions.

The concept of "promoting teaching and learning through competitions" has become an influential pedagogical strategy in higher education, particularly in disciplines that emphasize data analysis, statistics, and applied technological skills. Early studies, such as Chen (2019)[1] and Liu (2017)[2],

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highlight that integrating competitions into teaching can enhance students' learning motivation, deepen their comprehension of abstract concepts, and promote sustained engagement with course content. Later research by Hou and Jiang (2017)[3] and Xie et al. (2020)[4] further demonstrates that discipline-based competitions provide authentic, practice-oriented contexts in which students can apply statistical methods, conduct market research, and develop analytical competencies beyond what traditional classroom instruction typically affords. Together, this body of literature underscores competition-based learning as a valuable approach for improving instructional effectiveness and strengthening students' practical abilities in data-related fields.

A substantial subset of the literature is devoted specifically to competitions related to CP Group Market Survey and Analysis Competition. Liu (2017)[2], Wang (2020)[5], and Bai and Zhang (2024)[6] provide detailed analyses of the organizational structure, management issues, and pedagogical value of these competitions, demonstrating how participation helps cultivate teamwork, communication, and research design skills. Studies by Ke and Jiang (2020)[7], Song and Liu (2021)[8], and Liu et al. (2023)[9] examine how course instruction in market research or statistics can be aligned with such competitions to build students' abilities in questionnaire design, sampling strategies, and empirical data processing. Meanwhile, analyses by Tang et al. (2024)[10] and Long (2022)[11] further underscore that such competitions can effectively replicate the complexity of real-world data environments, requiring students to work with authentic datasets, navigate uncertain market conditions, and make evidence-based decisions under practical constraints.

Many scholars have further examined how competitions can be integrated into curriculum reform, particularly in the context of big data and ongoing digital transformation. Zhou and Yu (2025)[12], Liu and Xie (2024)[13], and Feng and Liang (2021)[14] argue that competition-driven teaching models help cultivate applied data analysis capabilities and mitigate the long-standing gap between theoretical instruction and industry expectations. Research by Liu et al. (2023)[9], Huang (2023)[15], and Long (2022)[11] provides additional support, suggesting that competition-based pedagogies stimulate innovation in course design by incorporating practical projects, collaborative tasks, and interdisciplinary skill development. Earlier work by Tang et al. (2024)[10], Hou and Jiang (2017)[3], and Lü and Liu (2019)[16] similarly indicates that competitions, when systematically integrated with formal coursework, can enhance students' computational literacy, critical thinking, and job-oriented competencies, particularly within data science, statistics, and business analytics programs.

Although the existing literature provides valuable insights into competition-based teaching models, several gaps remain. Most studies emphasize general instructional reform but pay less attention to the systematic development of practical competence among undergraduates majoring in Big Data, especially within local application-oriented colleges and universities, where students often require more focused, hands-on training. Furthermore, while research on the *CP Group Market Survey and Analysis Competition* offers useful case examples, it has not yet examined how this competition can serve as a structured framework for strengthening applied data skills across different stages of instruction. Building upon prior studies, the present research employs the *CP Group Market Survey and Analysis Competition* as a case study to explore how competition-based learning can more effectively support the cultivation of practical competence in Big Data undergraduates. The study aims to develop a feasible teaching model tailored to the needs of application-oriented institutions and to provide evidence-based recommendations for improving talent training quality in the era of big data.

2. Limitations of existing learning methods on practical skills development in Big Data majors

2.1. Insufficient practical engagement in skill development

Many local application-oriented colleges prioritize theoretical instruction, covering algorithms, statistical models, and programming fundamentals, while offering limited opportunities for students to apply these concepts in real-world contexts. As a result, current Big Data education exhibits an insufficient emphasis on experiential learning. Practical engagement is often restricted to simplified assignments or pre-structured exercises, offering little scope for independent problem-solving. This lack of hands-on practice reduces students' exposure to complex, unstructured, or incomplete datasets, which are prevalent in professional environments. Graduates often demonstrate solid theoretical understanding but insufficient applied skills and professional confidence to address complex, real-world data challenges, underscoring the necessity of incorporating authentic, project-based, and competition-driven learning approaches to strengthen practical competence.

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2.2. Fragmented integration of interdisciplinary skills

The fragmented integration of interdisciplinary skills represents a prominent challenge in Big Data education. Although effective practice necessitates the concurrent application of programming, statistical analysis, data visualization, and domain-specific knowledge, many curricula continue to deliver these competencies in a compartmentalized manner. Such separation impedes students' ability to cultivate a coherent, integrative approach to problem-solving, thereby limiting their capacity to manage complex, real-world tasks that require the simultaneous deployment of multiple skill sets. Consequently, students often encounter difficulties in projects demanding cross-disciplinary reasoning, coordination, and critical decision-making. This structural fragmentation diminishes their preparedness for professional environments and constrains the development of fully realized practical competence in Big Data-related disciplines.

2.3. Limited exposure to authentic industry scenarios

Limited exposure to authentic industry scenarios constitutes a significant constraint in Big Data education. Traditional curricula often rely on simplified datasets, controlled exercises, or textbook examples that fail to capture the complexity, scale, and uncertainty of real-world data environments. Students have few opportunities to experience the practical challenges inherent in professional data analysis, such as handling incomplete or messy datasets, designing effective surveys, or making timely, evidence-based decisions. This lack of authentic engagement restricts the development of higher-order analytical thinking, problem-solving, and professional judgment. Consequently, graduates may possess strong theoretical knowledge yet remain insufficiently prepared to navigate the multifaceted, dynamic contexts characteristic of contemporary Big Data-driven industries.

3. Strategies for enhancing the practical competence of undergraduates in big data majors at local application-oriented colleges and universities through competition-based learning

3.1. Strategies for enhancing practical competence through competition-based learning

In this section, drawing upon our teaching experience, our guidance of undergraduate students participating in the *CP Group Market Survey and Analysis Competition*, and insights obtained through consultations with multiple experts, we identify several strategies for enhancing the practical competence of Big Data majors at local application-oriented colleges and universities. These strategies include competition-integrated curriculum alignment, tiered difficulty design for skills progression, project-based learning embedded in competitions, industry-driven competition topic selection, interdisciplinary team formation mechanisms, mentor-student dual-guidance model, competition-oriented laboratory and platform support, simulation of realistic data application scenarios, assessment systems linked to competition performance, post-competition reflection and knowledge consolidation, and long-term competition training and talent pipelines; see Figure 1.

3.2. Strategies and their brief explanations

In this subsection, we present eleven interconnected pedagogical strategies: curriculum alignment, tiered task design, project-based learning, industry-driven topics, interdisciplinary teamwork, dual mentoring, dedicated platform support, scenario simulation, competition-linked assessment, post-competition reflection, and long-term talent pipelines. These strategies collectively form a comprehensive framework for embedding data competitions into data science education (see also Figure 1 for a schematic overview).

Competition-integrated curriculum alignment. This strategy aligns course content with the skills and knowledge required in major data competitions. By linking theoretical instruction to competition-relevant tasks, students develop a clearer pathway from foundational learning to applied analytical work, improving the coherence of their skill development.

Tiered difficulty design for skills progression. Tasks are organized from basic to advanced levels, allowing students to gradually strengthen technical and analytical capabilities. This structured progression supports steady competence building and reduces the cognitive burden associated with confronting complex problems prematurely.

Project-based learning embedded in competitions. Competitions are treated as extended projects

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that require end-to-end data workflows. Students engage in problem definition, preprocessing, modeling, and reporting, which helps them understand complete analytical processes and enhances practical problem-solving.

Industry-driven competition topic selection. Competition themes are designed around real industry issues, exposing students to authentic data contexts and current application domains. This alignment enhances their awareness of sector-specific constraints and deepens their understanding of the practical relevance of analytical tasks.

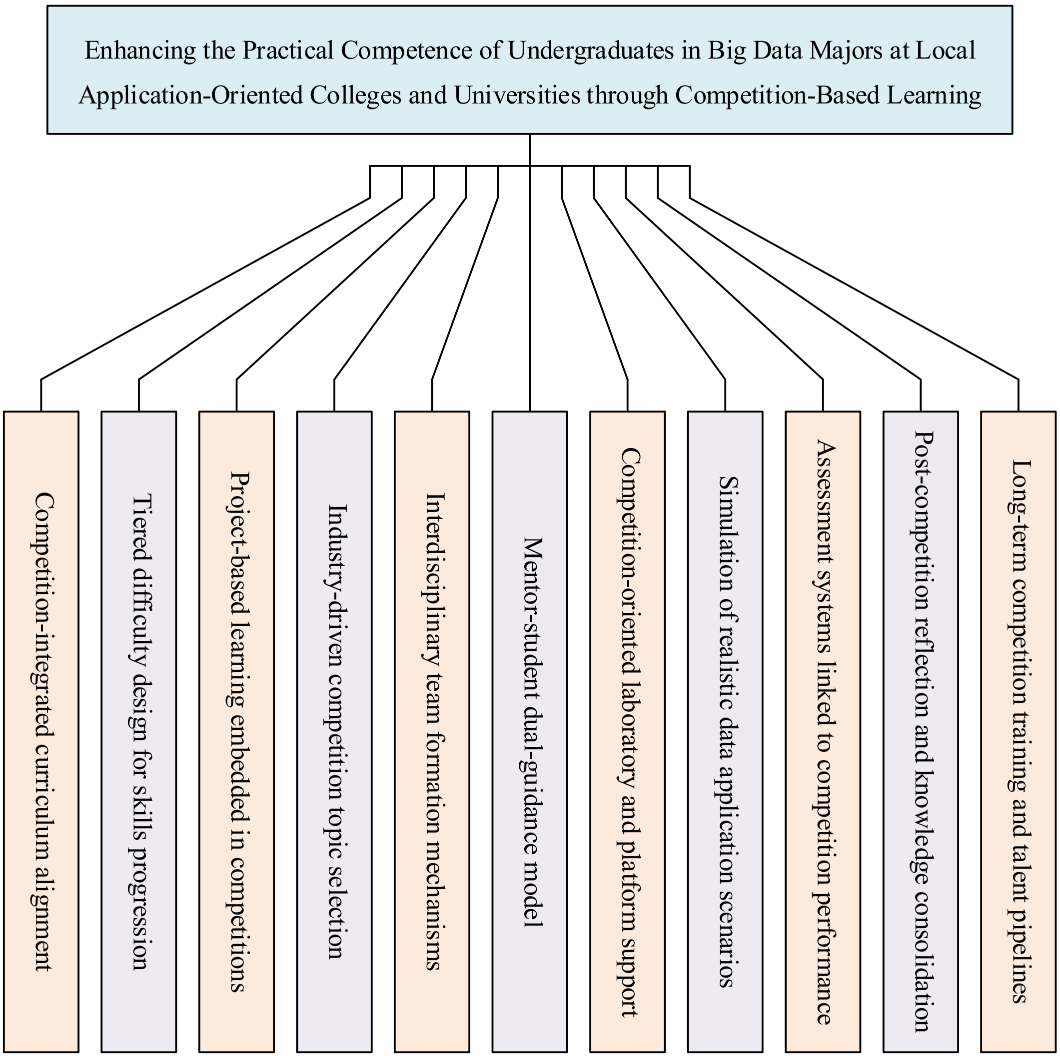

Figure 1: Strategies for enhancing practical competence through competition-based learning

Interdisciplinary team formation mechanisms. Teams combine students from different academic backgrounds, encouraging the integration of complementary expertise. This enhances collaborative reasoning and helps students recognize the multifaceted nature of real data problems.

Mentor-student dual-guidance model. Students receive guidance from both academic instructors and industry practitioners. This model blends theoretical rigor with applied insight, supporting more informed analytical decisions and improving methodological accuracy.

Competition-oriented laboratory and platform support. Dedicated laboratories and computational platforms supply essential software, hardware, and datasets, enabling students to conduct advanced analytical tasks. These resources create learning conditions that closely resemble real data environments, thereby supporting the development of applied technical competence.

Simulation of realistic data application scenarios. Training incorporates datasets and constraints resembling actual industry settings. Students learn to handle incomplete information, time pressure, and ambiguous tasks, improving their capacity to operate in realistic conditions.

Assessment systems linked to competition performance. Evaluation criteria incorporate

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indicators from competition participation, such as accuracy, coding quality, teamwork, and reporting. This ensures that practical competence is fully reflected in academic assessment.

Post-competition reflection and knowledge consolidation. Students engage in structured reflection on their analytical choices, solution quality, and team coordination. This process deepens conceptual understanding and strengthens long-term learning retention.

Long-term competition training and talent pipelines. Continuous training programs, and mentor groups support sustained skill development. Long-term participation nurtures consistent improvement and builds a solid foundation for advanced professional competence.

4. An empirical study

To support the development of these strategies, we collected data through teaching practice records, structured reflections from instructors guiding student teams, and detailed documentation produced across multiple iterations of the *CP Group Market Survey and Analysis Competition*. In addition, we conducted semi-structured interviews with competition judges, industry practitioners, and experienced educators to obtain expert insights into effective training mechanisms and common challenges encountered by Big Data undergraduates. Supplementary evidence was drawn from student project reports, performance evaluations, and post-competition summaries, providing a comprehensive understanding of learning outcomes and instructional needs within local application-oriented institutions. Prior to analysis, all data underwent necessary preprocessing procedures, including normalization, to ensure suitability for direct application in factor analysis.

We first conducted the Kaiser-Meyer-Olkin(KMO) test and Bartlett's test of sphericity on the aforementioned data to evaluate its suitability for factor analysis (see Table 1).

Table 1: The KMO test and Bartlett's test.

KMO statistic	0.9637	
Bartlett's statistic	χ^2	317
	df	110
	p-value	0.0047

The computed results demonstrated that both the Kaiser Meyer Olkin (KMO) measure and Bartlett's test of sphericity satisfied the commonly accepted criteria for conducting factor analysis, indicating that the collected teaching data possessed sufficient adequacy and statistical validity for subsequent analysis. These findings confirmed not only that the sample was appropriate for factor extraction, but also that significant intercorrelations existed among the observed variables, thereby fulfilling the essential prerequisites for identifying meaningful latent constructs. On this basis, an exploratory factor analysis was carried out to investigate the underlying dimensions associated with strategies for improving the practical competence of Big Data undergraduates in local application oriented colleges and universities through competition based learning. During the analytical procedure, three principal factors were established, namely Curriculum instruction integration, Authentic industry practice orientation, and Collaborative support and talent development mechanisms. These dimensions were determined according to clusters of closely related variables derived from teaching practice, expert consultation, and records of competition based educational activities.

To improve the interpretability of the factor structure and to ensure that the contribution of each variable to the corresponding factors could be clearly distinguished, an orthogonal rotation method was employed in the analysis of factor loadings. This rotation approach maximized the variance of squared loadings within individual factors while simultaneously reducing the occurrence of cross loadings among factors. The rotated results provided a more explicit representation of the relationships between variables and their associated dimensions, thereby emphasizing the relative significance of instructional integration, industry oriented practice, and collaborative support mechanisms in the cultivation of practical competencies. Furthermore, the scree plot presented in Figure 2 illustrated the eigenvalue distribution of the extracted factors and verified that the three factor model constituted the most concise and appropriate representation of the dataset. The rotated factor loadings reported in Table 2 further demonstrated the magnitude and direction of the relationships between observed variables and the identified factors, offering a solid empirical basis for the interpretation and implementation of competition based learning strategies in Big Data education; see Figures 1 and 3.

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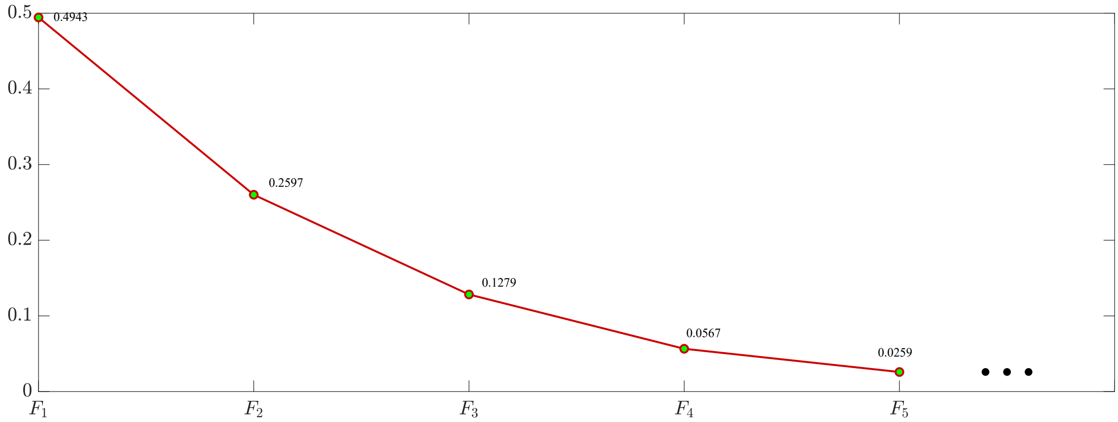

Figure 2: Scree plot during factor analysis.

Table 2: Factors and the rotated factor loadings.

Variables	The rotated factor loadings		
	Factor F_1	Factor F_2	Factor F_3
Competition-integrated curriculum alignment	0.8624	0.2157	0.2013
Tiered difficulty design for skills progression	0.8237	0.1984	−0.1875
Project-based learning embedded in competitions	0.8879	0.2341	0.2198
Industry-driven competition topic selection	0.2146	0.8326	0.2541
Interdisciplinary team formation mechanisms	−0.1983	−0.1003	0.8127
Mentor-student dual-guidance model	0.2417	0.2187	0.7893
Competition-oriented laboratory and platform support	0.1752	0.7912	0.2314
Simulation of realistic data application scenarios	0.2214	0.8265	0.2465
Assessment systems linked to competition performance	0.7921	0.1879	0.2037
Post-competition reflection and knowledge consolidation	0.2675	0.2413	0.8432
Long-term competition training and talent pipelines	0.2539	0.2538	0.7716

Factor analysis conducted on the collected teaching and competition-related data offers valuable insights into the key dimensions of strategies aimed at enhancing the practical competence of Big Data undergraduates in local application-oriented colleges and universities. KMO measure of sampling adequacy, calculated as 0.9637, alongside the statistically significant Bartlett's test of sphericity (χ^2 = 317, *df* = 110, *p* = 0.0047), indicates that the dataset is both statistically appropriate and sufficiently robust for factor analysis. These preliminary assessments demonstrate that the variables exhibit substantial inter-correlations and that the sample size is adequate for extracting reliable latent factors. Consequently, the results provide a solid empirical foundation and validate the suitability of the dataset for exploring the underlying factor structure, thereby supporting the subsequent identification and interpretation of the key strategic dimensions.

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The exploratory factor analysis identified three principal factors, which were subsequently rotated using an orthogonal method to enhance interpretability and minimize cross-loadings. The rotated factor loadings, presented in Table 2, reveal a clear and theoretically coherent structure among the variables. Factor 1, labeled Curriculum-instruction integration, demonstrates strong loadings on variables directly associated with instructional design and assessment, including competition-integrated curriculum alignment (0.8624), tiered difficulty design for skills progression (0.8237), project-based learning embedded in competitions (0.8879), and assessment systems linked to competition performance (0.7921). These results highlight that the alignment of curriculum content with competition tasks, the structured progression of skill development, and the integration of performance-based evaluation collectively form a coherent dimension, emphasizing the centrality of structured, instructionally integrated approaches in developing practical competence.

Factor 2, designated as Authentic industry-practice orientation, predominantly captures variables associated with real-world applications and alignment with industry demands. The factor exhibits high loadings on industry-driven competition topic selection (0.8326), competition-oriented laboratory and platform support (0.7912), and simulation of realistic data application scenarios (0.8265), indicating that this dimension reflects the provision of authentic, practice-oriented learning experiences. The prominence of these variables suggests that integrating industry-relevant tasks and realistic data environments into competition-based learning constitutes a distinct and essential component of practical skills development. By situating students in contexts that closely mirror professional settings, this factor emphasizes the cultivation of applied analytical competencies, technical proficiency, and problem-solving abilities. Overall, it highlights the critical role of connecting educational activities to industry practices in preparing Big Data undergraduates for the demands of real-world professional environments.

Factor 3, designated as Collaborative support and talent development mechanisms, encompasses strategies that promote teamwork, mentorship, and sustained skill development among Big Data undergraduates. Key variables loading strongly on this factor include interdisciplinary team formation mechanisms (0.8127), mentor-student dual-guidance model (0.7893), post-competition reflection and knowledge consolidation (0.8432), and long-term competition training and talent pipelines (0.7716). These loadings indicate that structured collaborative frameworks, guided mentorship, and systematic opportunities for reflection and ongoing engagement constitute a distinct dimension of practical competence cultivation. The results underscore the importance of fostering an environment in which students can develop technical, analytical, and interpersonal skills collaboratively while maintaining continuity through successive competitions and learning stages. This factor highlights the role of sustained support mechanisms in shaping professional readiness and cultivating a talent pipeline responsive to industry demands.

Examination of the rotated factor loadings shows that each observed variable correlates strongly with its intended factor and demonstrates only weak cross loadings on other factors. These findings confirm the distinctiveness, stability, and conceptual consistency of the extracted dimensions. The empirical evidence further suggests that strategies for enhancing practical competence through competition-based learning in Big Data education can be systematically classified into three interrelated but analytically separable domains. The first domain, curriculum instruction integration, stresses the alignment of instructional content, curriculum structure, teaching approaches, and assessment methods with clearly defined educational objectives and learning outcomes. This domain ensures that what is taught in the classroom directly supports the competencies required in competitive data analysis tasks. The second domain, authentic industry practice orientation, focuses on providing realistic, industry-relevant, and practice-centered learning experiences that help students bridge theoretical understanding with practical applications and professional expectations encountered in real-world settings. The third domain, collaborative support and talent development mechanisms, highlights the importance of mentorship, teamwork, institutional collaboration, and the sustained cultivation of professional skills throughout the educational and training process. These three domains form an integrated framework that guides the design of competition-based learning interventions.

Taken together, these three dimensions establish a comprehensive and reliable framework for designing targeted instructional strategies and educational interventions. Such a framework allows educators to implement organized, competition-driven learning models that effectively improve undergraduates' applied abilities. Students benefit from enhanced professional readiness, stronger practical competence, greater innovation capacity, and better overall performance. These improvements are particularly achievable within educational environments that are data-oriented, technology-driven, and practice-focused, where competition-based learning can be most authentically embedded.

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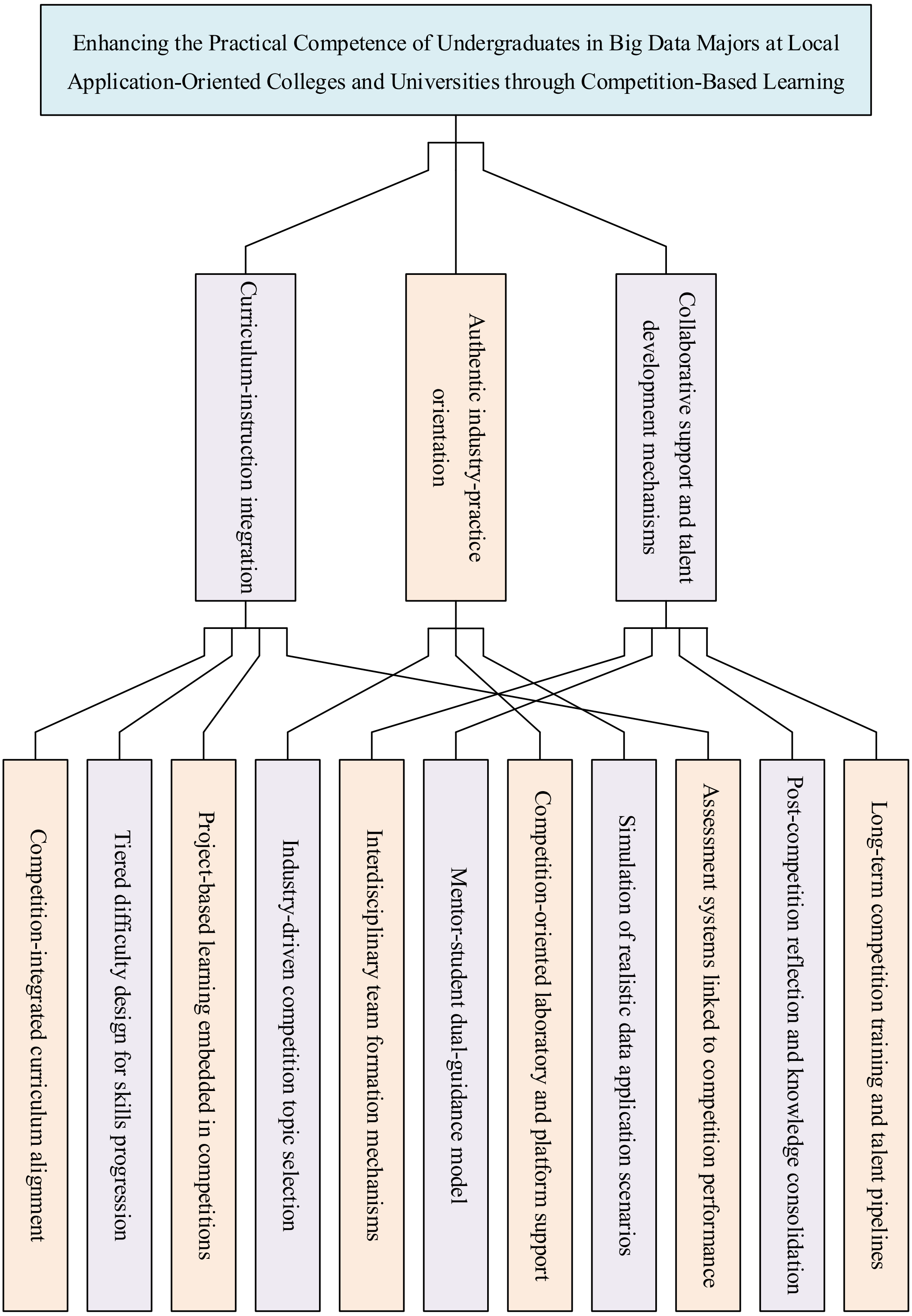

Figure 3: Strategies for enhancing practical competence through competition-based learning and their principal factors

5. Conclusions

This study systematically examined the limitations of existing learning approaches in Big Data majors at local application-oriented colleges and universities and demonstrated how competition-based learning can serve as an effective mechanism for enhancing students' practical competence. By integrating teaching practice records, expert consultations, and competition documentation, we

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identified eleven targeted strategies that address deficiencies in experiential learning, interdisciplinary integration, and exposure to authentic application scenarios. Through rigorous factor analysis, these strategies were empirically shown to cluster into three principal dimensions: curriculum-instruction integration, authentic industry-practice orientation, and collaborative support and talent development mechanisms. Together, these factors reveal the structural foundations through which competition-based learning strengthens students' applied skills, analytical abilities, and readiness for complex professional environments.

The findings provide both theoretical and practical implications for the design of Big Data education in local universities. Theoretically, the three-factor framework contributes to the literature by clarifying the core components required for a systematic approach to competition-based talent cultivation. Practically, the results offer actionable guidance for institutions seeking to reform Big Data curricula, establish competition-driven teaching ecosystems, and develop sustainable talent pipelines aligned with industry needs. As data-driven industries continue to evolve, cultivating undergraduates with strong practical competence becomes increasingly essential. This study demonstrates that competition-based learning, when integrated into instruction and supported by authentic practice environments and collaborative mechanisms, can significantly enhance students' professional capabilities. Future research may further refine these strategies across broader institutional contexts and explore their long-term impact on graduates' career development.

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