

Construction and Practice of an Organization and Management Model for Discipline Competitions at a Local University in Western China

Shenglong Xie¹, Xiaoyan Li^{2*}, Xinjie Zhu¹, Zhiyuan Gao³

¹College of Mathematics and Computer Science, Yan'an University, Yan'an 716000, Shaanxi, China

²Network Information Center, Yan'an University, Yan'an 716000, Shaanxi, China

³Educational Training Institute, Yan'an University, Yan'an 716000, Shaanxi, China

**Author to whom correspondence should be addressed.*

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Abstract: Discipline competitions are of great significance in cultivating innovative talents in Chinese higher education, but local universities still face persistent challenges such as low student participation, insufficient teacher motivation, and limited achievement transformation. This study draws on the theory of Outcome-Based Education (OBE) and collaborative innovation to construct and pilot a systematic discipline competition organization and management model for Yan'an University, a typical local university in western China. This model includes three implementation paths - mechanism optimization, capacity building, and technological empowerment, as well as four core elements covering mechanisms, capability, technology, and ecosystems. The main mechanisms include a dual incentive system, a university-enterprise collaborative resource pool, and a competition-teaching-research-industry integration ecosystem. After the implementation of this model within 24 months, the number of student participants increased by 20%, the award performance increased by 4.8%, teacher participation increased significantly, and it received generally positive feedback from stakeholders. This study provides a potentially transferable framework for local universities to enhance the educational function of discipline competitions and deepen the integration of industry-academia-research.

Keywords: Discipline competitions; Organization and management model; Local universities; Talent cultivation; Educational reform

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1. Introduction

1.1. Research background

Under the promotion of the national “mass entrepreneurship and innovation” strategy, discipline competitions have become an important way for China’s higher education to cultivate innovative talents. Competitions such as the China University Mathematics Modeling Competition (CUMCM), the “Huawei Cup” China Graduate Mathematics Modeling Competition, the “Lanqiao Cup” National Software and Information Technology Professional Talent Competition, and the China University Students’ Mathematics Competition (CMC) not only provide important platforms for evaluating students’ ability to apply theoretical knowledge to practical problems, but also promote the reform of curriculum and teaching modes ^[1]. The scale of these competitions has significantly expanded - since its establishment in 1992, the CUMCM has now become the largest mathematical modeling competition in the world ^[2], attracting 5390 teams from 85 universities to participate in the Shaanxi Province competition alone in 2025 ^[3]. However, there is still a significant gap between local undergraduate universities and top research universities in terms of participation, performance level, and achievement transformation, and many local universities find it difficult to achieve effective participation.

1.2. Problem statement

Local universities face four interrelated challenges when organizing discipline competitions ^[4], as summarized in **Table 1**. Firstly, student participation is still low: about 80% of students are aware of competitions, but only 30% are willing to participate, and 50% believe that these competitions are difficult to achieve - this gap reflects insufficient basic training and a lack of inclusive preparation systems ^{[5][6]}. Secondly, the degree of curriculum integration is weak, and preparatory activities conducted in a sprint style are often separated from regular courses and do not count towards credits ^[7]thereby limiting the educational value of competitions. Thirdly, the ability of the teaching staff is limited by insufficient guidance experience in emerging fields and a lack of performance incentive mechanisms for competition coaching ^[8]. Fourthly, the transformation effect of achievements is limited. Due to scattered support after the competition and weak industrial cooperation channels, most projects only remain in the award stage ^[9]. These issues belong to structural problems rather than purely operational ones.

Table 1. Key challenges in managing discipline competitions at local universities

Challenge Dimension	Specific Manifestations	Underlying Causes
Student Engagement	Low participation rates; elitist orientation; no systematic training for average students	Insufficient foundational training; no inclusive preparation systems
Curriculum Integration	Sprint-style preparation; outcomes not feeding back into teaching	Weak content-curriculum alignment; no credit recognition
Faculty Capacity	Limited expertise in AI/big data; low motivation	No standardized training; guidance not included in evaluation
Outcome Transformation	Projects ending at award stage; limited IP or industry application	Fragmented post-competition support; weak university -enterprise collaboration

1.3. Existing research and its limitations

Scholars have proposed various reform directions to address these challenges ^[10]. Some studies emphasize the use of incentive-oriented methods for team selection and training, advocating a hierarchical training path to stimulate students’ research potential ^[11]. Other studies explore the integration of competitions with classroom teaching through training courses and innovative credit systems. Some universities have established multidimensional incentive mechanisms, incorporating competition guidance into teacher performance

evaluation and providing graduate program recommendations for outstanding students^[12]. Several local universities have also developed tailored models, such as the “popularization + top-notch training” framework and departmental collaboration structure^{[13][14]}.

However, existing research has significant limitations. Most research focuses on well-known research-oriented universities with abundant resources, with insufficient attention paid to the unique constraints of local undergraduate institutions^{[6][13]}. The proposed management model often lacks dynamic adaptability and only serves as a static framework rather than an evolving system^[14]. Furthermore, mechanisms for translating competitive achievements into instructional resources, research outputs, or industrial applications remain immature in practice^[9].

1.4. Research context: The case of Yan’an University

To fill these gaps, this study takes a representative local university as the research object. Yan’an University, located in the relatively underdeveloped northern part of Shaanxi Province, is a typical local university facing such challenges^{[5][6]}. It has established a formal competition management system, including a leadership group, a guidance team, and a coordination support mechanism. This system offers incentive policies such as innovation points. However, its discipline competition performance is still relatively average; a list of CUMCM winning universities in Shaanxi Province in 2025 shows that although this university has won several provincial second prizes, it still has a significant gap compared to double first-class universities. This simultaneously reflects the systemic problems commonly existing in local universities in the western region^[5].

1.5. Research purpose and questions

This study is based on Outcome-Based Education (OBE), collaborative innovation theory, and the practical experience of the School of Mathematics and Computer Science at Yan’an University, aiming to construct and implement a systematic competition management model tailored to local universities. The model is characterized by full-chain coverage, dynamic adaptability, and intelligent support. We focus on three key questions: (1) What are the core structural obstacles in discipline competition management at local universities? (2) How can a model with a solid theoretical foundation and practical feasibility be designed to address these obstacles? (3) What measurable impacts will this implementation have on the level of participation?

2. Literature review and theoretical foundations

2.1. Evolution and current status of discipline competitions

Discipline competitions have a long history in Chinese higher education. Established in 1992, the CUMCM is one of the earliest and most influential national competitions. According to its charter, the competition is a science and technology initiative designed to encourage students to actively study mathematics. It helps to enhance their comprehensive mathematical modeling skills and to apply computer technology to solve real-world problems. Over the past three decades, the number of participating teams has grown from a few hundred to tens of thousands annually. This makes the event a vital pillar of innovation-oriented education.

Large-scale competitions typically employ a hierarchical organizational structure. Usually, the national organizing committee is responsible for formulating rules and designing test questions, while the provincial committee is responsible for publicity, registration, and preliminary screening. Although this two-tier

mechanism is highly effective for large-scale operations, it often leaves local universities with insufficient autonomy to develop discipline competition preparation and support systems tailored to their specific circumstances.

2.2. Existing management models and challenges

Scholars have proposed various models for organizing discipline competitions. The project-based management model regards each competition as a project with clearly defined planning, coordination, control and evaluation stages ^[11]. The three-level management model distributes responsibilities among universities, colleges and departments ^{[13][14]}. The competition-oriented model views discipline competition as a primary driver for curriculum reform and talent development, whereas the university-enterprise cooperation model leverages industry partners to provide real-world problems and resources ^[11].

Despite the existence of these models, local universities face unique challenges. Limited resources constrain their ability to provide practical training facilities, cover registration fees, and offer rewards ^[5]. Faculty professional capabilities are limited by a lack of knowledge in emerging fields and inadequate incentive mechanisms ^[8]. Student participation is limited by weak basic knowledge, and many competitions mainly target a minority elite group ^[5]. The disconnect between the curriculum and competitions often leads to “rushed” instructional preparation, thereby affecting the effectiveness of training ^[7].

2.3. Research gaps and positioning

Although the above literature provides valuable insights, there are still some limitations. Most research focuses on research universities. The proposed models often emphasize standardization rather than adaptability, and the role of technological integration is still underestimated. Our work aims to address these shortcomings by developing a model that is contextualized, dynamically adjustable, and technology-based for local higher education institutions ^[14–16].

3. Theoretical framework and model design

3.1. Core concepts

Discipline competitions typically aim to enable students to solve real-world problems by applying their professional knowledge. Its organizational and management model constitutes a systematic framework. It covers the planning, implementation, evaluation, and improvement of competition structures, processes, and mechanisms. Local universities usually serve specific regions and have relatively limited resources. The principle of comprehensive coverage requires competition management to run through all stages, generally including registration, training, participation, and the conversion and application of post-competition results.

3.2. Integrated theoretical framework

This model combines the OBE philosophy with collaborative innovation. OBE guides the implementation of the model through three processes: goal setting, reverse engineering, and continuous improvement; Collaborative innovation shapes its structural design through cross-functional collaboration, resource integration, and knowledge sharing.

3.3. The proposed whole-chain model

Based on the above framework, the model includes three implementation paths and four core components.

Mechanism optimization aims to redesign institutional structures, eliminate barriers, and establish incentive mechanisms; Capacity building aims to enhance the skills and motivation of teachers and students; Technology empowerment improves efficiency through the use of digital tools while achieving personalization and scalability. There are four core components - mechanism, capability, technology, and ecosystem, which correspond to the four challenge dimensions identified in **Table 1** and reinforce each other. As shown in **Figure 1**, the three interrelated implementation paths constitute the operational core of the model.

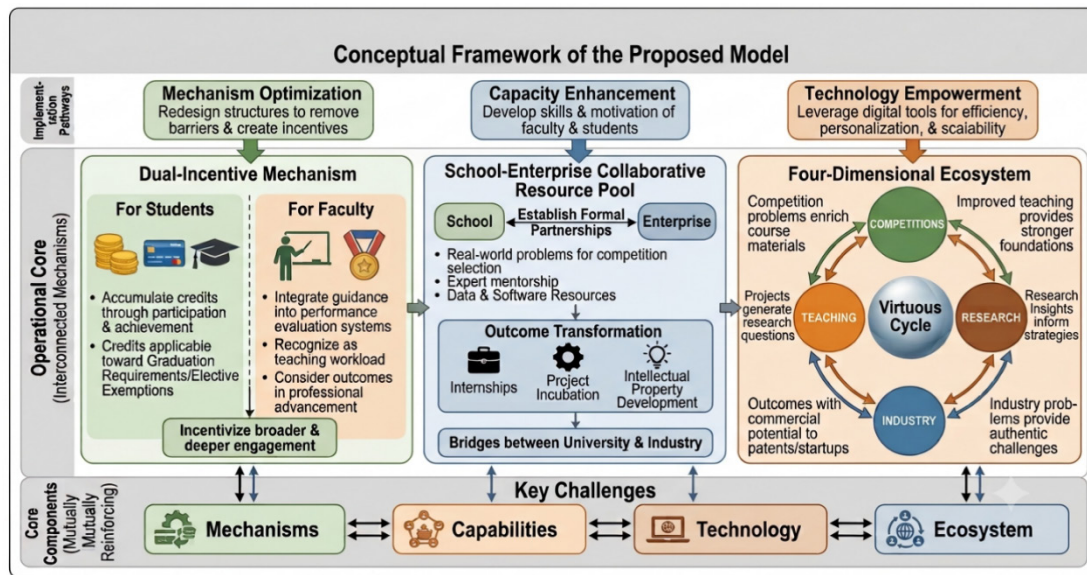


Figure 1. Conceptual Framework of the Proposed Model.

Dual-incentive mechanism. This mode provides students with a “competition points bank” system. It allows students to accumulate credits by participating in competitions and achieving results. These credits can be used to meet graduation requirements or exempt elective courses. For teachers, this model incorporates competitive guidance into the performance evaluation system. Consider it as part of teaching work, and incorporate the competition results into the considerations for career advancement.

Collaborative resource pool between universities and enterprises. This mechanism establishes formal cooperative relationships with industry stakeholders and provides real-world problems, expert guidance, data, and software resources for the competition through practical cooperation. This opens up channels for technology transfer and application, such as internship projects and intellectual property development.

Four-dimensional ecosystem. This forms a virtuous cycle. Specifically, competitions promote teaching, scientific research, and foster collaboration between industry, academia, and research. The challenges generated in the competition enrich the course content; The project generates competition topics; Transform commercially valuable research results into patents or startups. Conversely, the improved teaching has laid a more solid foundation for future participation in competition.

4. Research methodology

4.1. Research design and context

This study adopts a mixed-methods case study design, combining quantitative data such as participation

rate, award statistics, and questionnaire surveys, as well as qualitative data such as interviews and document analysis. Yan'an University is a comprehensive university located in the northern part of Shaanxi Province, mainly targeting local student groups, many of whom come from rural or disadvantaged backgrounds. The School of Mathematics and Computer Science actively participates in multiple important competitions, including the CUMCM, the “Huawei Cup” China Graduate Mathematics Modeling Competition, the “Lanqiao Cup” National Software and Information Technology Professional Talent Competition, and the CMC, providing a diverse practical environment for validating the proposed model.

4.2. Participants and Sample Characteristics

The demographic characteristics of the survey respondents are shown in **Table 2**. Baseline surveys were distributed to 408 students and 54 faculty members, with 320 student responses (78.4% response rate) and 45 faculty responses (83.3% response rate) collected. Post-implementation surveys were distributed to 367 students and 47 faculty members, yielding 280 student responses (76.3%) and 38 faculty responses (80.9%).

Table 2. Demographic Characteristics of Survey Respondents

Characteristic	Student Sample (Pre)	Student Sample (Post)	Faculty Sample (Pre)	Faculty Sample (Post)
Sample size	320	280	45	38
Gender				
Male	58.4%	56.1%	66.7%	63.2%
Female	41.6%	43.9%	33.3%	36.8%
Year of Study (Students)				
Freshman	18.1%	15.7%	-	-
Sophomore	27.5%	29.3%	-	-
Junior	31.3%	32.1%	-	-
Senior	23.1%	22.9%	-	-
Technical Title (Faculty)				
Professor	-	-	17.8%	15.8%
Associate Professor	-	-	31.1%	34.2%
Lecturer	-	-	42.2%	42.1%
Assistant	-	-	8.9%	7.9%
Discipline Area (Faculty)				
Mathematics	-	-	46.7%	44.7%
Computer Science	-	-	53.3%	55.3%

Source: Author's survey data, 2024–2026.

A semi-structured interview was conducted with 21 participants who were purposefully selected to represent the perspectives of different stakeholders, including 3 managers, 5 teaching competition instructors, 10 student participants (5 of whom had participation experience and 5 were first-time participants), and 3 non-participating students. Each interview lasted 30–60 minutes and was recorded with the participants' consent.

4.3. Data collection methods

Conducted pre- and post-implementation surveys on teachers and students. The student questionnaire assessed

awareness, motivation, obstacles, satisfaction, and self-assessment competency; The teacher questionnaire evaluated guidance experience, challenges, motivation, and institutional support. Semi-structured interviews were conducted with administrative personnel, teacher mentors, student participants, and non-participants. By analyzing institutional records, we have tracked participation rates, award performance, and demographic characteristics over the years.

4.4. Implementation phases

The model was implemented in four stages over a period of 24 months from May 2024 to May 2026. The first stage (baseline survey and framework design, May-October 2024) established an empirical foundation through questionnaire surveys, interviews, and document analysis. In the second stage (mechanism optimization and pilot application, November 2024 to August 2025), key mechanisms including Competition Credit Bank, teacher performance integration, and university-enterprise cooperation were implemented, and pilot projects were carried out in the fields of mathematics and computer science, physics and electronic information. The third stage (model validation and ecosystem construction, September 2025 to February 2026) tested its effectiveness through a complete competition cycle and expanded its implementation scope. The fourth stage (evaluation and outcome summary, March to May 2026) involved synthesizing research results, conducting quantitative and qualitative analyses, and ultimately forming deliverables.

5. Results

5.1. Baseline assessment

A baseline survey of 320 students showed a significant gap: 78% were aware of competitions, but only 32% had actually participated, and only 18% had participated in multiple competitions. The main obstacles include lack of confidence in basic skills (56%), unclear paths (43%), belief that the competition is only aimed at outstanding students (39%), time conflicts (35%), and limited information (28%). A survey of 45 teachers showed that although 71% of them recognize the importance of competition guidance, only 33% have formally guided a team. Obstacle factors include a lack of understanding of course load (62%), insufficient professional knowledge (48%), time constraints (44%), and limited institutional support (37%). File analysis shows that only one course was explicitly included in the competition content, and less than 5% of the competition projects produced any post-competition results.

5.2. Implementation outcomes

The detailed comparison of implementation effects is shown in **Table 3**. The number of student participants increased by 20.0%, with the most significant growth observed among second-year students and those who did not previously consider themselves competitors. The participation rate of girls has increased by 15 percentage points, and the participation level is more balanced in terms of academic performance. The overall award performance has improved by 4.8%, and the number of provincial first and second prizes has increased by 33.3%.

Table 3. Student Participation and Award Performance Before and After Implementation

Metric	Pre-implementation (2023–2024)	Post-implementation (2025–2026)	Change
Total student participants	300	360	+20.0%

Total participating teams	99	120	+21.2%
Female participation rate	32%	47%	+15 pp
Participation rate (non-top students)	18%	31%	+13 pp
Total awards received	42	44	+4.8%
Provincial first prizes	6	8	+33.3%
Provincial first- and second-prize awards	18	24	+33.3%
National-level awards	2	3	+50.0%
Second-year student participation	38%	52%	+14 pp

Source: Institutional records, 2023–2026. pp = percentage points.

The participation of teachers has significantly increased, with the number of formal mentors increasing from 15 to 28. The training workshop received high praise, and participants expressed increased confidence in guiding students. Three courses have been revised and competition content has been added. The competition credit bank system enabled 45 students to earn credits in their first year. Multiple competition projects have surpassed the award stage, including two that have developed into dissertations, three patent applications, and two case studies integrated into the curriculum.

The survey results after implementation showed positive feedback from relevant parties: 74% of students believed that the model made participation more convenient, 68% reported an increase in confidence, and 62% recognized the credit system. Among the teacher community, 79% of people believe that the recognition of workload is fair and reasonable, 71% of people prefer to guide the team, and 63% of people are satisfied with the training workshop. Administrative managers emphasize the improvement of coordination and resource allocation, while business partners point out opportunities to obtain talent support and carry out collaborative research and development.

6. Discussion

6.1. Interpretation of key findings

The findings suggest that the dual-incentive mechanism contributed to addressing incentive-related challenges. Competition credit banks convert participation into academic recognition achievements, while performance integration addresses teachers' dissatisfaction with unrecognized work. These findings are consistent with incentive mechanism theory and echo successful practices elsewhere. On the technical level, the potential of data-driven student profiling and intelligent resource matching has been demonstrated, but the resistance of teachers and the limitations of data quality indicate the need for more comprehensive infrastructure support. The four-dimensional ecosystem has shown initial signs of a virtuous cycle, but the cultural barriers between competition, teaching, research, and industry still require slower cultural transformation beyond structural reforms.

6.2. Comparison with existing models

This model, like existing methods, emphasizes governance and incentive mechanisms, but has three unique advantages. Unlike the generic model, this framework is designed specifically for local universities with limited resources and has a mechanism for continuous improvement, rather than operating as a fixed

framework. It explicitly integrates intelligent technologies such as data analysis and AI-driven resource matching, which are often missing in existing models. Its core principles can be widely applied to other local universities, but actual transferability depends on the readiness of each institution, cultural factors, and the availability of regional industrial cooperation.

6.3. Challenges and limitations

Implementation requires specialized staff time, training costs, technical infrastructure, and partnership development resources, which are not available in all local universities. Sustainability still depends on the sustained commitment of institutions, while scalability requires further coordination. As a single case study, its generalizability is limited, and the lack of a control group makes causal inference more complex. Future research should adopt comparative case studies, longitudinal design, and quasi-experimental methods.

7. Conclusion

This study developed and piloted a systematic discipline competition organization and management model for Yan'an University, a typical local university in western China. This model is based on results-oriented education and collaborative innovation theory, and includes three implementation paths - mechanism optimization, capability building, and technological empowerment- as well as four core elements covering mechanism, capability, technology, and ecosystem. The main mechanisms include a dual incentive system, a university-enterprise collaborative resource pool, and a competition-teaching-research-industry ecosystem. The implementation results are encouraging: student participation has increased by 20%, award performance has increased by 4.8%, teacher participation has significantly increased, and stakeholder feedback has been overall positive.

This study has made significant contributions both in theory and practice. In theory, it extends the principle of OBE to the field of competition management and applies collaborative innovation theory to competition governance, addressing an underexplored context in the existing literature that was mostly focused on elite colleges. In fact, the study provides a potentially transferable framework that includes adjustable components and a four-stage implementation roadmap. The tools developed through this study, including the design of competition credit banks, teacher training modules, collaboration frameworks, and competition case libraries, can be directly adopted or adapted by other institutions.

It should be pointed out that there are several limitations: a single case design limits the generalizability of promotion, a 24-month time span may not reflect long-term sustainability, the lack of a control group makes causal analysis complex, and self-reported measurements may have biases. Future research should adopt comparative case studies, longitudinal designs, quasi-experimental methods, and further explore technological innovation, policy support, and the long-term impact on student development outcomes.

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