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The Cultivation Mechanism and Pathway of Embedding Skills Competitions in Discipline-Based Student Organizations: A Case Study of Shenzhen Polytechnic University

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Abstract: Skills competitions are a major lever for talent cultivation in vocational colleges, and discipline-based student organizations are the primary site where competitors are selected and nurtured. How competitions are converted into systematic cultivation through organizational mechanisms nevertheless remains underexplained. This study takes the student organizations of one college at Shenzhen Polytechnic University as a case. It examines how competitions enter the routine operations of an organization and how student competence develops in the process. Competitions become embedded in organizational operations through three loops. The resource loop supplies industry projects and technical input. The process loop gives progressive selection and dual mentoring a stable footing. The outcome loop converts competition results into patents, ventures, and certifications. The three loops depend on one another, and the breakdown of any one of them weakens the output of the cultivation chain. Supported by this mechanism, student competence moves through three stages, from technical entry, through competition participation, to value creation. Each transition requires both a stronger challenge and a matching condition of support. Accessible training matters at the first stage, timely mentoring at moments of cognitive conflict at the second, and available channels for converting outcomes at the third. Embedding competitions in student organizations therefore means upgrading learning through competition from an occasional activity into a systematic cultivation design. What transfers across contexts is not the level of competition or the scale of investment but the construction of two conditions, namely an escalating challenge and matching support.

Keywords: Skills Competitions; Discipline-Based Student Organizations; Competition Embeddedness; Competence Progression; Vocational Colleges

1. Introduction

Skills competitions are a major lever for talent cultivation in vocational colleges, and discipline-based student organizations, being close to students and practice-oriented, have become the primary site for selecting and nurturing competitors. In most colleges, however, the combination of competitions and organizations remains ad hoc. A team is formed when a competition comes up and disperses afterwards. Competitions are treated as a supplement to organizational activities, not as a component of the cultivation process. The question is how competitions should enter the routine operations of an organization so that they are continuously converted into student competence. What decides the outcome is not the level of the competition. It is whether competition elements are embedded in three functions, namely resource input, incubation, and the accumulation of outcomes.

Research on competitions, student organizations, and talent cultivation has developed along three lines. One body of work examines the educational function of skills competitions and the psychological mechanisms at work in competitive settings. Competitions use authentic tasks and high-intensity challenges to accelerate skill formation and to subject competence to public scrutiny, but they are also the learning context with the highest psychological load: excessive pressure, fluctuating form, and the experience of losing are common difficulties for competitors [1]. Case studies further show that losing is not simply a negative event and that its direction of conversion depends on whether students receive timely, understanding support and attribution guidance afterwards [2]. At the practical level, studies have examined the

teaching models and organizational experience of "teaching and learning through competition" in specific events [3]; national survey evidence further shows that the experience of competing has a positive effect on students' competence development, whereas winning itself yields no additional educational gains [4].

A second line considers the effectiveness of student organizations as an educational vehicle and its variation across participants. Student organizations are an important vehicle for extracurricular education [5], and their effectiveness depends on the degree of organization, the quality of activities, and the availability of guidance [6,7]. Longitudinal evidence shows that leadership experience in different types of student organizations has heterogeneous effects on student development [8]. Other studies caution that organizational activities tend to drift from competence development toward social networking, which weakens their educational value [9], and that stratification among participation tiers leaves students in the same organization benefiting unevenly [10,11].

A third line addresses the resource support that college–industry collaboration provides for organizational operations. Industry participation is a key element in the high-quality operation of entrepreneurial student organizations [12]; college–industry cooperation is in essence a dynamic process in which the two sides bargain over their respective interests and reach an equilibrium based on reciprocity [13]; and discipline-based organizations are the organizational form through which industry resources are received and project-based operation is achieved [14].

Each line yields valuable conclusions, yet they share a limitation: competitions, student organizations, and cultivation are usually discussed separately, and the embedding of competitions in organizations is seldom examined as a systematic cultivation mechanism. Discussions of learning through competition remain largely at the level of advocacy and experiential description, offering little process-level explanation of how competitions are converted into student competence or of the conditions such conversion requires. This study addresses that gap by taking embeddedness as the mechanism of explanation and progression as the framework for analyzing competence, and by examining, through the case of the student organizations of one college at Shenzhen Polytechnic University, the structural ways in which competitions enter routine organizational operations and the corresponding growth of student competence.

2. An Analytical Framework: Competition Embeddedness and Student Competence Progression

2.1 The Meaning of Competition Embeddedness and Its Three Functional Loops

In this study, embeddedness means that competitions have been built into the routine operations of a student organization as a structural element. A competition then holds a fixed position in the operating chain instead of sitting outside it as an isolated activity. The number of competitions an organization enters in a year matters less than whether competition elements are present in three functional loops, namely resource input, incubation, and the accumulation of outcomes. Only when all three perform a competitive function does a competition shift from an "activity overlay" to "structural embeddedness."

Based on the practices of the college examined here, competition embeddedness can be summarized as three loops at the front, middle, and back ends. Resource embeddedness at the front end supplies authentic tasks and professional guidance; process embeddedness in the middle gives competence development a stable organizational footing; and outcome embeddedness at the back end turns competition results into assets that can be carried forward. The three loops between them answer where projects come from, how competence is generated, and how outcomes are consolidated. Whether a loop is present can be judged from observable markers. Resource embeddedness is visible when industry courses, projects, or mentoring are supplied on a recurring basis rather than once. Process embeddedness shows up in the schedule, where problem-solving sessions, tryouts, and mentoring appear within the organization's regular activity cycle. Outcome embeddedness appears when results are registered, converted, or passed on to the next cohort rather than left unused. ~~Their concrete operation is analyzed in Section 3.~~

The three loops form a cycle from resource to process to outcome and back to resource, rather

than three separate tracks. What the resource loop delivers as projects sets the effectiveness of incubation in the process loop. How far students develop in the process loop sets the quality of conversion in the outcome loop. The technological results and social influence accumulated in the outcome loop, in turn, strengthen the resource loop's capacity to secure further industry cooperation. Competition embeddedness is thus a mechanism that requires closure (see Figure 1).

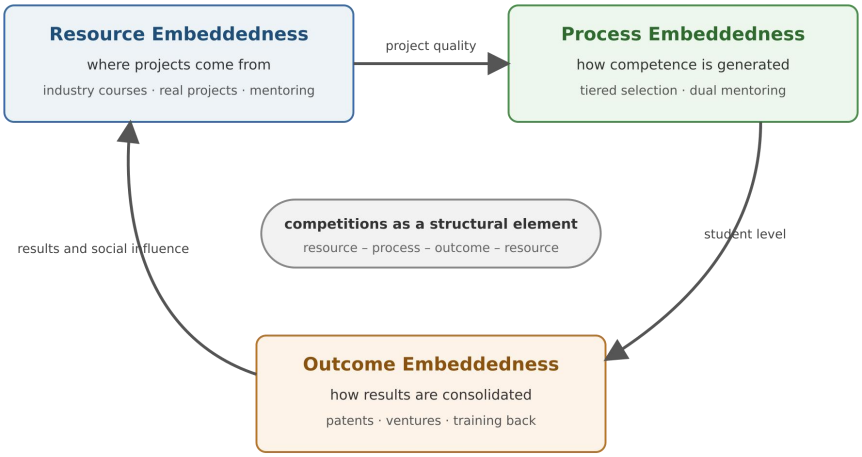


Figure 1. The Three-Loop Closed Mechanism of Embedding Skills Competitions in Student Organizations

2.2 An operational Framework for the Three-Stage Progression of Student Competence

Competence progression here means the successive advances in competence that students make through competition participation. The nature of the competence task serves as the criterion, and the growth is summarized as a three-stage form. Each stage centers on a distinct task, corresponds to a particular supporting condition, and yields a set of verifiable results. The three-stage progression is an analytical typology; it describes differences in the level of competence tasks, not a statistical distribution of how all participants develop. Nor does it rank the individuals who move through the stages, since what differs is the complexity of the task at each stage.

The first stage is technical entry. Students build up basic skills through technical courses taught by industry engineers and general training provided by the organization, and they can obtain industry-recognized qualifications by sitting certification examinations. Accessible training supports this stage, and access rests on low entry thresholds, flexible scheduling, and provision for all members. The verifiable results are the scale of training participation and the number of certifications passed.

The second stage is competition participation. Under dual mentorship, students take on authentic projects with technical uncertainty. Rejected proposals, unsatisfactory data, and disagreements within the team are the norm. Such difficulties are what the study calls cognitive conflict, meaning technical problems that arise in authentic tasks and do not match students' existing experience. The stage ends with assessable competition results. Whether students move past it depends on how promptly the two mentors intervene once cognitive conflict arises. Competition placements and award levels are the verifiable results here.

The third stage is value creation. Students turn competition results into patents and software copyrights, advance technical solutions into ventures, or return to the organization to train and mentor others, so that technology is converted into value that can be carried forward. This stage depends on the availability of conversion channels. The verifiable results are the numbers of patents and software copyrights and of ventures, together with the scale of mentoring provided back to the organization. Figure 2 summarizes this three-stage progression and its key supporting conditions.

The three-stage progression and the three-loop embeddedness are two sides of one cultivation process. Embeddedness explains where the conditions of cultivation come from; progression explains how student competence grows (see Table 1). The two correspond as a rule rather than one to one, since a single loop can support more than one stage. That correspondence also

implies that the focus of mechanism building is not the strengthening of any single loop but the continuity of transmission between loops.

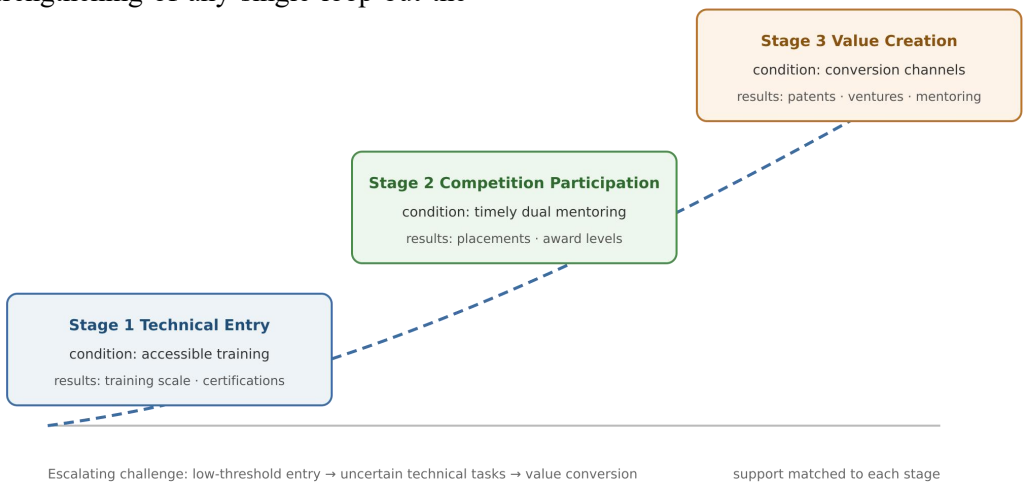


Figure 2. The Three-Stage Progression Pathway of Student Competence and Its Key Supporting Conditions

Table 1. Correspondence between the Three Loops of Embeddedness and the Three Stages of Progression

Loop of embeddedness	Function	Corresponding stage	Key supporting condition	Verifiable results
Resource embeddedness	Where projects and technology come from	Stage 1: technical entry	Accessibility of training	Scale of training participation; certifications passed
Process embeddedness	How competence is generated	Stage 2: competition participation	Timely intervention by dual mentors	Competition placements; award levels
Outcome embeddedness	How results are consolidated	Stage 3: value creation	Availability of conversion channels	Patents and copyrights; ventures; scale of mentoring back

2.3 The Framework as a Whole

Taken together, the two dimensions form the analytical framework of "three-loop embeddedness and three-stage progression." Embeddedness characterizes the structural way in which competitions enter the organization; progression characterizes the growth path of student competence; supporting conditions connect the two. Two judgements follow. Whether competitions are embedded can be settled by examining, loop by loop, whether competition elements are present. Whether a stage of progression is blocked can be settled by checking whether its supporting condition is in place. The following section applies this framework to the practices of the college examined here.

3. The Cultivation Mechanism of Three-Loop Embeddedness and the Practical Pathway of Three-Stage Progression

The case examined here is the student organizations of one college at Shenzhen Polytechnic University. The college offers programs in ICT fields including cloud computing, big data, artificial intelligence, the Internet of Things, and information security. It maintains long-term cooperation with a number of well-known domestic and international enterprises. Cooperation with industry brings in resources, skills competitions select and incubate students, and innovation and entrepreneurship convert outcomes, so the college has a complete cultivation chain. Over the past three years the college has won 37 national awards and 100 provincial awards at first prize or above, has produced more than 80 patents and software copyrights, and has seen students found their own companies. The case materials consist mainly of institutional documents, operational records, and routine ledgers; the data come from the college's award ledgers, competition management system, and certification records. All materials concerning individual students have been anonymized, and the institution is referred to as "the college" by anonymization agreement.

This is a mechanism-explaining case study, and it aims to show how competition embeddedness works. The functional loops of embeddedness are first identified and assembled into the framework of three-loop embeddedness and three-stage progression; the case is then revisited

against operational records to examine how far the framework matches actual practice, and the transferable mechanism features and conditions are distilled in the conclusion. The key supporting conditions for each stage were identified through within-case comparison: teams that received the relevant support completed the progression, whereas students lacking that condition at the same point dropped out.

3.1 Resource Embeddedness and Stage One: Technical Entry

The college's student organizations have established long-term cooperation with a number of well-known ICT enterprises, covering four areas, namely technical training, project practice, competition topic selection, and internships. Industry engineers regularly teach technical courses within the organizations, covering cloud computing, big data, artificial intelligence, the Internet of Things, and information security, and the courses are driven by authentic corporate cases and tools. Enterprises also convert some of their technical challenges into practical projects for the organizations, which students take on in teams, with the results used to screen competition topics; industry technical staff take part in topic review so that competition tasks stay close to the industry's technological frontier. Each year enterprises offer more than 200 internship places to students in the organizations, and more than half of those students join the companies formally after their internships. Besides industry resources, general training offered by the college to all students constitutes a second source of resource embeddedness.

This resource structure creates the conditions for students to enter the first stage. Courses such as "Photoshop Basics," "Android Development," and "Web Development in Practice" have been delivered more than 1,000 times, benefiting more than 2,000 students each year [15]. Industry engineers also offer introductory courses in cloud computing, big data, and the Internet of Things. Training has no technical threshold: students need only interest and time, and on completion they may sit enterprise certification examinations and obtain industry-recognized qualifications. This low-threshold skill base enables large numbers of students to take the first step from having no technical background to having a skill. More than 300 students have obtained cloud computing certifications through organizational training, of whom more than 30 have earned top-level certifications.

The case was selected for its typicality and for the traceability of its records: the organizations operate in a technology-intensive field with long-standing industry ties, and their activities are documented in ledgers, which allows the mechanism to be reconstructed from evidence rather than from recollection. The training sessions, beneficiary numbers, internship places, and certifications reported in this section are all drawn from the college's organizational activity records and certification ledgers, over the past three years.

3.2 Process Embeddedness and Stage Two: Competition Participation

Process embeddedness turns competition incubation into an institutionalized part of routine activity, replacing last-minute cramming before an event. In terms of selection, the college has established a three-tier progression channel running from all members of the organization, to interest groups, to competition teams. The first tier provides general skills training to all members and serves to broaden participation and identify technical interests. From that training the second tier draws students with a solid technical foundation into interest groups, which run regular activities in a project-based format where students complete authentic tasks at low risk. Promising candidates are then drawn from the interest groups into competition teams that prepare intensively, pushing competence to competition-level intensity. The tiers are progressive but not rigid: at both the interest group and competition team stages some students drop out because of technical ability or time commitment, but these students nevertheless accumulate technical qualifications through the earlier training and certification examinations.

Competition teams operate a dual mentorship system combining industry technical experts and college faculty. Industry mentors vet technical solutions and bring industry standards into the mentoring process, while faculty mentors fill theoretical gaps and manage preparation. In preparing for competitions students face authentic tasks with technical uncertainty, where rejected proposals, unsatisfactory experimental data, and disagreements within the team are routine. Cognitive conflict at this stage can push

students forward or drive them out. Excessive pressure, unstable form, and the experience of losing are the common difficulties for competitors [1], and whether a loss is converted depends on the timely, understanding support and attribution guidance that follow it [2]. The dual mentors intervene promptly once conflict arises. They calibrate technical direction so that students avoid repeated trial and error, fill theoretical gaps to reduce frustration, and turn the experience of losing into the basis for the next round of improvement. Survey evidence shows that the educational gains of competitions come mainly from the process of participation and the quality of guidance rather than from winning itself [4].

The trajectories of award-winning students at the college bear out this progression. In cloud computing, for example, the first cohort of award winners took nearly a year to move from training into a competition team, during which they saw several technical solutions rejected and rebuilt; the following year's winners, building on the experience passed down from the previous cohort, achieved a comparable technical breakthrough in less time. In the Internet of Things, one student began with organizational training, accumulated project experience in an interest group, and then joined a competition team, eventually winning a national first prize. Over the past three years 37 teams from the college have won national competition awards, all of which went through the complete incubation process from training to competition, and in the course of this a pattern formed in which each cohort mentors the next.

3.3 Outcome Embeddedness and Stage Three: Value Creation

Competition results flow back into the organization's continuing operation through three channels. The first is intellectual property. Technical solutions from competitions are organized into patents and software copyrights, more than 80 in total, which gives the technical accumulation of the competition process a formal carrier. The second is venture incubation. Drawing on the entrepreneurship park and platforms such as the "Internet Plus" competition, competition results are advanced into ventures, and the founders of the student companies incubated so far are all competition award winners who emerged from the organizations. The third is social service. Award-winning students serve as trainers who give back to the organization by teaching technical courses and mentoring newcomers, and through this mechanism more than 300 students have obtained cloud computing certifications while 43 have earned top-level certifications (together with the more than 30 in the organization described above, a total of more than 70).

In the third stage students change from "people who learn technology" into "people who create value with technology" [16,17]. Unlike the first two stages, which focus on mastering technology and solving difficult problems, the progression at this stage involves three new dimensions. The first dimension is technological conversion, the ability to judge which competition results have the potential to become patents or products and what commercial prospects a technical solution has. The second is knowledge transmission, the ability to organize one's own experience into teachable courses and mentoring practices. The third is team management, the ability to organize the division of labor and advance progress in team collaboration. This last competence has a fairly concrete form in the case. Within competition teams, work is divided by technical module and by the writing of competition materials. The team leader coordinates progress, and the dual mentors check progress and the feasibility of solutions at periodic reviews, forming a rhythm of "divide, review, adjust." In the student-founded companies and ventures, by contrast, team members work together on joint development. None of these three competences is systematically trained in the first two stages; they arise in the new context of outcome conversion and mentoring back to the organization. This echoes the mechanisms of cultivating innovation capacity, where improvement comes from the combined effect of practical platforms, long-term mechanisms, and progressive guidance [16] rather than from the strengthening of any single link.

The three-stage progression is not a fixed sequence. At each stage students may choose whether to continue or withdraw; students with a solid technical foundation may move directly into venture incubation, and students at the third stage may return to the organization to mentor the next cohort, forming a knowledge transmission mechanism in which each cohort mentors the next. Not all students who take part in training complete the full progression, but those who withdraw nevertheless accumulate

technical qualifications and project experience in the preceding stages, and these gains constitute the baseline benefit of the mechanism.

3.4 Three-Loop Interaction and the Requirement of Closure

Closure is the precondition for three-loop embeddedness to support three-stage progression, and no loop can stand in for another. If the resource loop fails, competition incubation loses its project supply, and students have no access to authentic tasks or industry standards. Industry resources cannot be turned into student competence without the process loop, and projects remain one-off activities. Where the outcome loop is missing, competition results are never consolidated into assets that can be carried forward, and the cultivation chain breaks off when students graduate. The three loops are also interdependent over time: the quality of output from any one loop is transmitted to the next and, through the accumulation of results, returns to the acquisition of resources. This cycle, however, does not sustain itself. The level of detail in project briefs issued by teachers, and the timeliness with which competence and project information is updated, both require institutional maintenance; once that maintenance lapses, the cycle degenerates into one-way resource provision.

The quality of competition embeddedness therefore turns less on the number of competitions or the level of awards than on whether the three loops are simultaneously present and mutually engaged. The college's ability to produce results consistently in national and provincial competitions over the past three years is associated with the simultaneous operation of all three loops. The problems that have surfaced in its operation can in most cases be traced to weak transmission at one loop. For example, project briefs issued by some teachers lack sufficient detail, a transmission problem from the resource loop to the process loop. Under semi-manual conditions, updates to competence and project information also lag, which affects the accuracy of matching in the process loop.

4. Conclusion

Taking the student organizations of one college at Shenzhen Polytechnic University as a case, this study has analyzed the cultivation mechanism of embedding skills competitions in discipline-based student organizations and the progression pathway of student competence, and it draws three conclusions.

First, the effectiveness of embedding competitions in an organization depends on the closure of the three loops and on their progressive interdependence. The three loops are interdependent rather than parallel. The cycle runs from resource to process to outcome and back, and any break in it weakens the output of the cultivation chain. Whether competition-based cultivation has in fact become a mechanism therefore turns less on the number of competitions entered than on whether resource input, incubation, and the accumulation of outcomes are simultaneously present and mutually engaged.

Second, student competence develops through a three-stage progression from technical entry, through competition participation, to value creation, and each transition requires both a stronger challenge and a matching condition of support. Accessible training is decisive at the first stage. At the second, timely intervention by dual mentors once cognitive conflict arises matters most. At the third, what counts is the availability of channels for converting outcomes. Because the three stages and the three loops are connected through supporting conditions, the basic method of cultivation design follows: determine the target stage first, then put in place the supporting condition that stage requires, avoiding the mismatches of adding challenge without support, or providing support without sufficient challenge.

Third, what turns learning through competition from an occasional activity into a systematic cultivation design is the structural embedding of competitions. Overlaying competition elements on the existing list of organizational activities is not enough, because their effect then depends on the commitment of individual teachers and students and is difficult to sustain. Only when competitions enter the three loops of resource input, incubation, and outcome accumulation and become part of routine organizational operation do they acquire a stable cultivation function.

Accordingly, in professional fields with a stable basis for industry cooperation, vocational colleges can advance organizational development along three lines. One is a matching mechanism that turns industry courses, authentic projects, and engineers' guidance into a

regular supply for student organizations rather than ad hoc cooperation tied to particular competitions. Another is a progressive selection and incubation mechanism that broadens participation through the tiered channel running from all members, to interest groups, to competition teams, and that secures timely intervention once cognitive conflict arises through dual mentorship. The educational gains of competitions come mainly from participation and the quality of guidance rather than from awards themselves, which is consistent with the mechanism identified here. The third is a mechanism for converting outcomes, providing stable channels for patent applications, venture incubation, and training that feeds back into the organization, so that competition results are consolidated into educational assets that can be carried forward.

The case examined here presents the logic of mechanism building and initial operating experience, and its representativeness is limited by being a single-college case; the actual effectiveness of the mechanism needs to be tested across more disciplines and over longer periods, which is also the direction for further research.

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