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Exploring the Cultivation Model of Application-Oriented Mechanical Talents via Discipline Competitions under the Emerging Engineering Education Context

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Abstract

In response to practical problems in the current cultivation of application-oriented talents in mechanical majors—such as the disconnection between curriculum systems and industrial needs, insufficient systematicness of practical teaching, superficial school-enterprise cooperation, and inadequate activation of student subjectivity—this study takes discipline competitions as a breakthrough point and constructs a talent cultivation model guided by the OBE (Outcome-Based Education) concept and supported by competition projects. This model integrates discipline competitions into routine teaching activities through curriculum restructuring, project-based teaching reform, school-enterprise collaborative guidance, incentive mechanism construction, and ideological and political education integration. It realizes a pedagogical shift from "learning before doing" to "learning by doing." Practice shows that using discipline competitions as a lever can effectively mobilize students' initiative, enhance their comprehensive ability to apply professional knowledge, and improve their engineering practice literacy. This offers a feasible reform path for mechanical talent cultivation in local application-oriented undergraduate universities.

Keywords

Emerging Engineering Education, discipline competitions, application-oriented talents, mechanical majors, cultivation model.

1. Introduction

The ongoing advancement of Emerging Engineering Education has placed higher demands on the cultivation of application-oriented mechanical talents[1]. Internationally, Germany's dual-track education system, the UK's modern applied discipline development, and the US land-grant college movement have all, to varying degrees, achieved large-scale delivery of applied talents, providing useful references for China's engineering education reform. In this context, the Ministry of Education has continued to promote the "Excellent Engineer Education and Training Program 2.0," and a number of local undergraduate institutions have responded positively by accelerating their transition toward an application-oriented positioning.

Nevertheless, the current cultivation model for mechanical application-oriented talents still faces multiple difficulties[2]. At the curriculum level, the connection between training objectives and corporate hiring needs remains insufficient; course content updates lag behind the pace of industrial technological iteration, creating a structural gap between what students learn and what positions require. In practical teaching, although new concepts have been explored, most remain at the advocacy stage, lacking systematic institutional support and platform guarantees, resulting in fragmented and formalized practical instruction[3]. In school-enterprise cooperation, while collaboration models are diverse, the depth of cooperation varies considerably, and the efficiency of converting corporate resources into

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teaching resources is low; thus, the educational function of industry-education integration has not been fully realized. Regarding faculty orientation, many universities still favor research over practice. This tendency reduces the energy and motivation of teachers involved in undergraduate practical teaching [4]. These issues accumulate. The actual outcomes of talent cultivation fall short of societal expectations.

Among them is that Mechanical Disciplines Competitions are now quite specialized, and all-inclusive. Systematic, practical. The top competition projects tend to line up very well with what actual businesses and industries want. Interdisciplinary knowledge, complete engineering skills [5 6]. A new way of dealing with these problems is offered by this method. Leverage competitions for a strong model of practicing engineering. Stimulates students' initiative. Breaks down barriers between industry education. Improve the quality of developing application talents.

2. Constructing a Competition-Based Cultivation Model for Mechanical Application-Oriented Talents

It uses OBE. It moves disciplines competitions from after school activities into in-class drivers. Competitions are throughout the whole talent cultivating chain. The way to do it has many steps. First step: Study job groups and skill requirements for people who major in mechanics. Use competition knowledge modules to change the curriculum all the time. Second step: promote project-based teaching reform based on OBE, turn competition projects into teaching carriers; realize a transition from "learning before doing" to "learning by doing". Thirdly establish multiple incentives, create "golden competitions" recognition mechanisms so that teachers and students can have their internal drive stimulated at once without affecting competition quality. Fourthly extract ideological-political elements, integrate them in every part of education, make sure values match skills. Build industry-education collaboration system, strengthen application ability and practice skill. And then summarize what we got so far to improve things more. They help one another. A closed loop feedback structure is created by these components together. Together they form an organized new paradigm of applied talent development. As shown in Figure 1.

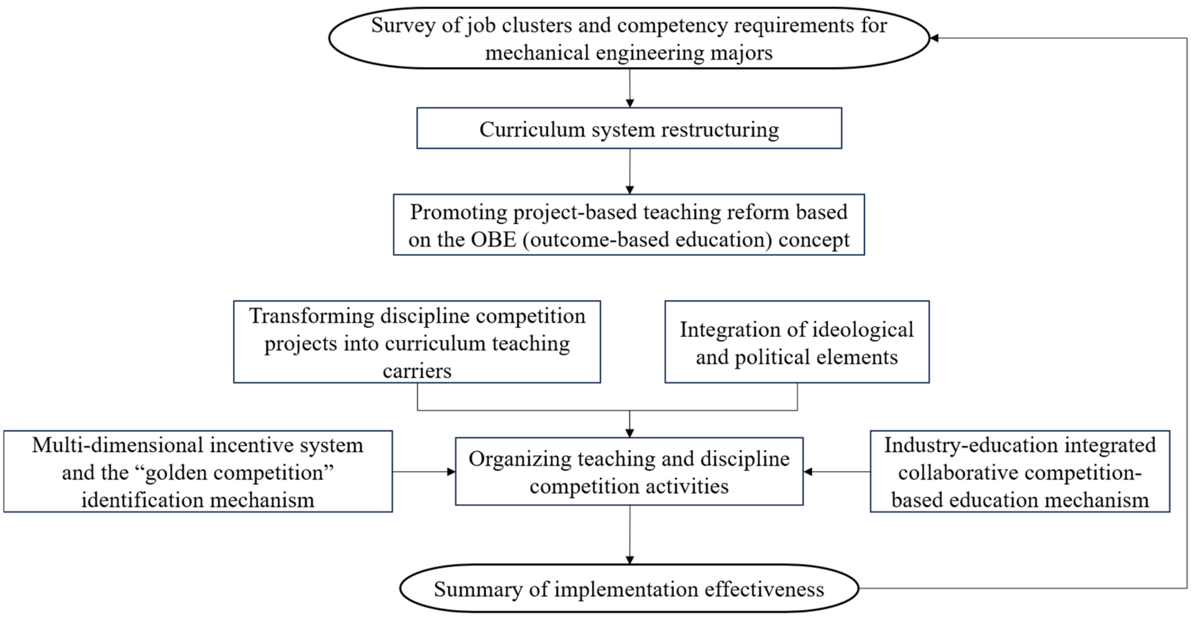

Figure 1. Implementation pathway

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2.1. Curriculum restructuring in accordance with industrial requirements

Curriculum System is the skeleton for talents to grow. Project team followed Emerging Engineering Education requirements. They did a thorough look at what courses we had already in place. Training goals and graduation standards. Corporate/industrial experts participated. Basic idea: include latest industry & tech developments. Include new demands on talent development. Improve course category structures, improve credits hour structure. Discipline competitions spread knowledge around. Team mapped out which knowledge modules each competition involved. They turned these into teaching material. And they created their own syllabus and lesson plan as well as lecture notes that would go along with it. It will be updated all the time through this system so there's no disconnect between what you teach students versus what employers actually want right now.

Take Robotics for instance. The project team carried out thorough curriculum reorganization according to Emerging Engineering Education and OBE ideas. Starting with program goals and graduates' qualities. Teachers visited partner companies, did on-site investigations and exchanged techniques, looked at trends in industry tech and changes in job skills. Senior technical staff and industry professionals participated in symposiums regarding the revision of programs. So it kept the adjustment of courses matching up to real industrial needs. They gave up the usual textbook order. Instead they made four progressive parts. These were basic info, thinking about things, making guesses, and doing math. To keep the content new they use the knowledge spreading part of competitions like academic ones. They picked apart what knowledge was needed and abilities from events like RAICOM or China Robot & Artificial Intelligence Competition. And then mapped those back into course material. Made competition-tied syllabi, lesson plans, talks. At the same time turning genuine engineering case studies and tech specs provided by their partners into teaching resources; compiling a set of cases that come off real products made in factories. It formed many-courses collaboration teaching unit together with university-industry cooperation.

2.2. OBE-Based Competition-Driven Teaching Reform

Using outcome-based education as my guide, I'm going to take all these competitions and just stick them right into regular school. In terms of the main logic changes for teaching is it goes away from being a straight line. We did before we would do theory then after that would be practice. This time around though it's like participating in learning by doing. And now, competition project's engineering case becomes our course material. Individual knowledges points connect with each other through some real world projects. All along the way designing, building out, fine tuning on competition things; students pick up basics systematically. They also sharpen their analytical skills and ability to apply what they've learned.

Robotics class reform again, the team abandoned their textbook's chapters. The reorganized contents in four stages of progress: basics knowledge stage; theoretical derivation stage; induction analogy stage; scientific calculation stage. Use the creation of a SCARA robot as the main thread, they made five sub-projects around it including drawing kinematics diagram, building up models for kinematics, creating Jacobian matrixes, making dynamic model and running computer simulations. Students got all the key info and abilities after finishing everything on the whole project. It was systematically integrated into teaching material with engineering practice.

2.3. Competition Incentive Mechanisms and "Golden Competition" Identification

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The enthusiasm of students is the competition lever. The project built up a multidimensional reward scheme. In grade rankings, competition outcomes factor into all-around assessments.

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In terms of credits, there's another channel for the second classroom. For awards and commendations it goes to the winners, teachers who taught them as well. It’s like when you sign up. Students systematically learn theories. Use theory in practice. After events, they do self-analysis and talk about teams. Broaden their academic horizon. To achieve combined effect: promoting learning, teaching, innovation, integration via competitions.

Like Incentives the team finds “golden Competitions.” There is variation in Mechanical discipline competition. The team looks at higher level things which are very close to what you’d find as a professional trainee. They get rid of the low-value "water competitions" which don't have any real need for them. So we can invest our time into something good and not waste all these money and also students' time, make sure that this will help us achieve some goal with competitions instead of just being wasted on some random event. And it makes sure competitions are done properly so they actually work out. For example: Team guided students take part in prestigious events such as RAICOM and China Robot & Artificial Intelligence Competition, and got good results.

2.4. Industry-Education Integrated Collaborative Competition-Based Education Mechanism

Mechanical discipline competition has some particularity and practicability. This kind of nature is a natural link between school and enterprises for cooperation. The project team formed steady partnership relations with many companies. Companies get deeply involved in lab creation, course curriculum talks, skills training, job prep classes. University provides application talents which fit the company's demand. Both sides jointly find “golden competition” projects that are very relevant to the courses and industries. Give systematic advice on students from both theories and practices. It makes an arrangement among men, stuff, cash.

In practice it was made by the team that a closed loop of collaboration around competitions. Enterprise problem setting - Teacher-student problem solving - Competition based verification - Industrial application of outcomes. Implementation, they first set up a university-industry consultation system. At beginning of every semester, the team and its partner companies evaluate emerging industrial tech trends and production roadblocks together. And these evaluations will guide us on what direction our competition topic is going to be in. Technical difficulties can be divided into three levels according to their degree of difficulty: basic level, intermediate level, and advanced level. Different levels of study get different jobs. So there’s good fit between which contest you pick and your studies. Two-way conversion channel for resources among industry, competition, and curriculum. One side: technical specs & typical cases from prod become train modules & teach matls. Other side: innovative solutions made by students while competing are examined jointly by uni/enterprise experts. Then added to company's tech repo. Regular combined examination of technical suggestions, stages of results appraisal, and changing instruction fine-tuning guarantee compliance with both industry benchmarks and engineering rules during readiness. Team also used some projects that we had with other schools, like universities, so we got these shared labs, training facilities. In-class practical training, after-school competition practices, vacation-time internships take place here. Students finish project creation under near-industrial settings.

2.5. Organic Integration of Ideological and Political Education with Competency Development

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Discipline competitions is more than a place for applying what we know. It's where morals get trained too. In competition time, teachers will subtly guide the students with their own professional competence and work ethic and values attitude. The team actively finds ideological and political parts hidden in contests. They show it by guiding through 4 dimensions of

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knowledge application, ability development, quality improvement, and value creation. Ideological education as main thread in designing competition teaching activities. While solving engineering problems, students develop independent thinking, teamwork, and continuous improvement. To satisfy all-around quality demands from Emerging Engineering Education.

In specific teaching practice, the team innovated a “knowledge classification + ideological-political integration” BOPPPS teaching design framework. All knowledge points are divided into seven categories: factual narration, heuristic transfer, objective application, complex abstraction, fuzzy confusion, computational modeling, and hands-on practice. For each category, corresponding ideological and political elements are deeply mined and organically integrated. Then, in each stage of the BOPPPS model, flexible teaching methods such as lecturing, discussion, case analysis, and practice are employed. The ideological and political education is carried out along three main threads: professional ethics and practical spirit, respect for science and self-directed learning, and patriotism and social responsibility. This achieves an organic unity of knowledge transmission and value guidance.

2.6. Multi-dimensional Evaluation and Continuous Feedback Mechanism

Any training model needs to be evaluated and fed back systematically. Based on OBE philosophy, the project team developed a three-tier progressive evaluation framework. Process Evaluation, Stage Assessment, Summative Evaluation. Evaluation subjects have grown out of just being one teacher based towards many stakeholders involved with this process now including: Student Self Assessment, Peer Review, Instructor Grading & Industry Mentor Feedback.

On the level of processes, they set up some quantitative observation points for key phases of competitions. Scheme Design phase, Simulation Analysis Phase, Prototype Fabrication Phase and Debugging Optimization Phase. Project logs, stage presentations, and technical defenses. Dynamically track students’ knowledge mastery and practical engineering skill growth with these tools. Stage assessments are done by way of mock contests or internal campus selections. The intention here is to look at what every team can do when faced with difficult engineering issues within certain limits. Results feed back into future changes to how coaching happens. Summative evaluation consists of last competition standings, technical reports after competitions, as well as reflections post-competition. A complete judgment about whether a student has mastered their specialized knowledges, if he has good creative thoughts, and if his work ethics meet requirements.

The feedback part talks about closed loop iteration. The team set up a routine workflow: “evaluation – diagnosis – improvement.” After every contest, the supervising teachers collect all kinds of evaluation information. And they make this thing called teaching effectiveness analysis report. We’re gonna use that to revise our coaching plans and course stuff for next year. Graduate tracking surveys and employer satisfaction interviews send outside opinions back into designing classes and picking competition topics. In the last 3 years it has kept this self renewal capacity going. Student projects have been getting closer and closer to what companies actually want out there every single year. Multi-dimensional evaluation and continuous feedback shift the training approach which is based on experience into one where decisions are made through data. Provides institutional support for ongoing quality improvement in teaching.

3. SummaryImplementation Outcomes

3.1. Remarkable Improvement in Students' Overall Abilities and Creativity.

Reform through competition has made students’ learning more proactive and full of innovation. In the last three years, we helped our student win 6 projects on innovating and starting business. Two at the national level, four at the provincial level. Students participated in over twenty

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provincial-level or higher discipline competitions. Like:National College Student's Mechanic Innovation Design Contest; China's robot & AI contest etc. They got one first prize nationally, three third prizes nationally, three first prizes provincially, five second prizes provincially, and twelve third prizes provincially. Showcasing that these folks have grown quite a bit when it comes to putting all sorts of things they know about together, actually doing some engineering stuff with hands-on experience, and getting along well with others during this whole thing. A positive cycle where converting competitive results into educational material was set up.

3.2. Steady Improvement in Teachers' Teaching Competence and Research Capabilities

The model reform has driven rapid growth of the teaching team. In the last three years, team members have won a second prize in the Hebei Provincial Course Ideological and Political Teaching Competition, received four university-level teaching competition awards, and earned honors such as "Hebei Provincial Teaching Master" and "University Outstanding Teacher Model." Through the process of guiding student competitions, instructors have enhanced their own engineering practice experience, course design skills, and teaching organization abilities, and the positive effect of teaching-research mutual promotion has gradually emerged.

4. Conclusion

Emerging Engineering Education imposes new requirements on mechanical majors that equally emphasize knowledge, competence, and qualities. Application-oriented undergraduate institutions must actively explore new cultivation pathways that meet industrial demands. This reform practice, using discipline competitions as a lever, has formed a complete closed-loop cultivation system through curriculum restructuring, pedagogical logic transformation, school-enterprise collaborative education, and competition system development—namely, "needs investigation → curriculum update → teaching reform → incentive identification → collaborative education → ideological integration → feedback optimization." The core value of this model lies in: making curriculum reform targeted and well-directed through competitions as carriers; promoting deep school-enterprise integration and incorporating corporate resources into the entire talent cultivation process through collaborative guidance; and stimulating student initiative with a student-centered approach, forming an internal drive mechanism for learning through competitions. Continuous implementation and optimization show that this scheme has strong operability and scalability, and can provide useful references for promoting innovation in application-oriented talent cultivation models for mechanical majors in local universities.

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