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Enhancing the Problem-Solving Skills of Vocational Students Through Skills Competition

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Abstract: Unlike general education, vocational education aims to nurture skilled people for various sectors in the society. The development of students' problem analysis and problem-solving skills is crucial. As an important part of the vocational education system, skills competitions are considered a "booster" for improving the quality of teaching in vocational institutions. This paper examines the problem-solving skills of students in preparation for skills competition. First of all, we introduce China's education policies and conduct a review of early scholars' views, followed by a discussion on the specific problems faced in the design of the entry for skills competition and an exploration of the process of enhancing students' problem-solving skills around these problems; we then propose several suggestions for vocational institutions to enhance their participation in skills competitions. Skills competitions provide a "special stage" for students in vocational institutions to show their abilities. The question of how this "stage" can be utilized to better improve students' abilities is worth exploring in different fields.

Keywords: Skills competition; Problem-solving skills; Vocational students; Vocational colleges

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1. Introduction

Vocational education and general education are positioned differently, but they have equal importance. Vocational education is positioned to nurture skilled and application-oriented talents for various industries in the society. As the pace of industrial upgrading and economic restructuring continues to accelerate, the demand for skilled personnel by various existing industries is increasing; additionally, the status and role of vocational education is becoming more prominent [1].

At present, there are several shortcomings in the method of training vocational education talents, and a gap exists between graduates and the job requirements set by enterprises. Companies value practical skills and require their employees to be able to solve problems in the production line. The main teaching method used by vocational institutions is the traditional classroom lecture method, which poses a challenge to the development of students' problem-solving skills. As an important part of vocational education, skills competitions can promote the internal development of vocational institutions. As an important supplement to traditional classroom, it is a strong impetus for the reform and innovation of the talent training model. Taking the Mechanical Innovation Skills Competition as an example, students, under the guidance of their instructors, are required to design and manufacture products on their own. Whether in the design and manufacturing process or the product optimization process, students will inevitably encounter problems.

In April 2022, the Chinese government introduced the "Law on Vocational Education," which emphasizes the role of skills competitions in vocational education. The document states that vocational institutions should provide a platform for technical skilled personnel to showcase their skills and compete with each other and continue to train more high-quality skilled talents through skills competitions [2,3].

2. Literature review

What is the role of skills competitions in promoting vocational education? Early scholars have carried out research work in different fields. American scholar Liu [4] argue that participating in skills competitions is a win-win situation for both students and teachers. He believes that teachers would be able to improve their professional competence, and thus the quality of teaching, while students can consolidate and improve their professional skills and enhance their overall quality. In a study, Japanese scholar Wan [5] used big data to investigate the intrinsic relationship between vocational skills. His findings have provided a theoretical basis for other vocational skills research fields, including vocational skill training, vocational skill mining, and vocational skill identification. Wu [6] has conducted an in-depth analysis of the problems in digital education and suggested the addition of a simulation operation competition module within the operating system, where students would play games (compete with each other) to complete learning tasks, thus improving the quality of teaching and learning. German scholar Green [7] has reformed the curriculum based on the core skills theory. He has discovered that highlighting core skills in teaching enhances the integration of academic and vocational learning through teaching experiments. Zheng [8] explained the importance of cultivating applied senior talents from the perspective of the rapid development of the sports market and analyzed the relationship between vocational skills competitions and the cultivation of applied talents. She designed a new system for cultivating applied talents based on skills competition, thus providing a reference for cultivating applied talents in sports economy management. Li [9] analyzed the importance of the "tiered ladder" training mechanism in the context of vocational skills competition, taking secondary-level electronics students as the research subject. Maia [10], a British scholar, believes that skills competitions can improve the attractiveness of vocational education. He conducted 110 interviews with contestants from a skills competition. Based on these data, he analyzed the potential contribution of skills competitions to revitalizing British vocational education. In a study, Lv [11] analyzed the methods and ideas of industrial product innovation practice based on a case of "industrial product digital design" in a senior vocational skills competition. He believes that skills competition is important for curriculum reform and students' innovation ability development.

3. Research logic

The previous section discusses the views of scholars, in which they all agree that skills competitions are important and contribute to the enhancement of students' abilities. However, there are only a few literary works on the analysis of typical cases. This study analyzes the role of skills competitions in promoting students' problem-solving skills through their participation in the "Internet +" College Student Innovation and Entrepreneurship Competition. The research logic is shown in **Figure 1**.

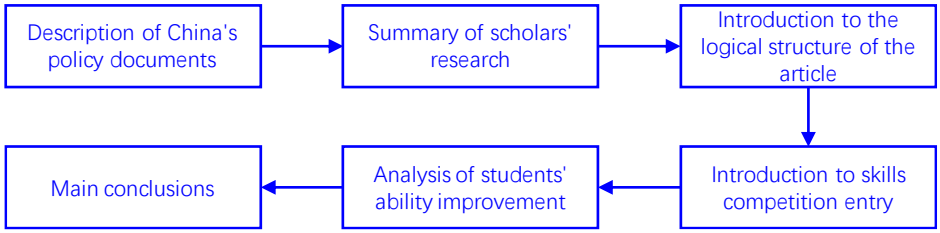

Figure 1. Research logic diagram

First, the Chinese government's education policy is described in this paper. Second, the perspectives of scholars are reviewed. Third, the skills competition entry is presented, along with the problems faced by students. Fourth, the ability improvement process of the students is analyzed with regard to the four problems addressed. Suggestions are then made for vocational institutions to increase their participation in skills competitions.

4. Skills competition entry

Five students from Beijing Polytechnic formed a team and participated in the "Internet +" College Student Innovation and Entrepreneurship Competition. Under the guidance of the research team, the participating team preliminarily formed the "Unmanned Disaster Rescue Vehicle" (**Figure 2**) as an entry. The application scenario of the entry is as follows: at the disaster scene, the unmanned rescue vehicle enters the hazardous area to transport emergency rescue materials (such as medicines and rescue equipment).

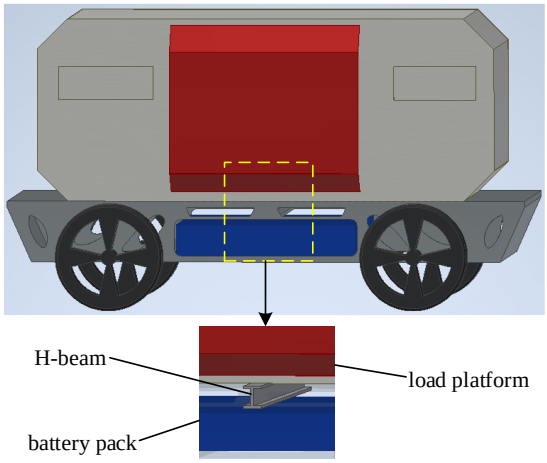

Figure 2. Structure of the skills competition entry

It can be seen from the application scenario that the load capacity of the rescue vehicle is an important parameter. As shown in **Figure 2**, the upper part of the rescue vehicle is a load platform, and below the load platform is a battery pack. The load platform is separated from the battery pack by a load-bearing steel beam. Obviously, an overweight load will cause severe bending deformation of the beam, pressing the battery pack and causing an accident. The students' creativity is evident from their work. However, many factors need to be considered to complete the design and the production. The key, yet difficult aspect, of the design is the safety of the work.

5. Promoting effect and analysis

5.1. Solving the problem of untestable situation

In order to ensure the reliability of the entry, the students wanted to carry out a three-point bending mechanical experiment to test the bending resistance of the H-shaped steel beam (as shown in **Figure 2**). However, the school did not have the corresponding mechanical experimental equipment or cutting device to cut the H-beam according to the sample size requirements of the three-point bending test equipment. Therefore, the idea of conducting the experiment could not be realized. In order to improve the safety and stability of the entry, it is necessary to test the mechanical properties of the beam. How then to solve the problem of not being able to conduct experiments? The students had to think of a solution. After searching from various books to look for a solution, they proposed a solution, whereby simulation would be used to simulate the deformation. This solution was approved by the instructors. The research team introduced the basic theory and related software of finite element to the participating team. In order to establish a more

accurate model for bending performance simulation, a geometric model must be established.

5.2. Solving the problem of establishing a geometric model

In order to exercise the students' problem analysis and drawing abilities, the task of establishing a geometric model was assigned to the students by the research team. The students looked up various relevant materials during their spare time and came up with specific dimensions for the beam. Subsequently, they drew a geometric model diagram, as shown in **Figures 3** and **4** (the diagrams were drawn by the students). The geometric models drawn by the students were approved by the instructors. On this basis, the finite element model was built and computed on the server.

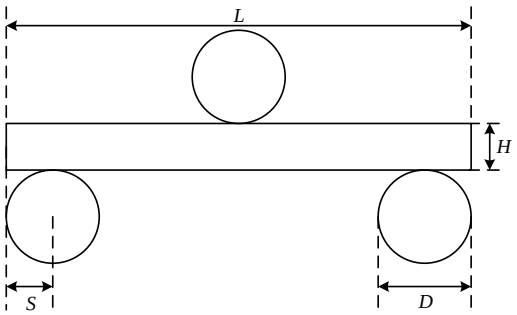

Figure 3. Geometric model of the H-beam bending test

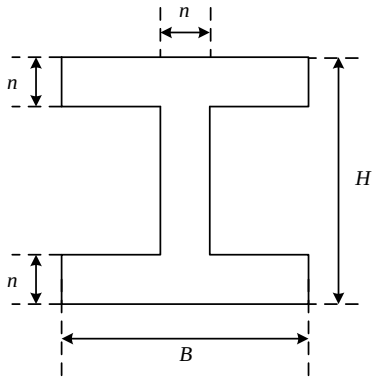

Figure 4. Cross-section of the H-beam

5.3. Solving the problem of data analysis

It is necessary for students to possess basic data analysis ability. Skills competitions provide students with the opportunity to collate and analyze data. What data should be obtained through simulation technology, and how to set specific parameters? Therefore, students are required to plan. The data to be measured are as follows:

(1) the stress distribution of the beam corresponding to each reduction amount and the maximum stress value;
(2) the pressure value of the load platform (self-weight is not considered) corresponding to each reduction amount.

The instructors carried out the modeling and simulation work. Through simulation, a lot of data were obtained. The students were required to process and analyze these data, including the maximum Mises stress values corresponding to different depressions (as shown in **Figure 5**). In order to complete these data processing tasks, the students learned the Origin software by themselves and made drawings in strict accordance with the requirements of the paper.

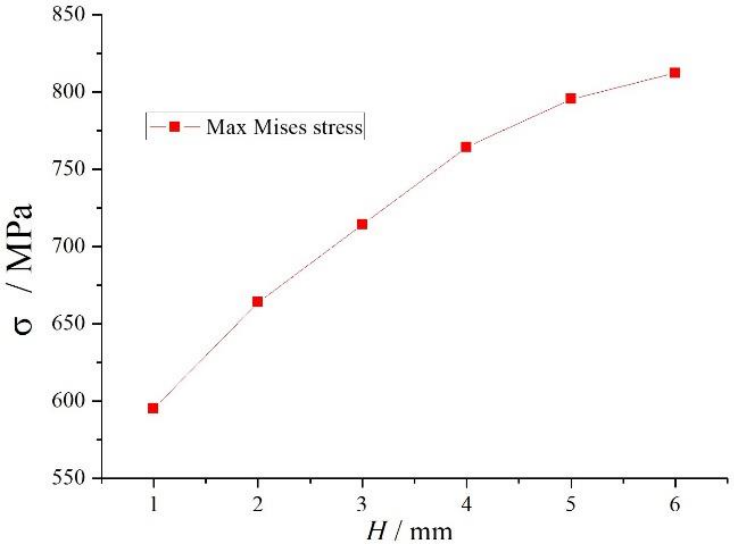

Figure 5. Maximum Mises stress values corresponding to different depressions

5.4. Solving the problem of less content in the declaration

As mentioned earlier, analyzing the problem is important, but solving it is even more critical. At the beginning, when preparing to write the declaration, the students had no idea how to start. Under the guidance of the instructors, the students came up with an overall plan. They divided the declaration into several parts, in which each part was analyzed according to the following questions: "What are the problems faced?", "What is the solution?", "What are the supporting figures and data?", and "What are the main conclusions?". With such an overall plan, the students completed the application. The colors in the stress nephogram (as shown in **Figure 6**) were the highlights of the declaration. The redder the color, the larger the stress, while the bluer the color, the smaller the stress.

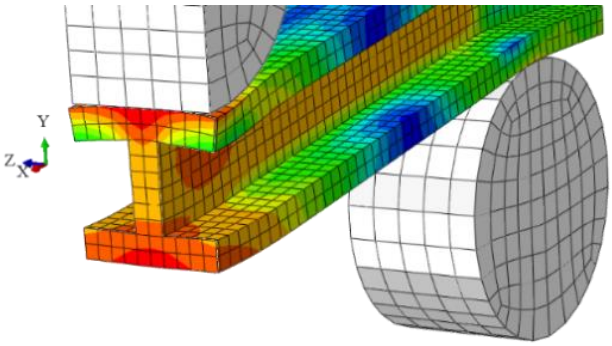

Figure 6. Stress nephogram of bending deformation of H-beam

6. Conclusions

The current professional talent training system of vocational colleges has several shortcomings, and a gap exists between skilled talents and the job requirements set by enterprises. Vocational skills competitions are a major reform and conceptual innovation of the vocational education system. It is necessary for students in vocational colleges to participate in skill competitions. However, it is inappropriate for schools to overemphasize the importance of obtaining award certificates; instead, teachers should attach importance to the process of improving students' ability to analyze and solve problems.

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Disclosure statement

The authors declare no conflict of interest.

Author contributions

S.W. and F.P. conceived the idea of the study and wrote the first draft of the paper. M.L. revised the article's format.

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