

Reform of the examination and evaluation system for the mechanical specialty in universities

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ABSTRACT: Against the background of high quality talent cultivated through higher education, this article considers the drawbacks of the current examination and evaluation methods in universities. The diversity and dynamics of the examination form, the comprehensive and scientific content of the examination, and rationalisation and diversification of examination evaluation were studied. Further, a pilot reform was carried out in the main course of the mechanical specialty, covering material, such as mechanical principles. It has a certain theoretical and practical significance for cultivating and improving the comprehensive ability of students in the mechanical specialty.

INTRODUCTION

Examinations have been an important part of teaching activities in universities, and have been an important means of evaluating teaching. The examination has been closely related to teaching, learning, as well as education quality and student quality.

The basic functions of the examination cover its several facets: assessment, guidance, incentive-providing, evaluation and feedback [1]. Although the past examination and evaluation methods of universities played an important role in China, these methods rarely took the teachers and students as the focus. Many examinations did not correspond to the examination functions, so student initiative was difficult to exercise. Even the creativity of students was being stifled, and it was not conducive to the cultivation of innovative talent.

In recent years, the examination system has been reformed in many universities, through reforms, which included paying attention to ability evaluation, enriching the examination form and promoting multiple evaluations, etc. These reforms had a certain effect on cultivating the comprehensive ability of university students, but there was still a big gap to the expected reform goals.

Taking a course from the mechanical specialty as the research object, and combining it with several important courses in the mechanical specialty offered at Wuhan University of Science and Technology, China, the diversified, dynamic, open examination and evaluation system was researched and reformed. The aims were to refine the goals, diversify the content and method, monitor the process and evaluate the effect. If the feasibility and effectiveness of the reform programme was confirmed, it could be extended to other professional courses, so that innovative talent cultivation under the new situation could be adapted.

EXISTING PROBLEMS IN THE CURRENT EXAMINATION SYSTEM FOR CULTIVATING INNOVATIVE TALENT

It can be seen from Figure 1 that there are problems and influences on the cultivation of innovative talent.

Lack of Understanding of the Examination Function and Examination-oriented Trend

Examinations should be defined for universities using a variety of ways and means to carry out a comprehensive evaluation of students. However, the actual situation was that teachers regarded examination scores as an evaluation conclusion at the end of the course for students, and the examination scores were the main basis for their appraisal, awards and graduation. Examination results were a quality index to measure the effectiveness of teaching and learning,

and it was a method rather than a purpose. However, teachers, education administrators and students have diverse ways of guiding, motivating and modelling the function of examinations. The evaluation goal was the accumulation of knowledge and memory, the judgment and evaluation was very simple.

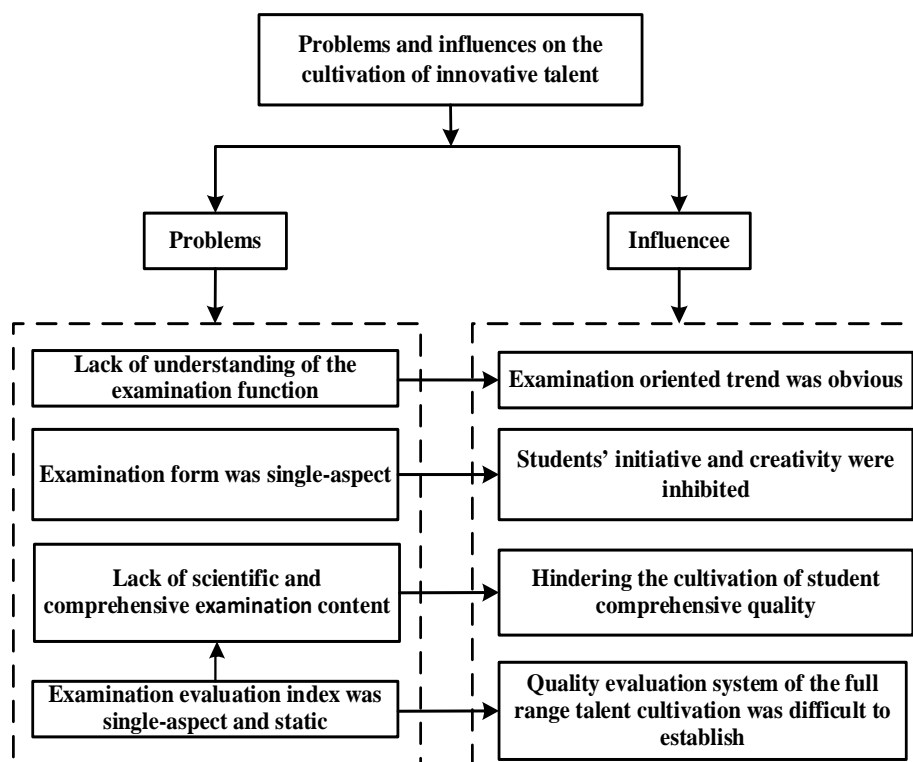


Figure 1: Problems and influence on the cultivation of innovative talent.

An examination-oriented tendency was more obvious in examinations; the value function of the examination score was over-emphasised. Students treated the examination in a more and more utilitarian way and they paid little attention to ability cultivation, which could enable them to solve practical problems. Instead, students opted for rote learning and cramming before an examination, thereby achieving the purpose by passing examination.

Single-aspect Examination Form was not Conducive to Stimulating Students' Initiative and Creativity

At present, the final examination is the main form of course examination in universities. All of the students proceed to a unified examination. There were no exceptions, especially for those students who have the expertise to provide an examination. The form of examination mainly emphasised a written examination, and the evaluation of student results was mainly based on results from the final examination. The final examination was more focussed on theoretical and standardised examinations, and less focussed on process examinations, comprehensive examinations and the evaluation of ability.

Although the diversification of examinations has been approved widely at universities, in reality, they tended to simplify the examination form. Many universities set up standardised teaching methods: paper contents, answering methodology and scoring criteria were clearly defined. Therefore, a form-based unified paper format was set up for each course. These examination forms were less used for oral examinations, focus-group discussions, course projects, reports, and so on. Many teachers adopted the simple examination form to evaluate students.

The single-aspect examination form was not conducive to talent cultivation in universities, and the students' learning usually involved cramming rather than flexible learning methods, which have affected the students' quality cultivation. On the other hand, the lack of dynamic feedback information in the teaching process caused a disjunction between teaching and learning; it was not conducive to cultivating students' self-study ability.

Lack of Scientific and Comprehensive Examination Content was not Conducive to the Cultivation of Students' Comprehensive Quality

At present, the examination questions come from the teaching material, so the examination trend is for rote learning, memorisation and understanding book knowledge. The *standard answers* to questions often could be found in the teaching material, and the evaluation of students' skills, operations and practice ability was tested less often. The content of the theory with practice was rarely used and cutting-edge knowledge about the course and dynamic development was not tested.

On the other hand, the examination pattern was mostly based on computation of choice, judgment, short answers, calculation and standardised questions, but comprehensive questions, analysis questions and discussion topics were used less; there was little space for students to respond freely [2].

At the same time, examinations were not carried out according to the characteristics of the students. The uniform syllabus required the same examination paper for different teachers in the same course, which led to the teachers teaching without *personality*, and limited the engagement of teachers' personal characteristics. On the other hand, unified content and uniform standards of the examinations did not give students enough opportunity to demonstrate their potential. The individual differences of students were neglected, and the students' creative consciousness was restrained. The ideal state was that the teacher should teach according to the syllabus, but it was not limited by the syllabus. According to the characteristics of the teaching object-designed examination content, different subjects responded to different topics, testing fully the ability of each student.

The bias of examination content required students to memorise and was not conducive to the cultivation of students' divergent thinking, team spirit and critical consciousness, and inhibited the students' learning enthusiasm.

Single-aspect and Static Evaluation Index and Personnel Training Quality Evaluation System in all Directions not Established

A quality evaluation system of personnel training is one of the important bases to determine the direction of education. The traditional quality evaluation index of personnel training in China is single-aspect, and it is often based on the students' final examination results; and the process control of the students' learning is also lacking. The evaluation of students in universities cannot be based on consensus. However, the current situation was labelled with a single standard and was uniform everywhere. The diversification of personnel growth patterns and evaluation models was based on a single standardised stand.

Thus, it can be seen that the current university examination plays an important role, but people's thought and understanding of the formation of examinations, examination content, evaluation and many aspects are not scientific. At the same time, although the current examination also requires teachers to carry out examination situation analysis, it is only a formality. The teaching effect and the analysis of knowledge application receives less attention and it cannot reflect the problems in the examination paper to students. Therefore, it is necessary to reform the examination system of the course and to establish a scientific and reasonable examination system.

REFORM METHODS OF EXAMINATION AND EVALUATION SYSTEM FOR THE MECHANICAL COURSE

In view of the main problems existing in the university examination system and examination reform orientation, the examination content and mode of the mechanical specialty should be reformed comprehensively and the diversity, research and openness of assessment should be emphasised. In order to adapt to the new situation of personnel training, the objective must be refined, the diverse modes should be strived for, the process should be monitored and the effect should be evaluated [3].

Rethinking the Concept of Examinations

The establishment of a scientific examination concept is the premise of examination reform, which would create a good environment for the reform of personnel training. The scientific concept of examinations proceeds from *people*, with emphasis on the comprehensive and balanced development of students' quality. The purpose of the examination is not only to make students master knowledge from books, but also to make students willing to learn more proactively, and for them to become good at solving problems using these means. At the same time, the scientific examination concept is also required to test the students' non-intellectual factors, so that they can form a correct view of the world, life and value, and fully reflect the educational function of the examination.

Therefore, it should be realised by students, teachers and educational administrators that an examination is only a means of evaluation, which aims at testing students' basic knowledge, finding out about existing problems in teaching, testing the students' study effect, supervising students' learning and feeding back the examination results in a timely manner.

Under the circumstance of recent history, higher education should be transformed from an examination-oriented educational model to quality education as soon as possible, and university administrators, teachers and students should acquire with this a kind of *transformed ideological consciousness* [4]. Therefore, students' development should be regarded as a goal of examinations and students' comprehensive development should be central to assessment activities.

Attention should be paid to each student's personality and specialty skills, so that they can assert their advantages and potential. At the same time, through guiding the students' learning motivation and curiosity, and cultivating students' independent thinking ability and innovation consciousness, students' personality will develop comprehensively, so that they realise their personal value and make a great contribution to society.

Exploration of the Diversified Examination Mode

In order to explore the diversified examination mode, an ideal syllabus should be made according to the content and characteristics of the course and the specific situation of the students. Diversified test modes appear in diversified test forms, and appear in both closed-book and open-book examinations, both written and verbal, both knowledge examinations and papers or case discussions, both theory examinations and skill practice, both memory tests and rational and analytical thinking, both summative examinations and periodic evaluations, and both personal abilities and team work spirit. At the same time, students' personality and specialties should receive full attention, and teaching and testing should be in accordance with their aptitude, so that students seek their own development mode and develop from different angles and different approaches.

Starting from quality education, multi-level and flexible examination methods should be established and dynamic comprehensive evaluation models combined of periodic process test and final evaluation actively explored. Combination of various forms and high value of process evaluation are a comprehensive aspect of students' ability. Periodic tests include monthly examinations and mid-term examinations. Final examinations mainly adopt the closed-book mode. The test form contains the theme discussion, special defence, design and production, research projects, research analysis, research papers, model making, software development, engineering practice, and so on.

Taking the national final course - *Mechanical Principles* as an example, the course was established to be diversified, to be a dynamic pilot reform, which moves away from the single form of only depending on the final examination, as in the past. The total course grade consists of several parts: periodic tests, homework, curriculum projects and the final examination. Among them, the periodic test scores account for 30% of the total grade, including a monthly examination and a mid-term examination.

The form of examination should have knowledge tests, analysis and design, curriculum short papers, panel discussions and so on. Homework is after-class practice of each chapter, which accounts for 20% of the total grade, and there are also two projects that need to be done, which account for 10%. The final examination adopts a closed-book examination, which accounts for 40%. The test content mentioned above should be finished by students independently and some by groups. The mechanical principle experiment is set up as a stand-alone lesson, which is graded separately based on an overall completion of experiments.

Design of Examination Content Guided by the Comprehensive Ability Cultivation

In order to overcome the drawbacks of past examinations, which presented theoretical material and much rote learning, it is necessary to design scientific, comprehensive, open and individualised examination content, and to encourage teachers to try new approaches in examination propositions and scoring criteria.

The scientific nature of test content is that the propositions not only reflect students' *book* knowledge, but also play a role in guiding students towards divergent thinking, vivid thinking and creative thinking. The comprehensiveness of text content is that the propositions should cover internal and external textbooks, theory and practice content, memory and rational content, simple and complex content, and so on, instead of being limited to the key knowledge textbooks. Of course, it is necessary to combine a variety of examination forms.

Openness means that teachers' propositions and students' answers have greater freedom, which breakthrough the form that pays more attention to standardised examination papers and answers. It will also mobilise teachers' and students' subjective initiative, encourage creative thinking and examine students' ability to solve practical problems. Personalisation refers to arranging examination content based on the actual characteristics of different courses. At the same time, teachers should understand each student's personality and teach students in accordance with their aptitude, so that they are able to develop all kinds of talent.

For mechanical students, the examination should be focused on examining professional knowledge, scientific computing ability, engineering practice ability, software applications ability, innovative design ability and other professional skills [5]. Taking the Mechanical Principles course as an example, the design of test content is built around monthly and final examinations and content that has adequate coverage. Combined with the degree of importance of teaching content and the factors of the teaching time, weights should be allotted reasonably between content and goal and the weight of high-level goals should be increased appropriately.

Basic knowledge should be examined, including students' understanding, application, analysis and comprehensive ability, and the argument, analysis and innovative design topic should be increased to promote the development of creative intelligence. The content of the project course is set as follows: mechanism motion simulation programming, innovation mechanism or mechanical system design, 3D animation simulation of the organisation, writing papers in the field of machinery, oral presentations, mechanical manufacture and engineering training, and so on. Students can choose two courses to be completed independently or within a group according to their own specialty and interest, which can mobilise enthusiasm and cultivate comprehensive ability [6].

Establishment of Evaluation System of Comprehensive Talent Training Quality

The current talent training evaluation system is too narrow, and test scores are always the main basis of rewards and employment. The single, static talent evaluation system is unscientific. The system under the new situation should be diversified and dynamic.

Performance evaluation is an important part of the test process, which affects the fairness of the examination and test quality. Diversified forms and content of the science are premises of a diversified and comprehensive system. According to the characteristics of the course, the teaching goal, the examination topic and others should be used to establish scientific and flexible scoring rules.

At present, the results of many courses use the *usual results + final examination results* approach. The *usual results* generally refers to operations, attendance and experiments. It takes the total score of 20%-30%. Due to the low proportion of the usual results, there are few things that can be examined. It cannot reflect the students' potential and quality.

The University has carried out reform of the performance evaluation of the Mechanical Principles course, and established a diversified evaluation method. The main approach is to reduce the final examination results from 40% of the total score. The other 60% are given by the students' usual results. Usual results are various, periodic and dynamic assessments. The examination has various forms and multiple types of content. This examination and its assessment can also include discovery, feedback and solutions to problems that can be found in the usual teaching and learning.

MEASURES AND RESULTS OF EXAMINATION AND REFORM

Measures and results of the examination reform can be seen in Figure 2.

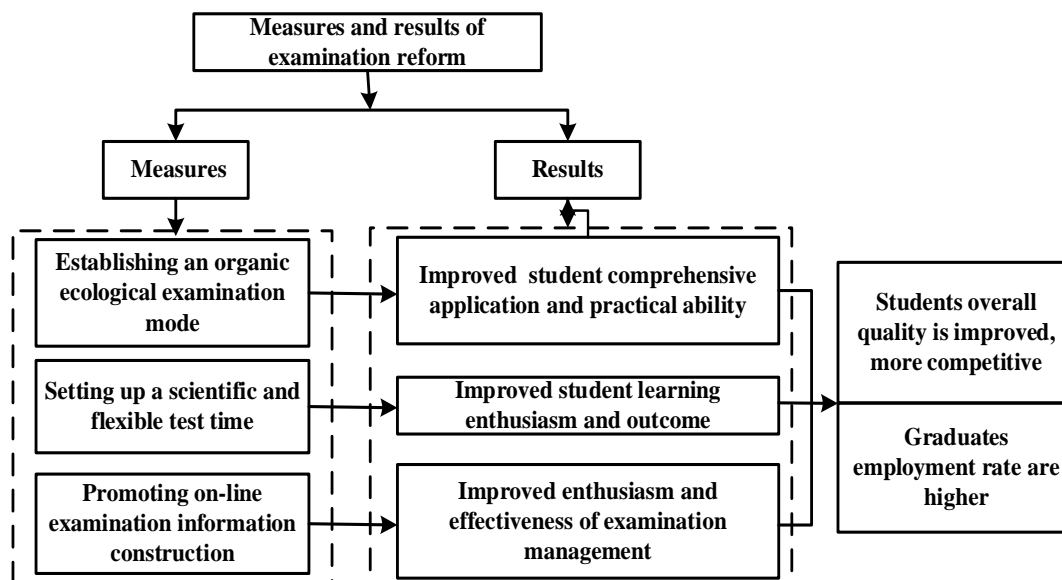


Figure 2: Measures and results of examination reform.

The Establishment of a Multi-course Continuity, Progressive, Integrated Examination Mode

The current curriculum examinations are basically independent, that is, the examination and the content are not directly related. This will result in the need for fusing of classroom knowledge in a short time. So, examination reform should be advanced to become multi-course, progressive and integrated. First of all, the task is to decompose each course according to the industry background and professional characteristics of the university, such as design of integrated mechanical and electrical teaching. For example, mechanical drawing, mechanical principles, machine design, mechanical manufacture technology, hydraulic transmission, electric control and PLC applied techniques should be combined to promote examination reform.

Examination reform sets the specific mechanical system as the object. In the mechanical drawing examination, mechanical parts mapping should be completed to exercise basic structure analysis and mapping ability. In the Mechanical Principles examination, the work principle and institutional plan should be designed, the 3D model by software should be built and motion simulation by ADAMS should be completed. In mechanical design and other classes, structure design, strength check and optimisation design of mechanical parts should be completed. The 2D engineering drawings and 3D solid models should be given and analysed using CAM/CAE software. In the *Mechanical*

Manufacturing course, manufacturing processes and assembly plans, fixture designing and the tool equipping, processing technics of the component should be completed. Hydraulic system design of the machine in the *Hydraulic Transmission* course and the design of the control system in the electric control and PLC applied technique should be completed. This part of the examination can also be used to choose good work for the Mechanical Innovative Design Competition for National College Students.

This kind of examination reform will promote the integration of knowledge, develop students' comprehensive application ability and engineering practice ability.

The Establishment and Appointment of Flexible Examination Time

Now, the examination is generally divided into a curriculum examination, an arranged examination and a retake examination. The examination time is arranged at the end of the course, the end of the term, the beginning of next semester or the next year. This arrangement has its reasons. But, with the deepening of the education reform, many universities are now beginning to implement a credit system reform; the test time should be more flexible. Each student is different in learning ability, the specialty and the hobby. Under the premise of the students' usually diversified assessment, according to the specific circumstances of different students, they can make an application and make an appointment about the examination time in advance, and the university will help them to organise the examination. Students with good grades can take the examination and even graduate in advance.

Construction of On-line Examinations and other Systems

In order to achieve a flexible, forward-looking and personalised examination mode, especially in the characters of large subjects, large numbers of participants and a longer test period, it is necessary to promote the construction of an information examination system. It is impossible to complete this work in the traditional manual operation. Computer technology, network technology, information technology and other technologies can be used to improve the scientific and effective examination management.

The Results of Examination Reform

After three years' reform, teachers find and solve the learning problems of students in time and guide them to develop through ability training. This reform also reduces the examination pressure, stimulates the interest in learning, improves the effect of learning and cultivates comprehensive ability, communication ability and cooperation ability at the same time. During the past three years, the students have taken part in the Mechanical Innovative Design Competition for National College Students, and other competitions, such as the *Challenge Cup* Business Plan Competition for National College Students, the *Challenge Cup* Extra-curricular Academic Competition Works of Science and Technology for National College Students, the National Contest of engineering Training for Comprehensive Abilities for College Students, the National Contest of Digital Design of Mechanical Product for College Students, the Students International Olympiad on Mechanism and Machine Science, and so on.

The students have been able to get more than 30 awards including the national second prize in the 2010 3DDS competition, the national second prize in 2012 of National Contest of Digital Design of Mechanical Product for College Students, the national second prize in 2013 of 3DDS, the national first prize in 2014 of National Contest of Digital Design of Mechanical Product for College Students, the national first prize in 2014 of Mechanical Innovative Design Competition. They have also applied for more than 10 patents and have published more than 10 papers. It can be seen from these academic achievements that students are more competitive. Graduates are more popular with employers, which directly improves the employment rate of the university's graduates, and this also reflects the success, which has flowed from the reform of the examination process [7].

CONCLUSIONS

In order to adapt to the new situation of cultivating innovative talent in universities, reform of examinations and the evaluation system is imperative. Examination reform is an important breakthrough in education reform, and it will lead to good results if the focus is on the reform of the examination and evaluation methods. The reform and evaluation of the examination system is a systematic project, which requires teachers, students and education management to work together to establish a modern examination concept, cope with the teaching syllabus, teaching practice, teaching management and other aspects of reform. The reform team needs to learn from domestic and foreign advanced reform experiences and listen to the views of peer experts, teachers, students and teaching management staff. If one can take advantage of the test and evaluation, one can cultivate talent that can adapt to the development of modern society and have fine integrated quality.

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