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Exploration and practice in the establishment of a professional “Trinity” teaching platform for the mineral processing major

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ABSTRACT

Given that the traditional teaching model can no longer adapt to the current talent training program of the mineral processing industry, this paper proposes a professional teaching platform in the form of the “Trinity” teaching platform, which is the systematic training model of "theoretical teaching platform—experimental teaching platform—outside-school practice platform". Through several years of exploration and practice, this teaching system has been proved to successfully broaden students’ knowledge under the premise of establishing a strong theoretical basis. Moreover, over 85% of high quality experimental teaching resources have been made accessible to undergraduates, and such an approach has effectively promoted the expansion of teaching practice from the experimental center towards the teaching internship base and scientific research base. As a result, students’ innovative capabilities, such as a cognition ability of basic theories, experimental skills, practice techniques, field experience and comprehensive quality, have all been greatly enhanced. Furthermore, such an approach has provided a vast space for the cultivation of applied talents in the mineral processing field and multi-level innovative talents in general.

KEYWORDS

Theoretical teaching; Experimental teaching; Outside-school practice.

INTRODUCTION

As a traditional field of study in the Xi'an University of Science and Technology, the main purpose of the mineral processing major is to train advanced engineering and technical personnel in the fields of mineral processing (e.g., metals, non-metallic minerals, coal) and mineral resource utilization; such students will go on to work on aspects such as mineral production, industry design, scientific research and development, and technological innovation and management. As the enterprises' entry requirements for graduates in the mineral processing major have become increasingly higher, coupled with the reality that the mineral processing industry has put more emphasis on application ability and engineering practical ability, the traditional education model is unable to meet the enterprises' demand for talented engineers.

Over the years, the Xi'an University of Science and Technology has striven to explore innovative ways of education in order to reform the traditional education model, with its geographical features and teaching styles as the basis. To cultivate high-level professional personnel in the mineral processing major, not only are students required to have a solid theoretical basis, they are also required to be familiar with every experimental operation. In doing so, they can consolidate and deepen their understanding of theoretical knowledge during future practical experience, and thus obtain some new knowledge or inspiration that it would not be possible to obtain in the classroom. Meanwhile, students' design ideas, exploration cognition, practical skills, independent ability and innovative ability could be developed. In recent years, through constant exploration and research, professors from the Xi'an University of Science and Technology have proposed the "Trinity" professional teaching platform that aims at training students in the mineral processing major; this training model can be simplified to "theoretical teaching platform—experimental teaching platform—outside-school practice platform".

CHARACTERISTICS OF THE TRADITIONAL TEACHING MODEL IN THE MINERAL PROCESSING FIELD

As the Shaanxi Province's key discipline, the subject area of mineral processing at the Xi'an University of Science and Technology has been studied by a large number of qualified personnel who excel in coal preparation technology. With the rapid development of coal preparation technology and wide computer applications, the traditional teaching model can no longer adapt to the current talent training program of the mineral processing industry. Overall, several problems could be identified with the traditional teaching model of the mineral processing subject area.

The lagging training model

Although the education model in China has experienced changes and updates over the last century, the entire educational system still cannot rid itself of the shackles of the traditional education model. For instance, the direct purpose of school education is to simply impart knowledge, with good examination scores as the ultimate goal. As a result, a typical exam-oriented education model has been well established, and students majoring in mineral processing from the Xi'an University of Science and Technology are no exception. An adverse outcome from such a training model is that since the assessment system overemphasizes the mastering of knowledge, students rely heavily on rote memorization to pass exams, but totally lose their motivation and passion for study. In terms of the education system, because all arrangements should strictly follow the unified educational system and curriculum planning of the Ministry of Education, professional education generally lacks specificity and does not reflect the individual school's unique characteristics. As for the teaching subjects, the curriculum content is generally obsolete and out of date with modern challenges, and thus it fails to introduce students to the forefront of the development of mining technology, or the latest development in the field of mineral processing. Obviously, such a teaching model cannot meet the regional mining enterprises' demand for professional talents.

An unreasonable curriculum system

Mineral processing professionals are developing in the direction of sharing resources, gaining high economic benefits, and developing highly automated processes. Several problems exist in the original curriculum system, such as an improper balance between compulsory courses and optional courses, narrow professional width, and poor usability of teaching content. For a more cutting-edge curriculum, relevant key technologies, such as mineral processing cutting-edge technology and the comprehensive utilization of resources, need to be enriched and updated. Meanwhile, with the popularity of computers, the application of computer technology into the mineral processing field is gradually deepening. However, mineral processing related courses, such as mathematical models of the mineral processing process, mineral processing automation and CAD design, haven’t been incorporated into the undergraduate curriculum system.

An incomplete practical segment

The practical segment represents an important part of undergraduate education, and is the key to cultivating innovative talents. Cognition practice, production practice and graduation practice are all important parts of mineral processing practical experience, which enable students to learn to analyze and solve problems independently. The practical segment generally relies on the nature of school experiments and the practices of enterprises. Due to the safety issues, production status, and management strategies, which are the major concern of most enterprises, they are reluctant to accept internships; this leads to a lack of out-of-school practical sites for students majoring in the area of mineral processing. Through alumni resources, a few short-term practical positions are available. However, due to a variety of factors, the actual practical process mainly consists of visits, and students don’t have much chance to participate in the production operation process. Meanwhile, due to the relatively low assessment standards of the practical segment, in most cases students can pass such an assessment as long as they have completed their practical report, although the purpose of practical teaching is seldom met.

APPROACHES TO THE ESTABLISHMENT OF THE MINERAL PROCESSING "TRINITY" TEACHING PLATFORM AND ASSOCIATED CHARACTERISTICS

In order to overcome the shortcomings of the traditional teaching model regarding the mineral processing field, and to achieve the optimization goal of the mineral processing teaching mechanism in the Xi'an University of Science and Technology, with western (based in Shaanxi) professional training service features and geographical features fully taken into account, this paper proposes a professional teaching platform and considers the establishment of the “Trinity” teaching platform; namely, the systematic training model of "theoretical teaching platform—experimental teaching platform—outside-school practice platform".

The improvement of the theoretical teaching platform

The priority of any teaching program is about theoretical teaching, which is directly related to what kind of students to train, and how to establish a reasonable knowledge structure for students. Only students who have a full knowledge of technology, management, law and economics, and who are good at handling a variety of technical, economic and social relationships can meet the talent needs of today's society. Therefore, in the course of theoretical teaching, the cultivation of students' social skills and humanistic qualities should not be neglected. In recent years, the Xi'an University of Science and Technology has started to reform its theoretical teaching practice from the aspects of the curricular system and modern educational technology. Through the establishment of a multi-level teaching model, the improvement of teaching conditions and by incorporating modern technologies, the university strives to cultivate professional talented engineers with a solid theoretical basis, high overall quality and strong adaptability, who specialize in the mineral processing field.

In terms of the improvement of the curricular system, the overall optimization condition is the major concern of mineral processing professionals in the Xi'an University of Science and Technology, or, in other words, the goal is realized through changing the original teaching plans under the premise of

maintaining professional characteristics. The first step of optimizing the teaching curriculum is to increase the teaching hours of basic and professional courses, with their proportions going up around 10 percent. In particular, more teaching hours should be allocated to subject areas such as crushing and grinding, gravity separation and magnetic selection, floating processing, solid-liquid separation and mineral processing machinery. In addition, in order to broaden students' professional width, senior professors are invited to teach professional courses, such as clean coal technology, pulverized coal molding technology, computer applications in mineral processing, the mineral processing forefront and modern analytical techniques. Moreover, in order to improve students' humanistic qualities and innovative ability, several optional courses are available to students, including innovation projects, public relations, administration management, physical etiquette and linguistic culture. Additionally, to meet students' extracurricular interests, courses such as graphic design, high-level language programming, multimedia technology and computer networks are also available to students.

With the development of technology, modern educational technology has seeped into the classroom, which is mainly reflected in aspects such as multimedia textbooks, network resource sharing, computer assistance and video teaching. Only if there are complete hardware facilities installed can students get full access to the theoretical knowledge in a systematic, dynamic and figurative way, and consequently the teaching effect could be optimized. Therefore, in recent years, the mineral processing team in the Xi'an University of Science and Technology has invested more funds and efforts into building modern educational facilities and sites, such as campus networks and multimedia classrooms. Also, both the heuristic and discussion modes of teaching have been applied so that students can link theoretical knowledge to problems encountered during the mineralizing processing practical. For instance, in the module that deals with mineral processing machinery, professional professors will first demonstrate the operational procedures of the relevant equipment and the working mechanisms of all key parts. As a result, students will have an intuitive understanding of the relevant equipment, which could help their further study and lead to a better outcome.

The establishment of an open experimental teaching platform.

Experimental teaching is the top priority for the mineral processing field. In recent years, colleges and universities have advocated for the establishment of open laboratories that are available to students, and they have strived to cultivate innovative talents and achieve a quality education. The Xi'an University of Science and Technology has also been working on teaching reforms, with an emphasis on a teaching reform of laboratories, which aims to establish open laboratories with a favorable environment, prominent features and standard management.

The exploration of the teaching management model of laboratories with different open forms

With an increasing number of students majoring in the mineral processing area, laboratory capacity has become an issue that could constrain the improvement of experimental teaching quality. After years of trying to expand, the Xi'an University of Science and Technology has established specialized laboratories that focus on the mineral processing area in both the old and new campuses. The old campus is mainly open to graduate students, whereas the new campus is mainly open to undergraduate students. Also, once normal teaching tasks have been completed, the mineral processing laboratory located in the new campus could be partially open if the situation allows. As they rely on a gradually improved hardware within such specialized laboratories, many students take the initiative of organizing experimental groups, and actively participate in a number of extracurricular science and technology competitions. Although students in the mineral processing major of the authors' university have not yet won any contests, their ability to manipulate the equipment has been significantly enhanced.

The regular report on open experimental subjects

Professors in the field of mineral processing engineering should use their own research projects, and regularly publish the results of experiments, which do not belong to teaching plans but represent comprehensive designing experimental projects. Students could then determine what kind of experiments they plan to do according to their interests, hobbies and expertise. The design of open

experimental subjects should be completed by students independently; furthermore, they should finish the experimental report, which would then be graded by their mentors, and serve as the criteria for their score and credit assessment.

The encouragement of students to learn the operations of precision instruments

Through years of laboratory research, mineral processing professionals in the Xi'an University of Science and Technology have applied multiple new technologies and achievements to enterprises and promoted the industrial upgrading of such enterprises. The current specialized laboratories have a variety of sophisticated research equipment, such as a jet milling-classification-grouping system, coal and mineral cleaning and processing experimental platform. In the past, these sophisticated devices were only available to professors and graduate students, whereas undergraduate students rarely had access to them. Now, through the implementation of the open experimental teaching reform, professional professors release information regarding the open content and open time of such devices in advance, and all students are able to apply for the training opportunities. Through this reform, students will have more chances to work closely with high-tech equipment, and their ability to manipulate it will be greatly enhanced. Moreover, the utilization rate of such large equipment is increased, and the open laboratories will encourage students to regularly participate in the maintenance of these devices.

The strengthening of the practical teaching platform establishment.

Practical teaching represents an effective way to consolidate theoretical knowledge and deepen the understanding of such knowledge. As a professional major that is highly-application oriented, the mineral processing program puts a great emphasis on its practical teaching aspect. However, with an increasing demand for talented mineral processing professionals and the large scale expansion of school enrollment, universities and colleges are gradually facing a series of problems, such as shortages of funding for practical places, inadequate practical opportunities for students, and the lack of long-term practical teaching bases. Moreover, these problems, which have existed for a long time, have led to poor practical ability and innovative capability amongst students. Therefore, professors in the mineral processing field from the Xi'an University of Science and Technology have striven to propose new reform plans on the basis of the existing professional infrastructure and expansion of training capacity, in order to gradually improve the problems that have arisen during the course of the practical teaching process.

The strengthening of the practical teaching segment

The main practical teaching segment for mineral processing professionals in the Xi'an University of Science and Technology includes metalworking practice, cognition practice, production practice, curriculum design, graduation practice and graduation design. Through a continuous adjustment of practical time, the rearranged time schedule for practical arrangements is shown in Figure 1.

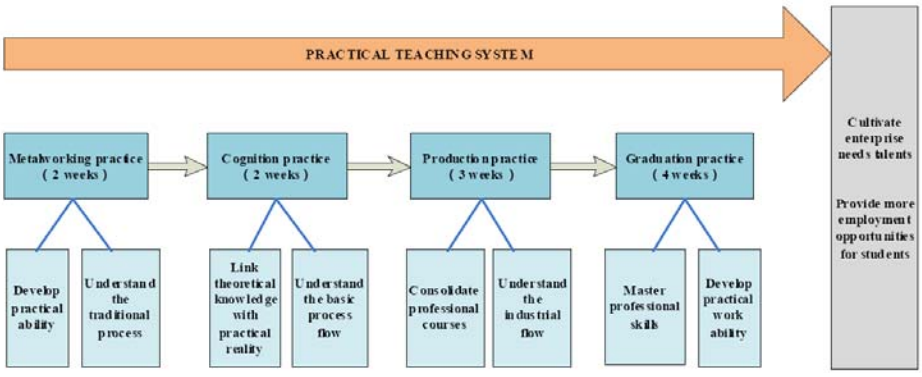

Figure 1 : The rearranged time schedule for practical arrangements

① As an important segment before the learning process of specialized courses, cognition practice could help students better understand the basic process flow and equipment functions. Moreover, it is a convenient way to link theoretical knowledge with practical reality, which will facilitate students' in-depth study of specialized courses in the future. The time frame of the adjusted practical arrangements spans two weeks, which takes place in the second semester of the sophomore year, just before the specialized courses offered to junior students.

② Production practice allows students to consolidate their understanding of professional courses. Moreover, through hands-on experience of how enterprises work, students are able to better understand the industrial flow and existing problems. Mineral processing professionals in the Xi'an University of Science and Technology allow three weeks for production practice, during which period students are required to review all the knowledge they have obtained from courses within a one year timeframe, such as "crushing and grinding", "gravity separation and magnetic separation", "mineral floating selection" and "solid-liquid separation". Furthermore, they need to carry out an on-site data analysis within a limited time frame. Therefore, the teaching time for production practice will be gradually extended in the future in order to further help consolidate the students' basic skills.

③ As the last and the most important segment of practical teaching, graduation practice could enable students to further consolidate all the professional courses and basic professional skills, and thus cultivate their work capabilities. For the mineral processing major in the Xi'an University of Science and Technology, a time frame of four weeks is allowed for graduate practice. Going by the students' practical experience in previous years, a four-week graduation practice is sufficient for students to consolidate the basic theoretical knowledge that they have learned, subsequently they should focus on graduation design work for the rest of the semester with continuous innovations.

The establishment of an outside-school practical teaching base with cooperation over the long-term

For mineral processing professionals, the outside-school practical teaching base represents an integral part of the teaching segment that provides a solid guarantee for developing students' operational skills and practical experience, as well as cultivating their applied talents. When mineral processing professionals in the Xi'an University of Science and Technology selected an outside-school practical teaching base, they followed the principle of "good matches of career and personal values, proximity cooperation and long-term cooperation". Moreover, they considered a company's development scale, market benefits and practical conditions. Currently, they are in a long-term cooperative relationship with the Ningxia Coal Industry Group and Shanxi Coal Industry Group, and have established several outside-school practical teaching bases. On one hand, these enterprises have cultivated many applied talents that are in demand and attracted more attention and investment in the establishment of outside-school practical teaching bases; on the other hand, students should have more employment opportunities as a result of these bases.

The reform of the graduation design's assessment mechanisms

Graduation design is a process that not only enables students to integrate the theoretical knowledge they have learnt over the years with engineering practice, but also represents a comprehensive training process. Over a number of years, professional professors in the mineral processing area of the Xi'an University of Science and Technology have been strict about the students' graduation design, and are continually proposing new teaching ideas. On one hand, they are strict about aspects of the selected topics of design, process monitoring and quality assessment, with the expectation that the students' engineering quality and innovative cognition could be enhanced. On the other hand, the presence or absence of innovative ideas in graduate design will determine whether a student can get a good grade or not. In particular, a thesis defense puts an emphasis on checking whether a student has brought forward new ideas during the design process.

THE ACHIEVEMENT AND ENLIGHTENMENT OF THE MINERAL PROCESSING "TRINITY" INNOVATIVE TEACHING PLATFORM

With an excellent teaching platform as the basis, the establishment of an open experimental teaching platform as the forerunner, and the strengthening of a practice teaching platform development as the carrier, the authors’ university has formed the “Trinity” teaching system that has been guided by professors with students that are encouraged to learn and practice freely. Through several years’ exploration and practice, it has been proved that the students’ knowledge width has been successfully expanded under the premise of developing their solid theoretical basis; furthermore, over 85% of high quality teaching facilities and resources are open to undergraduate students. Moreover, the teaching practice has been effectively expanded from the experimental center towards a teaching practice base and scientific research base. As a result, the goal of cultivating students’ innovation abilities, such as basic theoretical knowledge recognition, experimental skills, practical skills, field experience and integration capability has been accomplished. Currently, the mineral processing professionals in the Xi'an University of Science and Technology follow their school’s unique teaching styles, and carefully consider internal plans developed by the College of Chemistry and Chemical Engineering. Through resource sharing, they strive to develop professional disciplines and unique subjects, forming the education system with the slogan “promoting professional development with traditional excellent disciplines as connotations, and cultivating top-notch talents”. Specifically, they propose a new education model that aims at cultivating multidisciplinary top-notch talents who excel in the mineral processing area with the aspects of theoretical teaching, experimental teaching and practical platform all having been explicitly considered in the design of such anew education model. The ultimate goal is to open up a vast space for the cultivating of applied talents in the field of mineral processing and multi-level innovation talents in general.

For the immediate future, the mineral processing professionals in the Xi'an University of Science and Technology will continue to do more explorations in aspects of teaching, experiment and outside-school practice in order to highlight professional uniqueness. With the development of coal, metals, nonmetals and other mineral resources in Shannxi and other western regions as the basis, and with the development of provincial and national energy development strategies as an urgent requirement, the Xi'an University of Science and Technology strives to perfect the mineral processing major so that it could become a strong professional field that meets the energy development demands of Shanxi, other western regions and the entire country. Also, a large number of excellent talented professionals could be cultivated for the state and relevant enterprises.

CONCLUSION

The combination of a theoretical teaching platform, experimental teaching platform, and practical teaching base, or, in other words, the establishment of the “Trinity” teaching and training model, is a guarantee by the Xi'an University of Science and Technology that it will achieve its professional training objectives of students majoring in the mineral processing area. Through the reform of the current curriculum system and the update of modern educational technology facilities, the mineral processing professionals of the Xi'an University of Science and Technology have gradually formed an excellent theoretical teaching platform, which forms an important basis for cultivating professional talents with a solid theoretical basis, good overall quality and strong adaptability. Moreover, the establishment of an open experimental teaching platform is not only helpful for reasonable arrangements, standard management, and an effective sharing of laboratories, but is also useful for the efficient allocation and comprehensive integration of experimental equipment. At the same time, such a platform is essential for the cultivation of high talents. Additionally, the establishment of a practical

teaching base not only promotes a student's innovative spirit and practical ability, but also lays down a solid basis for their future employment and career.

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