

Construction of Online-Offline Hybrid First-class Course of Instrumental Analysis under the Perspective of "Industry, Academia, Research, and Application" Collaborative Education

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Abstract. Based on the background of "Industry-Academia-Research-Application" teaching integration, the teaching reform of Instrumental Analysis is the main research object, focusing on the reform and exploration from the aspects of teaching mechanism, teaching methodology, resource library construction, teaching team construction, teaching assessment and so on. It studies the construction mechanism of the integration of Industry-Academia-Research-Application of Instrumental Analysis; explores the specific implementation path of the integration, and researches the problems and characteristic innovations of the integration of Industry-Academia-Research and Application in the course of Instrumental Analysis.

1. Introduction

"The Outline of the Fourteenth Five-Year Plan proposes to insist on the self-reliance and self-improvement of science and technology, to focus on "neck-breaking" technologies in important fields, to promote the in-depth integration of the innovation chain with the industrial chain, the education chain, and the talent chain, and to build a technological innovation system that is a deep integration of "Industry, Academia, Research, and Application"(IARA).

IARA is a kind of project that integrates production, teaching, scientific research and practical application systematically, that is to say, with the social demand for talents as the goal, through the organic combination of the traditional university education based on theoretical teaching and the scientific research practice and social production based on practical experience and practical ability, to realize the creation of highly competitive new high-quality professionals^[1]. Talent Cultivation. The IARA cooperative education targets the whole process of talent cultivation program, therefore, how to combine the IARA integration construction with the teaching construction of specific professional courses, and to build the new teaching method of IARA integration? Therefore, how to combine the integration construction of IARA with the teaching construction of specific professional courses, build a new teaching mode of IARA integration, and make the professional course construction map the connotation of social demand are the practical problems to be solved in the process of undergraduate teaching, and it is also the need to implement the reform of the innovative talent training mode of higher education.

Instrumental analysis course is a specialized course involving a wide range of subject knowledge and

difficulty^[2]. It is an analytical method established on the basis of physical and physicochemical properties of substances, using special instruments for qualitative, quantitative and morphological analysis of substances, which is widely used in the industries of medicine, chemical industry, biological sciences, material science, pharmacology and environmental protection. Nowadays, the use and popularization of large-scale analytical instruments have entered a new period of rapid development, however, there is a serious lack of practical, skillful and innovative instrumental analytical talents who can adapt to social and economic construction^[3]. At present, most of the instrumental analysis course teaching focused on theoretical knowledge, due to the difficulty of the course, teaching methods and tools are more traditional, the teaching effect is difficult to meet expectations, the update of experimental equipment to keep up with the pace of technological updating, while the price of large-scale instrumentation is high, the teaching conditions of colleges and universities are limited, the students to get the actual hands-on operation of the opportunity is not much, resulting in the lack of hands-on practical ability and innovation ability of the students, the comprehensive quality can not meet the requirements of the enterprise industry^[4]. Quality can not meet the requirements of enterprises and industries.

To solve the above problems, the instrumental analysis course is necessary to carry out "industry-university-research" integrated teaching mechanism construction, need to reform the course teaching methods, teaching mode, assessment methods, the establishment of "industry-university-research" resource base and course teaching team, also need to reorganize the training objectives of talents, improve the relevance and practicality of the course teaching, enhance the students' practical hands-on and innovative capabilities^[5]. Talent

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training objectives, improve the relevance of course teaching, practical, enhance students' practical ability and innovation ability, effectively solve the problem of poor match between talents cultivated in colleges and universities and talents demanded by enterprises, and cultivate high-quality and applied instrumental analysis talents.

2.Content and methods

2.1.Building a mechanism for integrating IARA

According to the teaching of instrumental analysis courses and the application of the relevant enterprises and industries, the teaching content is designed as a whole into four modules: industrial teaching, university teaching, scientific research teaching and application teaching, and builds an integrated teaching mechanism of "industry, academia, research and application" for instrumental analysis courses.

In the integrated construction of IARA of instrumental analysis course, the functions of industrial teaching module are: to provide teaching objectives of the course according to the industrial needs of enterprises, to broaden the horizons of teachers and students, to reorganise the training programme for talents in applied chemistry; to build internship bases by using the venues and resources of enterprises, and to carry out case study-type real-life teaching. The functions of school teaching module are: to implement the basic teaching of theoretical knowledge and experimental skills, cultivate students' independent learning ability, make full use of the resource library to improve their own knowledge system; to innovate and adjust the basic theories and experimental contents, and to build virtual simulation teaching. The functions of the research teaching module are: to provide cutting-edge knowledge and advanced skills, to integrate research conditions into practice conditions, to cultivate students' research and innovation ability, and to carry out innovative practical teaching. The function of the application teaching module is: to take practical application as the ultimate purpose, implement project-based teaching, and carry out comprehensive project-based practice, to improve students' comprehensive ability and quality, and cultivate high-quality application-oriented talents.

2.2. Bridging the IARA integrated teaching

Teaching team is an important organisational form of teaching construction, and teachers are important factors affecting the teaching effect. To achieve a high degree of integration of "industry-university-research-use" in the teaching of instrumental analysis, it is necessary to build an efficient operation team. The construction of instrumental analysis classroom teaching team should be comprehensively constructed from the four aspects of "industry-university-research-use". From the perspective of industrial teaching, enterprises send high-level technicians or senior instrumental analysts to universities as part-time teachers, enriching the human resources of the teaching team, enhancing students' understanding of the

practical operation of enterprise instrumental analysis, and making it easier for them to adapt to the work of the enterprise industry in the future; from the perspective of teaching in colleges and universities, teachers of instrumental analysis specialised courses adopt the teaching mode of one teacher, one instrument, and each type of instrumentation is taught by the teachers who are good at it. From the perspective of scientific research teaching, teachers of discipline competition, teachers of scientific research training programme and senior undergraduates are organised as members of the team, so that the content of competition and scientific research can be closer to classroom teaching, and can also play the role of transferring, helping and leading; from the perspective of application teaching, the scope of teachers' composition is enlarged, and in addition to teachers of instrumental analysis, teachers who have achieved remarkable results in the application of instrumental analysis are hired as team members. The team is composed of teachers who have achieved remarkable results in the application of instrumental analysis. Each teacher in the teaching team has his/her own duty, and the teachers take the standard of instrumental analysis talents demanded by the society as the teaching goal, complement each other's knowledge to cultivate professional talents together, and each teacher is responsible for his/her own specialised teaching content, and gives full play to his/her strengths to provide teaching for the students, so as to realise the instrumental analysis course in the "production", "learning", "teaching" and "learning". "Learning", "research" and "use" of the instrumental analysis course in the "production" and "learning", "research" and "use" of the four aspects of the seamless link, but also to achieve the effective docking of the training of university personnel and the needs of enterprises and industry personnel.

2.3. Construction of an integrated resource base for IARA

In order to further develop and deepen the integrated construction of instrumental analysis, it is necessary to create a matching teaching resource library, which is also a manifestation of the improvement of teaching quality. Resource library construction can integrate and optimize the resources involved in industrial teaching, university teaching, scientific research teaching and application teaching to make up for the lack of instrumental analysis teaching resources. Instrumental analysis teaching resource library is a learning platform composed of "production", "learning", "research" and "use" teaching resources. The teaching resource library mainly includes case teaching resource library, offline teaching resource library, online teaching resource library, scientific research training program library, competition program resource library and comprehensive program resource library. Each module resource library materials, such as video, PPT, electronic materials, task book, exercise library, etc., through the network platform for display, forming a rich content, comprehensive type of instrumental analysis network resource library platform.

2.4. Formation of IARA integrated teaching team

Teaching team is an important organizational form of teaching construction, and teachers are important factors affecting the teaching effect. To realize the high degree of integration of IARA in the teaching of instrumental analysis, it is necessary to build an efficient operation team. The construction of instrumental analysis classroom teaching team should be comprehensively constructed from the four aspects of IARA. From the perspective of industrial teaching, enterprises send high-level technicians or senior instrument analysts to colleges and universities to be part-time teachers, enriching the human resources of the teaching team, enhancing the students' understanding of the practical operation of the enterprise instrument analysis, and making it easier for them to adapt to the work of the enterprise industry in the future; from the perspective of teaching in colleges and universities, teachers of instrumental analysis specialization adopt the teaching mode of "one teacher, one instrument", and the teaching of each type of instrument is carried out by the teachers who are good at it. From the perspective of scientific research teaching, teachers of discipline competition, teachers of scientific research training program and senior undergraduates are organized as team members, so that the competition and scientific research contents are closer to classroom teaching, and can also play the role of transferring, helping and bringing; from the perspective of application teaching, the scope of the teachers' composition is enlarged, and in addition to the professional teachers of instrumental analysis, teachers who have achieved remarkable results in the application of instrumental analysis are hired as team members. The team is composed of teachers who have achieved remarkable results in the application of instrumental analysis. Each teacher in the teaching team has his/her own duty, teachers will take the standard of instrumental analysis talents demanded by the society as the teaching goal, complement each other's knowledge to cultivate professional talents, each teacher is responsible for his/her own good teaching content, and give full play to his/her strengths to provide teaching for the students, which realizes the instrumental analysis course in the "production", "learning", "teaching", "learning", and "teaching". "Learning", "research" and "use" of the instrumental analysis course in the four aspects of the seamless link, but also to achieve the effective docking of the training of university personnel and the needs of the enterprise industry personnel.

2.5. Establishment of IARA integrated teaching assessment

In the past, the teaching assessment of instrumental analysis was mainly presented in the form of final examination, and teachers evaluated the results according to the paper, which could not reflect the teaching effect completely. Reform the phenomenon of single theory examination, adopt the IARA multiple assessment method, focus on the evaluation of students' comprehensive ability, industry, teaching, scientific research and comprehensive project application scores are calculated according to a certain ratio to form a comprehensive evaluation system.

The proportion of theoretical examination score is reduced, and the proportion of practical and comprehensive ability assessment score is increased. Taking the total score of 100 points system as an example, the university teaching assessment accounts for 60%, the industry teaching assessment accounts for 10%, the scientific research teaching assessment accounts for 10%, and the application teaching assessment accounts for 20%.

3. Innovative points and characteristics of the project results

At present, there are many reports on the teaching reform of instrumental analysis based on the online and offline hybrid teaching mode, but there are no reports on the teaching reform of all the teaching contents of instrumental analysis from the perspective of "industry-academia-research-use" collaborative education. This project is based on the Learning Channel smart teaching tool to synergise blended teaching with the integration of "industry-university-research-use" teaching to carry out the teaching reform of instrumental analysis course for the applied chemistry majors of grades 2019 to 2021.

(1) The integration mechanism of IARA has been constructed, which provides the basis for the reorganisation of the teaching objectives of the courses and the revision of the cultivation programme.

According to the requirements of professional development, the course content is designed into three progressive modules of basic knowledge, principle application and innovative practice, incorporating modern scientific research, reflecting cutting-edge applications, and designing and implementing teaching tasks originating from the front line of fine chemicals production. Through the real-life case teaching and advanced design tasks, the course better follows the students' learning rules, from low to high, from theory to application and practice, and also better meets the students' personalised learning needs.

(2) We have created an integrated resource library and teaching team, which solves the problems of low utilisation of resources and poor ability to deal with practical problems.

The teaching mode of flipped classroom for instrumental analysis improves students' independent learning ability, information technology and resource utilisation ability. Targeted selection of discipline competition and scientific research training project related content, through resource integration, content innovation and dynamic adjustment, applying it to the first classroom teaching content of instrumental analysis, to solve the current teaching of cutting-edge, insufficient innovation and other problems. Through the project-based teaching method, we can improve students' ability to solve practical problems as well as students' comprehensive literacy, humanistic literacy of solidarity and collaboration, and scientific and technological innovation ability, and solve the problem of poor match between talents cultivated by colleges and universities and talents demanded by enterprises.

(3) The integrated teaching assessment system of IARA has been established to solve the problems of

insufficient feedback of classroom teaching and difficulty in continuous improvement of teaching.

The assessment of basic knowledge, practice and innovation, and course ideology and politics is carried out throughout the whole process. Using big data technology, strengthening process evaluation, competence evaluation, value-added evaluation, exploring non-standard answer evaluation, making students focus on every step of the learning process, promoting the overall development of students, and improving the degree of achievement of course objectives.

4. Conclusion

The teaching reform practice of instrumental analysis course aims to shift the curriculum of instrumental analysis to practical application. The teaching reform of this course is oriented to the improvement of comprehensive ability, integrating industry, teaching, scientific research and practical application, designing thematic teaching content, modularizing the teaching form, adopting group collaborative learning, project/case-based course teaching, and focusing on multi-dimensional and high-precision construction of evaluation, so that the students can build the knowledge system of the basic theory, design and application of instrumental analysis, and at the same time, improve the professional The students are able to build the knowledge system of basic theory, design and application of instrumental analysis, and at the same time improve the comprehensive ability of professional and technical talents. The teaching of the course adopts the integration reform of IARA, which is oriented to the social demand, combines theory and practice, fully demonstrates the characteristics of fundamentality, comprehensiveness, practicability and innovativeness, mobilizes the students' enthusiasm for learning, and improves the quality of teaching obviously. However, the integrated teaching construction of IARA of this course still needs further improvement, especially the cultivation of students' ability to integrate theoretical knowledge into engineering practice. In the future, we will continue to update the content of the course to cover the latest technology and development trend, evaluate the teaching effect to optimize the external incentive and endogenous motivation of students' growth, and set up cooperative projects and platforms between industry, academia, research and application to provide comprehensive practice opportunities, so as to promote the cultivation of high-quality professional talents with good professional literacy and comprehensive practice ability.

Students' performance has increased by 6.2% compared with that before the reform and improved year by year; according to the standard of engineering professional accreditation, the degree of achievement of the course objectives is located in the top 10% of the courses in the whole university.

In the past three years, students' enthusiasm in participating in subject competitions has increased by 17% year-on-year. Using the curriculum as a carrier, students of the programme have presided over 15 innovation and entrepreneurship projects for college students at provincial and ministerial levels and above, and won 4 provincial

gold prizes in the China International College Students' Innovation Competition, 1 second prize in the National College Students' Life Science Competition, 1 second prize in the National College Students' Chemistry Experiment Innovation Design Competition, 3 third prizes in the National College Students' Energy Conservation and Emission Reduction Social Practices and Technology 3 third prizes in National University Energy Conservation and Emission Reduction Social Practice and Science and Technology Competition, 19 first prizes in provincial academic competitions, 6 papers published and 11 patents authorised.

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