Research of Teaching Application of Science and Technology Innovation Problem Based Learning for Post-graduate Students

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Abstract. Innovative talents training is the core goal of higher education which determines the fate of the country and draws world’s major countries’ attention. This paper puts forward the teaching mode of "science and technology innovation problem based learning" (STIPBL), which elaborates the teaching link of the teaching mode. And puts forward the teaching model of “STIPBL” based on the three elements of the ability of scientific research and innovation, which are systematic thinking, creative thinking and practical ability. Paper elaborates the model of teaching and process of setting and teaching methods to assess the impact of cultivate innovative achievements and innovative talents. On this basis, it analyzes the effect of teaching practice and the main teaching problems to be solved, as well as the significance in the cultivation of innovative talents.

Introduction

The core of talent training is the cultivation of innovation ability which is the essential part for social progress [1]. The ability of scientific research innovation of college students depends mainly on three factors: systematic thinking ability, creative thinking ability and practical ability [2]. In fact, these three abilities can be cultivated through teaching methods. Innovative methodological education is an effective means to cultivate systematic thinking and creative thinking [3-5]. Practical ability can be trained and developed from many practical practice teaching skills [6]. In the paper, a STIPBL teaching model is proposed on the bases of PBL teaching model. The practice of the new teaching model has achieved good practical results.

Introduction of Traditional PBL Teaching Model

Problem-based learning (PBL) originated in the 1950s medical education and has been widely used in the international as teaching methods. PBL teaching model is characterized by learning in complex and meaningful problem research situation so that students solve the real problem through cooperative research. They learn relevant scientific knowledge that hide behind the problem and master the skills to solve real problems and the ability to learn independently [7-8].

PBL teaching model emphasizes the students to self-learning rather than relay on teachers to teach the core of teaching activities as the traditional curriculum teaching has always attached importance to. PBL model learners must be responsible for their own learning tasks and sense of mission and fully committed to solve the problem. The long-term practice of foreign universities shows that the PBL teaching model is an effective way to cultivate students’ independent access to knowledge and improve their practical ability. Many famous universities at home and abroad will PBL as an important teaching methods to carry out teaching practice. PBL model of teaching steps are as follows:

Organize team → problem selection → problem analysis → task settings → problem lock → proposed program → program demonstration → implementation study → project report → project assessment and other ten steps. In the PBL teaching model, the problem selection and the analysis of the problem determine the goal and direction of the study. General "6W" method is used to analyze...
the problem. The “6W” are “what”, “why”, “where”, “when”, “whom” and “how”. The answer of these problems can clarify the task of the research.

PBL model emphasizes the processor of solving to the problem rather than simply explore and discover. Nowadays, all teaching activities not only need to pay attention to the knowledge, but also the cultivation of innovative ability. As the choice of the problem is generally from the practical problems and many may be resolved complex problem which makes the traditional PBL model emphasis much on the solution of practical problems and ignore the ability to innovate and explore the unknown scientific and technological problems. The contribution for the cultivation of innovative talents and scientific research achievements are small.

**Introduction to STIPBL Teaching Mode**

In order to solve the shortcomings of traditional PBL teaching mode and to promote innovation, we try to improve the quality of personnel training. We propose the STIPBL (Science & Technology Innovation Problem Based Learning) Teaching Mode based on science and technology innovation problem. At the stage of topic selection, we pursue research with the emphasis on the unresolved scientific and technical problems in the field of disciplines. Since such problems are often very difficult, the final solutions of the problems are no longer considered as targets, while the STIPBL Teaching Mode aim for the scientific research innovation achievements in stage during the process of study. We improve the ability of learners to innovate and research and cultivate high-level innovative talents by means of scientific research and cultivation.

STIPBL teaching model builds three stages "Theoretical teaching → Scientific research practice → Achievements cultivation" and six levels of integration "Innovative methodology education → Independent topics → Project demonstration → Teamwork → Interactive discussion → Innovation results summary" during the teaching process. In the six levels of teaching links, each link introduces different teaching methods according to their own characteristics and needs as follows:

1. The stage of classroom teaching introduces the innovative methodology education. And we inspire students of systematic thinking, creative thinking and innovation awareness by means of the case teaching method and TRIZ innovation method;

2. At the stage of independent topic selection, students think about the discovery of valuable scientific and technological innovation using literature research, science and technology search method, and the application of innovative ways;

3. At the stage of the project demonstration, the brainstorming method [10] is used to demonstrate the innovative value, innovation, research methods and technical route of the subject and the expected results. All teachers and students express their opinions equally through brainstorming and determine reasonable research plan and valuable scientific issues;

4. At the stage of collaborative research, the members of each research team study the subject cooperatively according to the PBL model. When the research team encounters difficulties, they start expert consultation to invite related research experts or Senior doctoral candidate to help solve the problems encountered in the study;

5. The interactive discussion forum will be held in the course of scientific research and the stage of achievement of scientific research. The course group will use the form of academic conference or brainstorm method to analyze and demonstrate the research and innovation of the subject.

6. At the stage of innovation results summary, we guide students to complete the final scientific research and innovation achievements by means of guidance of high level of scientific research papers, patent achievements and scientific and technological competition at the end of the research.

**Analysis of the Teaching Problems and Practical Effects of STIPBL**

After many years of research and practice, STIPBL teaching model has made a series of achievements in teaching content, teaching methods, innovation and practice, examination methods, scientific
research and innovation achievements construction and innovative talents training, teachers and so on. To solve the teachers and students in Teaching and research in the existence of many problems, which mainly focuses on the following areas:

1. Innovative methodology teaching: In the course of teaching, the method of innovation is introduced, which solves the problem that the lack of scientific research innovation theory and method in the traditional teaching system leads to the lack of students' innovation ability. In the course of graduate teaching, the author introduces the scientific research and innovation ability methodology education, analyzes the key factors that affect the scientific research and innovation ability, and analyzes the characteristics and thinking ways of the systematic thinking and creative thinking through the practical case analysis; comprehensively introduces the TRIZ innovation methodology to enable the graduate students to master the scientific research. The general methods and techniques to guide students to find valuable scientific problems and technological innovation. To carry out the training of innovative talents, we construct the three-level six-level integrated interactive research team collaborative STIPBL teaching mode, which solves the problems of fixed and old teaching in traditional teaching and traditional teaching methods. The teacher-centered indoctrination teachings.

2. The traditional teaching model of scientific research innovation and innovative talent to cultivate a weak issue: In the self-selected interactive research team collaborative STIPBL teaching model, all the research topics are selected by the students, through the curriculum group collective evidence-oriented science and technology issues, innovative and challenging, to stimulate students' innovation research Enthusiasm, the cultivation of scientific research and innovation achievements and innovative personnel training has played a proper role. At the same time, to ensure that the results of student research indeed become valuable research and innovation results, after the end of the study, enter the teaching model of the critical link - innovation concise links. In this part, we will guide the students' research team to high-level the results of the paper through the senior research and development of the research results, the guidance of the high level of patient results, the competition of science and technology competition, High-level invention patent and high-level competition award:

A. High level of scientific research results guidance: including pre-trial, review, re-evaluation and language format changes total four parts. In the pre-trial stage, published by two high-level academic papers teachers or senior doctor pre-trial, and proposed amendments. A small academic symposium will be held by the course group teachers, teachers and relevant staff in the relevant field. The students will explain the paper in the form of academic reports, focusing on the scientific nature of the paper, the research content, innovation, and academic contributions, as well as the result which will be made in the future. The revised comments may be carried out several times, according to the results of the previous review and the results of the discussion to discuss, until the high level of academic standards; language and format changes are generally published in the high level of academic papers. To amend the language and format, until the high level of academic papers to meet the language expression and format requirements.

B. High level of patent results guidance: including results concise, and content and format changes in three parts. First of all, the results of the students of the value engineering and technical results condensed into technical inventions. And then patent and technology search, to confirm the patent application can be applied to the invention of the patent. Students write patent applications, the course group teachers according to experience for the contents of the patent and format changes, until the application in line with the declaration of patent claims.

C. Science and Technology Competition Guide: including concise the results, entry guidance and entry report guidance three parts. First of all, according to the results of the study of the students, we concise the subject and content of the competition. In the course of the competition, we carry out technical guidance to the team. Finally, the entry report or technical papers for writing guidance, focusing on the results from the scientific, advanced, innovative or practical point of view, to obtain a good entry and award-winning level.
In the 6 years of the practice, the project team applied the above methods to train graduate students. We achieved some achievements, published more than 60 SCI papers, EI search papers more than 70 articles, access to more than 30 patents, authorize 30 patents, access to 9 graduate students innovation competition national award, provincial awards more than 20 items.

Students get a high level of innovation results, so have advantages naturally in a variety of innovative talent evaluation. In the six years of the test period, we cultivate many innovative graduate students using our teaching mode, including 2 people who won the provincial outstanding master thesis, 10 people who received gold and silver master's degree of graduate students, 6 people who received national master's degree scholarship.

(3) The positive interaction mechanism between teaching and scientific research has been established, which solves the problems that the teaching and research activities are disjointed in the traditional teaching mode, the teachers are difficult to take into account the difficulties between teaching and scientific research, and the construction of teaching staff is insufficient. Teaching practice of STIPBL model can establish the interactive mechanism of teaching and research. Teaching and research activities have been integrated, and teaching model is based on the research achievements and the cultivation of innovative talents for the purpose with high level of teaching idea and method of the high level of training innovative talents. The teaching and scientific research, personnel training and the construction of teachers are fully improved by means of high level of research and innovation implementation. Due to the advanced teaching idea, all the students become a member of the research group. The innovative achievements promote the teachers' teaching and scientific research. After training on students in an innovative method of creative thinking, a lot of good ideas become active on the teacher's scientific research. Teachers who have abundant experience can often find out the ideas and direction from the creative thinking of students and improve teachers’ teaching and research in full scale.

In the six years of the test period, the construction of curriculum team and scientific research achievements have made considerable progress. We cultivate 2 people who received the Harbin Institute of Technology Rookie Award, 2 people who won the Harbin Institute of Technology excellent first-class Award, and 1 person who joined the first school teaching young top-notch talent plan. The teachers of the curriculum team received 14 items of the National Natural Science Foundation of China, and 5 other scientific research projects.

(4) This paper constructs a comprehensive and comprehensive assessment method and the analysis mechanism of the assessment results, and solves the problem that the traditional assessment method is not validated and instructed for the future research and innovation activities. The establishment of a comprehensive ability-oriented assessment methods, assessment results analysis and feedback mechanism helps students correctly understand their own learning effect and practical ability to improve their own deficiencies and receive a very good practical results in the future work. According to STIPBL model for the scientific research and innovation achievements, we set up five aspects of the cumulative assessment method including the project topics, research programs and technical route, research completion, innovation and the contribution of achievements to the research. Moreover, we developed the "STIPBL model curriculum assessment results and learning effect analysis and evaluation system" software, assessing the results of each part and getting feedback to the students on the test results and learning effect. So students can correctly understand their own advantages and disadvantages in scientific research and innovation to make up for shortcomings and create more and more innovation results in the future work.

Summary
In summary, STIPBL teaching model closely linked to the cultivation of innovative talents and innovative achievements from the teaching methods, teaching process, teaching links, teaching content and assessment. It established a complete set of teaching system which put innovation methodology education, scientific research innovation topics, innovation results concise and other
aspects of problem-based learning teaching model together to solve the weak point in traditional PBL teaching model of innovative personnel training and innovation achievements. The teaching practice shows that: STIPBL teaching model can greatly enhance the learner’s ability to innovate and guide learners to obtain scientific research and innovation achievements. At the meantime, it solves the problem of insufficient construction of faculty caused by the lack of interaction between traditional teaching and scientific research. The STIPBL proved to be a good innovation talent teaching model.

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