Research and Practice of Scientific Research Engineering Practice Model Based on TRIZ Theory

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Abstract. At present, social development needs a large number of talents with innovative thinking ability and relevant practice experience. This paper takes the practical teaching and graduation design of mechanical and electrical integration specialty in higher vocational colleges as an example, and students' innovative thinking and innovation ability are systematically trained under the guidance of TRIZ innovative education theory. The research and practice of "scientific research" engineering practice model based on TRIZ innovation education theory is put forward from the aspects of solving the problem and the design and implementation of engineering practice mode.

1. Introduction

TRIZ theory is an innovative design theory that keeps pace with the times [1]. It plays an important role in many fields, and is paid more and more attention by academic circles both at home and abroad. With the deepening of the reform of higher education system and the improvement of the quality requirement of talents in society, the talent with the innovative thinking, ability and the practice are becoming the common needs of the society. TRIZ is geared to the needs of the designer, it is an innovative methodology based on the theoretical knowledge of the subject to solve the problem of invention. From this point of view, it is feasible and necessary to carry out research and practice of "scientific research" practice model based on TRIZ innovative education theory.

Therefore, in the field of electromechanical integration practice teaching and graduation design, guided by TRIZ innovation theory, it is of great significance to guide and train students' creative ability and innovative thinking, and to establish an executable practical teaching model aiming at training students' innovative consciousness.

2. The Main Problems Solved in the Practice Model of Scientific Research Engineering Practice Model Based on TRIZ Theory

2.1 Evaluation of Students' Innovative Ability

To evaluate students' creative ability: to measure the degree of students' understanding of innovation by means of questionnaires; to assess students' innovative ability through propositional design.

1)Questionnaire survey: a questionnaire survey was conducted among 42 students of grade 2014 electromechanical integration in a college. Questionnaire indicators include: the definition of innovation, the practice or experience of participating in the promotion of innovation ability, the suggestion on the innovation environment of higher vocational schools and the reasons for the innovation ability.

2)Project design: according to the requirements of electromechanical integration practice courses, draw up a number of research directions, students are divided into groups (3-4 persons, one group). According to their own interest in the selection of research, determining the design issues, the design proposal.

3)Innovation capability assessment: to select experts to form an expert group for evaluation, according to the indicators to the subject and design program to score. The scoring index mainly includes: the innovation of the research field, the advanced nature of the research method, the innovation value of the research object and the feasibility of the design scheme.
Through the evaluation of the results of the scoring, the reform model of engineering practice based on the TRIZ theory is used to evaluate the effectiveness of the improvement of students' innovative consciousness, and to find the problems and shortcomings.

2.2 Cultivation of Creative Ability Based on TRIZ Theory

In TRIZ theory, the most important way to overcome engineering problems is to solve technical conflicts [2]. The technical conflict flow is: the first step is to analyze the design of the system; the second step is to divide the system function into various sub-functions; the third step is to analyze the technical conflicts in each sub-function and describe the technical characteristics and deterioration of the technical characteristics that need to be improved by two of the 48 standard engineering parameters; the fourth step is to substitute the technical characteristics of the improvement and deterioration into the conflict matrix to find the corresponding inventive principle. Each of the 40 inventive principles will have a further explanation of the corresponding examples and engineering applications, and the use of the inventive principles can give the designer an effective solution to the problem.

In the engineering practice of college students, TRIZ theory is introduced to cultivate the innovative thinking, to improve the innovation ability, and to design guidelines for practical engineering practice. The previous practice manual contains only some illustrations and some of the traditional guidance, mainly used to demonstrate the description. The engineering practice model is to improve the students' ability of innovation as the main goal of scientific research engineering practice, requires the practice manual according to the students' comprehending ability to increase the relevant research field frontier content introduction, and put forward the "scientific research" practice need to discuss the research direction, to effectively solve the problems of students.

2.3 Research on the Application of Higher Vocational Education Based on TRIZ Theory

According to the current lack of innovation in electromechanical graduation design of vocational school, the old topic, the old model and other issues[3]. The TRIZ theory is applied to higher vocational graduation design, and the teaching reform is carried out aiming at enhancing the innovative ability of students of electromechanical major. According to the technical conflict resolution flow chart in TRIZ theory, combined with the characteristics of graduation design of electromechanical major, the conflict model of system design problem is established and the solution mechanism is put forward.

3. Design and Implementation of "Scientific Research" Engineering Practice Model Based on TRIZ Theory

3.1 Using TRIZ Theory to carry out "Scientific Research" Design of Engineering Practice

Through the TRIZ theory study, at the same time, under the guidance of teachers to enable students to consciously carry out innovative thinking exercises and subject design; using practice to promote students' innovative thinking into innovation capacity. The implementation framework of engineering practice training based on TRIZ innovation system is shown in Fig 1.
Frontier knowledge is taught to generate innovative demand. Generate innovative thinking and establish practical research topics.

Demonstrate project research scheme. Integration of creative thinking.

The research topic is completed and the transformation from creative thinking to creative ability. Repeated argument.

Innovative thinking training.

Figure 1. Implementation Framework of Engineering Practice Based on TRIZ Innovation System.

Applying TRIZ theory to carry out "scientific research" practice mode reform in curriculum practice. First of all, carry out TRIZ theory study, and then, under the guidance of the task group teachers to practice innovative thinking, and do some innovative ideas to improve the design, so the use of curriculum practice to promote students' innovative thinking into innovation capacity [4]. It is mainly divided into three steps.

1) First of all, the introduction and learning of TRIZ theory: the task group teacher systematically explains the origin of the TRIZ theory for the students, the scientific thinking method of TRIZ theory, the law of evolution of technological systems, system resource analysis, the 40 inventive principles of TRIZ, 48 engineering parameters and contradictory matrix, system analysis method, material-field analysis method, inventive problem standard solution, problem solving algorithm-ARIZ, phenomenon of scientific effect.

2) Secondly, complete the innovative thinking training: according to TRIZ theoretical innovation system, the following training:

① Let students have the demand for innovation, and guide the students in the forefront of knowledge, so that students understand the development of knowledge in their own field of expertise.
② The research has been demonstrated several times, and the innovative thinking has been cultivated in the process of continuous improvement of the design program.

3) Finally, the practice of scientific research, which transforms the innovative thinking into the innovative ability, is practiced:

① On the basis of the establishment of the subject, scientific research training is carried out. in the process of the implementation of the design plan, according to the understanding and application of knowledge, students constantly adjust their design plan.
② During the implementation of the design program, students are constantly encouraged to make breakthroughs and innovations in research methods, so as to improve their ability of thinking transformation.
③ Guide students to add new creative thinking in the implementation plan.
④ Some research directions of mechanical engineering practice are determined, and students are divided into groups. According to their own interests to develop research projects and design implementation plan.
3.2 Implementation of graduation project of Higher Vocational Education Based on TRIZ theory

The application of TRIZ theory to student graduation design can transform students to the dominant position [5-6], encourage students' innovative thinking, improve students' sense of innovation, reduce the similarities of graduation projects and avoid plagiarism of graduation thesis. TRIZ theory can be applied to electromechanical professional topics, opening questions, program identification and other graduation design process. Whether it is the conceptual design of products, or the detailed product design process, from product design to product innovation, teachers can guide the whole process of graduation design, to guide students to master the use of TRIZ theory, use the innovative design method of TRIZ theory. From the graduation design topics to the final specific mechanical principles and structure of the design, its specific application process is as follows.

3.2.1 Graduation project topic selection

The topic selection is the most important part of the graduation project, aiming at improving the students' innovative consciousness, which should combine the students' interest in scientific research, the practice experience and the research direction of the teachers. Guide students to the future direction of employment as the guide, through the investigation of the status quo, access to the latest trends at home and abroad. As well as reference documents published at home and abroad to obtain the relevant information required for graduate design. The selected topic comes from three aspects, the topic which the teacher draws up, the enterprise topic and the student according to the TRIZ theory which studies has formulated itself the topic, and the three aspects of the topic are related to the TRIZ theory.

3.2.2 Graduation project opening

The opening of the graduation project is the main work of the early design process, mainly related to the entire project design process and the final program development, in the opening stage, to guide students how to do and focus on what to do. In the proposed design scheme, we guide students to focus on Application of TRIZ theory in the process of conflict resolution, the 40 TRIZ theory of inventive principle and combined with the actual situation to obtain the final solution, and then draw the graduation design.

3.2.3 The Principle of Graduation Design and the Structural Design of Model

The principle of graduation design and the structural design of the model are the core stages of graduation design. In the premise of graduation design topics and opening, we guide the students to 3D design principle and mechanical structure of the graduation project, according to the technical conflict resolution flow chart and contradiction matrix and 40 invention principles in TRIZ theory, the technical conflict or physical conflict encountered in the design process is expressed by the standard general engineering parameter name. It is substituted into the conflict matrix to obtain the principle of the invention. The final solution is determined according to the actual situation. Then, the final solution is applied to the actual engineering problem according to the requirements of the project, and the design scheme is designed in detail.

According to the electromechanical integration of mechanical manufacturing technology practice content, to determine the five practical directions, the 42 students are divided into 5 groups, and the TRIZ theory is applied to the design of the specific program.

①Typical mechanical and electrical product structure analysis and design.
②Box parts processing technology and tooling design.
③Shaft parts processing technology and tooling design.
④Plate sets of parts processing technology and tooling design.
⑤Assembly process and tooling design.

Firstly, in order to design the function principle of mechanical design course, the content of mechanical design is arranged, and the application of TRIZ innovation method is emphasized. The students need not to design the structure and size, but to draw the function principle diagram; do not
need strength of parts calculation, but should express the origin and conception. Evaluation of the indicators is not a reliable structure and practical economy, but the principle of the novel and feasible. Secondly, to select experts to form an expert group for evaluation, according to the indicators to the subject and design program to score. The scoring index mainly includes: the innovation of the research field, the advanced nature of the research method, the innovation value of the research object and the feasibility of the design scheme. The subject has been demonstrated several times, and improvement measures have been put forward. In this process, students' innovative thinking has been cultivated.

Finally, an optimal scheme is selected and a detailed design of the scheme is carried out.

4. Conclusion

The cultivation of students' engineering practice ability is the most important part of the whole teaching process, and also the most practical and effective way to improve students' innovation ability. Through the teaching and practice of TRIZ theory, students can overcome their inertia thinking and improve their creativity, and cultivate their team spirit and sense of cooperation. Students are based on research groups, all the subjects are completed in the collaboration among the students, they can cultivate a good team and the spirit of collaboration. Through the introduction of TRIZ theory in vocational teaching and graduation design, it can stimulate students' enthusiasm for innovation and cultivate students' innovative ability to overcome similar problems of graduation project and improve the efficiency and quality of graduation design.

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6. References


