



## On Design Experiment Teaching in Engineering Quality Cultivation

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### Abstract

Design experiment refers to that designed and conducted by students independently and is surely an important method to cultivate students' comprehensive quality. According to the development and requirements of experimental teaching, this article carries out a study and analysis on the purpose, significance, denotation, connotation and characteristics of design experiment and then elaborates on the general design methods and specific steps in this kind of experiment. By practicing in design experiment, students will have their abilities in innovation and scientific research as well as comprehensive engineering diathesis improved.

**Keywords:** Design experiment, Practice teaching, Engineering quality

### 1. Introduction

With the development of science and technology as well as the quickening pace of reform and opening in China, higher comprehensive skills have been demanded for engineering technicians since the beginning the 21<sup>st</sup> century. Especially advanced polytechnic universities and colleges, the cradle for the cultivation of engineering technicians, are intended to improve students' engineering quality. Currently, experiment and practice courses are set in many polytechnic universities and colleges to train students in practical skills and engineering. Experiment-based courses should be one of the important knots in the basic training of an engineer with the focus on students' independent practical ability and innovative ability. With the in-depth development of teaching reform, the verification-based experiment teaching can't adapt itself to the demands of social development. Therefore, only by developing the design-based teaching method can we cultivate high-level professionals in conformity to our social demands.

### 2. The Purpose and Significance of Design Experiment

Experimental teaching is the core of the fundamental practice in the whole practical teaching system. With the strategic adjustment of China's economic structure, the whole Chinese society has called more for students' capacity in skills, comprehensive quality as well as innovativeness. Therefore, design experiment is intended to cultivate students' capacity in solving practical problems, innovation, organization, management and scientific research.

### 3. The definition of Design Experiment

Here design experiment refers to breaking the current experiment scheme to design new plans and steps for experiment in specific requirements and conditions and to fulfill the given requirements. Therefore, it is a kind of exploratory experiment either combined with the teaching of a specific course or independent from teaching. Due to the flexibility of design experiment, students are required to arouse their innovative ability besides solid knowledge and basic skills. Accordingly, it is an important way to cultivate students' creative thinking.

The experiments in textbooks are mainly instructive, in which teachers prepare the devices according to experiment instructions, and students are expected to conduct them according to instructions, record the result and then complete their reports. This kind of experiment is mainly designed to solidify some significant basic theories, to help students know about some phenomena, grasp basic experimental knowledge, methods and skills.

Design experiment is an independent activity designed and conducted by students themselves, in which students are

expected to choose devices, design experimental plans, study out experimental steps, conduct their observation, analysis and measurement activities and finally draw their conclusions. Generally, design experiment is based on routine and synthetical experiment and set after those experiment from simple to complex experiment. Before a design experiment, teachers will give the subject, purpose, principle, conditions, main methods and instructions to students clearly. Then it is up to students to reflect on and discuss their plans for their experiments independently, to put up with theoretical evidence, to choose their experimental methods, to establish the content for observation and presume the possible result. However, students should hand in their experimental schemes to teachers for instruction and approval. In addition, teachers are expected to help students to optimize their experimental content, to instruct the operation of their experiments, to solve the problems in their experiments, organize analysis and discussions on the result and help them to learn from their experiments and then get improved. More advanced design experiment is carried out by students totally independently to exert their enthusiasm for learning to the largest extent under teachers' instruction. This kind of experiment is intended to cultivate students' independent research ability. Only by referring to some materials to answer relevant questions can they understand the relevant principles, study out their experimental steps and then achieve the requirements of their experiments. By conducting these experiments, students will further their understanding of principles, improve their ability in self-teaching, practical operation, design, analyzing, studying and solving problems and have their innovative spirits inspired.

#### **4. The Characteristics of Design Experiment**

First, design experiment is innovative. Whatever kind of design experiment will involve the process of conception and design, in which students' creativity is called for. Due to its flexibility, students are required to have creativity besides a mastery of basic knowledge and methods.

Second, design experiment is comprehensive. Because such an experiment is based on verification experiment, students are required to apply their theoretical knowledge and skills to their experiments in a comprehensive way. Therefore, it will help to cultivate students' ability in solving practical problems with what they have learnt in class.

Third, the scheme of design experiment is diversified. Even with the same purpose, principle and requirements, diversified schemes can be produced if different devices are provided in the process of an experiment. Therefore, in our experimental teaching, a typical subject can be chosen for students to try different schemes in order to enlarge students' thoughts.

Fourth, design experiment is relatively independent. Students are required to refer to and collect materials, design their schemes and conduct their experiments independently. Obviously, during the whole process, with students being the subject, the student-centered educational idea can be reflected and students' enthusiasm and innovativeness will be exerted.

Last, the result of design experiment is relatively uncertain. Both success and failure can be expected of the whole design process. An analysis can be conducted to explore into the causes of success and failure, which will be quite useful in talent cultivation.

#### **5. The Specific Procedures and Requirements of Design Experiment**

According to the curriculum, students are expected to meet the following requirements:

- (1) Freely choosing their experiment projects from the given range, leaning about their subjects and specifying their tasks.
- (2) Referring to some relevant materials, putting up with possible schemes for experimental design, drawing necessary electric circuits and picking out the best scheme among all through analysis and comparison.
- (3) Defining the most proper method and conditions for experiment through an analysis on the relevant methods and specifying the method of operation.
- (4) Producing an adequate scheme for experiment design and conducting a detailed analysis on it.
- (5) Conducting their experiments to observe relevant phenomena and measure some targets to improve their ability in discovering, analyzing and solving problems.
- (6) Writing a complete and excellent design report different from those ordinary ones in format and paying their special attention to choosing experiment schemes, controlling experimental process, analyzing result and summarizing what they have learnt from their experiments.

It must be emphasized that the whole design process should be examined on its correctness. For example, with the expansion of the scale of the whole system as well as complexity in the courses based on electric and electronic experiments, the traditional way in which examination and attempt in forming circuits and making sample machines are conducted by human beings has to give way to EDA (Electronic Design Automation). During the verification process, analysis is employed as the basic method and EDA is used for simulation.

In addition, the Documents of design experiment are also of great importance and therefore should be emphasized throughout the whole design process. Design documents should be established at the very beginning, in which the design idea for each step, comparison and choice of schemes, the result of analysis and calculation and the final design blueprint should be recorded and compiled with clear structure and concise expression. During the process of document design, necessary communication should be conducted between managers and designers as well as designers and clients in order to exert management and restriction on the complexity of management design. Since the design of a large-scale system is fulfilled by many persons, it tends to be a failure without necessary communication and effective management of its complexity. Therefore, the establishment of documents has direct influence on whether the design of the whole system will be successful or not. In addition, design documents provide evidence and support for the system to be maintained and managed as well as for the design of the system to be applied to engineering production.

## 6. Conclusion

As famous educationist John Dewey once said, “students cannot have their intelligence and personality developed in their learning activities if they are only required to listen to the textbook and their teachers. Actually, only when they get opportunities to do something successful in their own experience do they really get educated no matter how poor their experience once was.” Design experiment will encourage students’ enthusiasm in learning, improve their ability in analysis, judgment and logic thinking, hence providing them with good opportunities to exercise their creativity. In this sense, design experiment will help to improve the overall quality of experimental teaching and college students’ engineering quality, hence cultivating more excellent professionals for the whole society.

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