

## Research on Engineering Enlightenment Education in Cultivating Engineering Concept for Freshmen in College

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**Abstract.** Engineering enlightenment education bears a dual task of guiding engineering freshmen in college. One is from science education to engineering education and the other is from the exam-oriented education to autonomous learning. Based on the dissipative structure theory and focused on students' learning behavior, the paper studied the process transition characteristics from an equilibrium state of exam-oriented education to that of autonomous learning, and carried out the exploration of teaching mode on engineering enlightenment education, and proposed serial methods on cultivating students' autonomous learning ability and engineering concept to put forward engineering enlightenment education.

### Introduction

The stage of engineering enlightenment education is usual in the first year for engineering freshmen in college. In China, the fundamental education mainly focuses on learning scientific knowledge and taking the college entrance examination as a goal. And students have little engineering experience and engineering concept. In an exam-oriented education environment of middle schools, a teacher provides a teaching mode depending on constantly *correcting*, and students form their own learning path dependence. But in an inquiry-based learning environment in college, learners are required to solve problems through independently repeating *trial and error*. Students need to adapt the shift from science learning to engineering learning[1]. Two tasks should be completed in engineering enlightenment education: one is to guide students from science education to engineering education, the other is to promote students from exam-oriented education learning behavior equilibrium to autonomous learning behavior equilibrium. It is urgent to explore a teaching mode of engineering enlightenment education.

### The Mode Exploration of Engineering Enlightenment Education

The cognitive process is a spiral upward pattern of practice-cognition-practice. Practice and theory are equally important, and their integration is the guiding principle for the development of engineering enlightenment education.

Adhering to the traditional classroom teaching mode, it will strengthen students' exam-oriented learning habits, then will lose the opportunity to guide students to develop autonomous learning habits. The dual tasks of engineering enlightenment education require students to shift their learning behavior from theory to practice. The engineering education mode has gone through apprenticeship mode, communication mode and reflection mode, and is moving towards community mode [2].

Engineering enlightenment education should start as early as possible. In order to adapt to the future engineering environment, it is necessary to introduce different modes into teaching activities correspondingly. Although the four modes mentioned above originated in different stages of engineering education development, they are all beneficial to freshmen who have no engineering experience and are helpful to solve some problems encountered in engineering learning[3]. For

operational learning activities, such as operating machine tools, it is necessary to adopt the apprentice mode. To learn engineering knowledge also needs teacher's explanation and indoctrination teaching. For an individual, the cultivation of the ability to deal with engineering problems also requires a student to reflect and carry out heuristic learning. Engineering teaching under the community model can play an important role in cultivating cooperative spirit and organizational ability. How to choose and develop a teaching mode is particularly important. Blended teaching can integrate the advantages of various modes to carry out engineering enlightenment education. Nowadays, blended teaching mainly focuses on online and offline learning. Part of the time is spent on formal school education courses, and part of the time is spent on online learning that students will independently control their own time, place, route or progress [4]. The blended teaching of engineering enlightenment education has a broader connotation. In addition to online and offline learning, it also includes experiential learning of engineering practice, including engineering practice training, independent design, independent manufacturing and enterprise training, etc..

A problem faced by teachers and students is the limits of teaching time. How to complete the cultivation of students' engineering concept in a limited time and promote students to transfer from the equilibrium state of learning behavior in exam-oriented education to that in autonomous learning? In information ages, great changes have taken place in higher education. Internet search and MOOCs have weakened the information asymmetry between teachers and students, and the teacher-student relationship has evolved from the argument between subject and object to the student-centered[5]. Meanwhile, the concept of time and space in teaching organizations has changed, time can be flexible and space can be changing. The key to solve the time limit problem of engineering enlightenment education lies in the cultivation of students' autonomous learning ability.

### **Cultivation of Autonomous Learning Ability in the Stage of Engineering Enlightenment Education**

Education has the characteristics of complexity, self-organization and dynamic [6]. Engineering enlightenment education is an open learning environment, and away from the exam-oriented education. In order to cultivate autonomous learning ability, teachers can introduce students learning entropy into blended teaching process, and can treat the whole engineering enlightenment education as a dissipative structure[7]. Based on the theory of dissipative structure, the cultivation of autonomous learning ability in the stage of engineering enlightenment education can be divided into two steps: firstly, breaking the equilibrium of students' learning behavior formed in the exam-oriented education environment to cultivate students' engineering concept; Secondly, under the learning environment of *trial and error*, the autonomous learning behavior habits of students should be cultivated, learning behavior equilibrium and path dependence should be constructed correspondingly.

Freshmen are far away from the exam-oriented education environment and enter a relatively free learning environment, with great interest and curiosity in college life and study. During this period, the sensitivity of students and the efficiency of information absorption are very high, which is an advantageous time to push students' learning activities equilibrium formed in the exam-oriented education environment of middle school to a new equilibrium. For freshmen, the learning equilibrium formed in the exam-oriented education environment of middle school will not disappear and transform automatically. If the curriculum of the first year of college still adopts the exam-oriented education method of middle school, it will inevitably push students back to the original exam-oriented education learning behavior equilibrium state, and strengthen this equilibrium state, thus missing the best opportunity to guide students to build a new equilibrium state.

Self-organizing learning is a means and method in the formation of new equilibrium state. Through self-organized learning, students can independently organize their own learning activities, strengthen the mutation in learning activities, and form individual learner's knowledge structure, learning and research ability. To reconstruct teaching organization, engineering enlightenment

education can start from the following aspects as follows. It is necessary to develop basic engineering skills and engineering concepts as early as possible. Blended teaching, discussion-based teaching, flipped teaching, etc. should be introduced into engineering enlightenment education. Disciplinary boundaries should be broken and students' overall awareness and overall view should be cultivated. It is to build learning environments in order to develop autonomous learning and autonomous practice, such as autonomous learning centers or innovation workshops.

The simple accumulation of engineering knowledge is not enough to form an effective engineering concept, and successful experience or failure is equally important. Not only knowledge but also experience are the source to form the engineering concept and build a learning path dependence. The learning activity is not a simple process of *learning- error correction- examination*, and engineering concept and the cultivation of engineering quality process follows *positiveness - negation - negation of negation*. Through preliminarily understanding, simply trying and achieving mastery, the whole process is a process of constant *trial and error*. The process of cognition spirals upward and finally reaches a relatively stable state. During the process, autonomous learning and exploration are the internal forces that promote the whole learning process to a new equilibrium state at each stage, and the transition process is shown in the Figure 1.

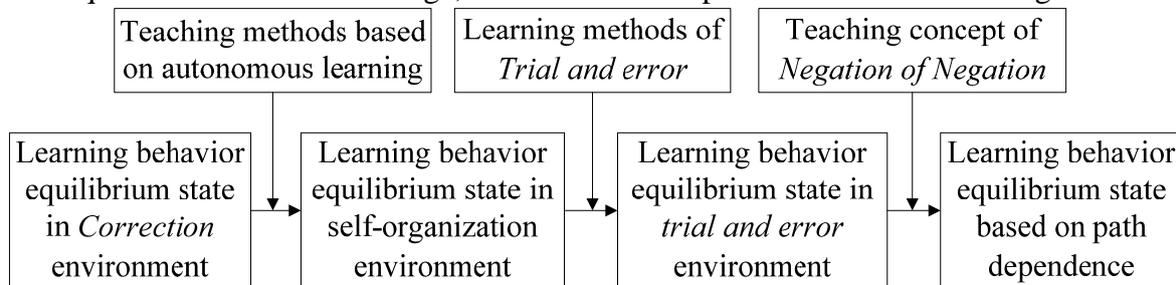


Figure 1. The transition diagram of the equilibrium state of learning behavior

## Exploring a Teaching Mode of Engineering Enlightenment Education Based on Blended Teaching

Engineering teaching mode develops with engineering itself. Due to the practical characteristics of engineering education and the dual tasks it undertakes, only theoretical teaching cannot meet the requirements. Blended teaching mode is helpful to solve this problem through a combination of online and offline learning and a seamless integration of time fragmentation and space change. A learning community will be built among students, teachers, peers and learning environment etc., and will help to promote students' autonomous initiative.

### The Characteristics of Blended Teaching on Engineering Enlightenment Education

#### *The spiral structure of cognitive logic*

Students' engineering cognitive logic is gradually cultivated. Starting from being interested in engineering, students are guided to appreciate the beauty of engineering. Step by step, from simple engineering problems to complex ones, from imitation to autonomous innovation, the whole cultivation process presents a complex spiral rising process.

#### *The combination of the theory and practice*

In the stage of engineering enlightenment education, engineering knowledge are sublimated through repeated comparison and verification in practice. In the blended teaching, offline practical cognition and theoretical learning are followed by in-class discussion or project-based teaching.

#### *Learning community mode*

Under the background of Internet learning nowadays, the model of learning community is developing constantly and the teacher's role changes from a coach to a partner. Learning community is no longer limited to students, but includes teachers, students, media such as the Internet, learning environment such as innovation workshops, enterprises, etc.. With the interaction of these elements, students' engineering quality and social responsibility will be cultivated.

## Constructing Blended Teaching in the Stage of Engineering Enlightenment Education

Constructing blended teaching focuses on cultivating autonomous learning ability and promotes students to reach a new autonomous learning equilibrium state.

### *Building an autonomous learning center based on the development of discipline*

In order to stimulate students' interest in engineering learning, it is an effective method to build an autonomous learning center. The project-based teaching will be developed in the center. Students will be required to complete a project using the instruments and materials by themselves. In the environment of autonomous exploration and learning, students will wake up their self-consciousness, enhance their self-identification and realize their goals, and their interest in engineering learning and innovative spirit will be gradually cultivated.

### *Reforming in-class teaching mode*

Discussion-based teaching will be the main teaching forms of blended teaching. Students will carry out discussion on a topic, such as a theory, an experiment, a kind of material, etc., besides learning knowledge in class. This is an important step to sublimate accumulated knowledge and experienced practical operation.

### *Dividing online and offline functions*

To divide online and offline functions mainly addresses the limits of learning time and individual difference. Basic, rational knowledge and repetitive content can be carried out in in-class teaching. Each student learns online content, which can be repeated and reinforced with appropriate online exercises, according to their own schedule and level of understanding. For engineering courses, it is necessary to practice firstly in order to increase perceptual knowledge, and then to carry out online learning and in-class discussion. According to the entropy of students' learning, teachers need to organize and manage the whole teaching process, and timely promote the transition of students' learning behavior equilibrium state. Online and offline functions are closely coordinated.

## Time-effectiveness of Blended Teaching in the Stage of Engineering Enlightenment Education

Time-effectiveness of blended teaching in engineering enlightenment education includes two aspects: one is explicit efficiency, the other is hidden efficiency. Firstly, online learning can offset the lack of time in classroom teaching, and different learners can organize their own learning process efficiently. Secondly, students' autonomous learning habits and abilities will benefit the learning effect.

There exist some misunderstanding forms on time-effectiveness. A large amount of video are uploaded to the Internet, and students will learn lonely. In the absence of peer groups, the rate of abandonment will be high. Offline activities are too single, and knowledge application is weakened. It will harm the effectiveness of blended teaching. A teacher still plays an important role in blending teaching, and it can't be weakened in spite of online courses. The role of a teacher should change from a coach to a partner in most time.

## Conclusion and Prospect

With the reconstruction of teacher-student relationship, the blended teaching on engineering enlightenment education will be fully developed. The fact of students' individual differences, the learning-centered teaching and the teaching concept of combining theory and practice will be fully respected. The flexible mode of blended teaching will certainly play an important role in solving the time-effectiveness of engineering enlightenment education.

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