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The effects of CDIO engineering education mode on the personality traits and the CDIO abilities of Chinese undergraduates

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ABSTRACT

A test on students and teachers between CDIO engineering experimental class and normal class in the same grade was adopted through 16 PF (Personality Factor) Test and CDIO Comprehensive Capacity Evaluation Questionnaire (including teachers' edition and students' edition). The results showed as follows, students in experimental class exceed remarkably in normal class in gregariousness, stability, excitatory, Daring, experimental, introversion and extraversion, psychological health personality factor, and personality factor of professional achievements; no significant difference was found in self-evaluation in four dimensions against personal abilities and attitude, professional abilities, professional morality, team cooperation and communication between students in experimental class and students in normal class, but students in experimental class is significantly higher in class evaluation. The research results indicated the implementation of CDIO engineering education mode exerts positive influence on the shaping and development of students' personality traits.

KEYWORDS

CDIO engineering education mode; Personality traits; CDIO abilities; Undergraduates.

INTRODUCTION

Engineering education plays a significant role in the senior education system in China. TABLE 1 shows the proportion of the students majored in engineering in total college students (2010-2014)[1]. According to the numbers of enrollment and graduates, the students majored in accounts for 30%~40% of the total students in senior education. Furthermore, the proportion increases year by year. However, there are defects in the engineering education quality in China, although the engineering technology talents in China present a quantitative advantage compared with those in developed countries. The defects mainly include poor teamwork, imperfection of original innovation ability and professional leadership, the lack of pioneering spirit, etc. Therefore, the development and reform orientation of engineering education have been extensively studied. CDIO engineering education was first studied, discussed, and implemented in College of Engineering, Shantou University, China in 2005. Owing to the differences of the cultures and values in Chinese and Western countries and the differences of management mode and developing path of enterprises lead to some questions in the implementation of CDIO mode in China: whether CDIO mode is completely suitable for Chinese senior education; whether engineering talent quality required by Chinese enterprises is consistent with the training objective of CDIO mode; whether the engineering talents trained according to CDIO mode is consistent with the requirements of Chinese social development. These questions have been solved. Moreover, the CDIO education mode which is suitable for Chinese higher education has been explored based on theoretical and practical analysis[2].

TABLE 1 : The proportion of the students majored in engineering in total college students (2010-2014) (Unit:10 thousand)

Year	Graduates		Entrants	
	Natural Sciences & Tech	National Total	Natural Sciences & Tech	National Total
2010	209	575	241	662
2011	223	608	248	682
2012	228	625	250	689
2013	255	699	253	700
2014	268	727	261	698

CDIO (Conceive, Design, Implement, and Operate) is a reformation plan for engineering education initiated by four engineering technology institutes, Massachusetts Institute of Technology in American, Linkoping University, Chalmers University of Technology, and Royal Institute of Technology in Sweden. It makes the four links in product life cycle (PLC): conception, design, implementation, and operation, which represent corresponding education and practical links. The major objective of CDIO reform is to cultivate well-rounded engineering technology talents, who master basic engineering technological knowledge, present operational capacity, lead the innovation in new products development, understand the importance of technological development for the society, and are capable of taking social responsibility. The CDIO ability includes four aspects: technological knowledge and inference; personal ability, attitude, professional ability and ethics; teamwork and communication ability; and the ability in conception, design, implementation, and operation in enterprise and social environment. The second and third aspects are discussed in the paper. The personal ability and attitude consist of general characteristics features, such as personal gumption, determination, innovation, critical thought, self-knowledge, curiosity, lifelong learning ability, and time management ability. Professional ability includes the vocational development planning, the vocational behavior, ability, and attitude required in lifelong learning. Professional ethics refers to professional integrity and social responsibility. Teamwork and communication ability contains teamwork ability, communication ability, and foreign language communication ability in multidiscipline team[3].

RESEARCH OOBJECTS AND METHODS

Research objects

Firstly, 100 and 80 questionnaires were randomly selected in undergraduate students in experimental classes and regular classes, respectively. All the students entered the Engineering College of a university in China in 2010. Finally, 91 and 76 valid questionnaires were collected from the regular and experimental classes, respectively. In the regular classes, there were 59 boys and 32 girls, including 38 students majored in machine manufacturing, 26 majored in computer technology, and 27 majored in industrial modeling design. There were 45 boys and 31 girls in the experimental classes including 25 majored in applied physics, 21 students studied mechanical automation, and 30 majored in software engineering. Additionally, 30 teachers including 19 male and 11 female, who taught experimental and regular classes at the same time, also returned questionnaires.

Research tool

In the study, we adopted the *Cattell 16 Personality Factor Test* (16PF), which was edited by Raymond B. Cattel in Institute of Personality and Ability Testing of Illinois State University and revised by Dai Zhongheng and Zhu Beili in East China Normal University in 1988.

The CDIO questionnaire for evaluating comprehensive abilities of students contains general demographic data (gender, age, class, grade, and student ID) and the CDIO comprehensive ability evaluation, which consists of 25 entries. The CDIO comprehensive ability evaluation involves four dimensions: personal ability and attitude, professional ability, professional ethics, and teamwork cooperation and communication. The score was marked in four levels and the integers (1, 2, 3, and 4) referred to the disqualified, normal, preferable, and excellent levels, respectively. Students evaluated themselves and their classes in all the entries and the main statistical indices involved the four evaluation dimensions.

The CDIO questionnaire for evaluating comprehensive abilities of teachers was composed of general demographic data (gender and title) and the CDIO comprehensive ability evaluation indices of 26 entries. The evaluation content involved four dimensions, including personal ability and attitude, professional ability, professional ethics, and teamwork cooperation and communication. The score was marked in four levels and the integers (1, 2, 3, and 4) represented the disqualified, normal, preferable, and excellent levels, respectively. Teachers evaluated their experimental and regular classes in all the entries and the main statistical indices involved the four evaluation dimensions.

Programming

The students in experimental classes and those selected from regular classes were evaluated by using 16PF and the CDIO questionnaires for evaluating comprehensive abilities of students. The teachers of the regular and experimental classes contemporary were evaluated with the CDIO questionnaire of comprehensive abilities of teachers. The testing results were statistically analyzed with SPSS15.0 software.

ANALYSIS AND RESULTS

Reliability analysis

Homogeneity reliability (α) and split-half reliability were used to test the reliability of the CDIO questionnaires for evaluating comprehensive abilities of students and teachers. According to the reliability indices of CDIO questionnaires for evaluating comprehensive abilities as shown in TABLE 2, the two questionnaires both present high homogeneity and split-half reliability, and meet the basic requirements of psychometrics.

TABLE 2 : Tthe reliability indices of CDIO questionnaires for evaluating comprehensive abilities

Reliability	Students' Evaluation for themselves (Students' Edition)	Students' Evaluation for their Class (Students' Edition)	Teachers' Evaluation (Teachers' Edition)
α Coefficient	0.9179	0.9587	0.9501
Split-half Reliability	0.8137	0.8125	0.8196

Comparison of 16PF Factors of students in experimental and regular classes

According to the comparison results shown in TABLE 3, the scores of each factor of all the tested students are in the range of 4~7, which corresponds to the low score characteristics and high score ones and meets the requirements of screening criteria. Among students' 16 personalities, gregariousness and experimental quality show significant differences (*P*<0.05) among the students, indicating that the students in the experimental classes are more cheerful, enthusiastic, amiable, and prone to be cooperated. They seldom scruple and stick to the environment, and are fond of new and better methods. The factors such as stability, excitability, and social boldness present the extremely significant difference (*P*<0.01). It is indicated that the students in the experimental classes are more mature and easy to adapt to new environment. They can cope with life issues and have stable emotions. They like social contact and are more energetic. They behave more freely in new communities with more adventurous and brave spirits.

TABLE 3 : The comparison of 16PF of students in the experimental and regular classes (M±D)

Factor	Experimental Class (N=76)	Normal class (N=91)	t
Gregariousness (A)	5.47+1.85	4.58+1.71	2.16*
Intelligence (B)	5.53+2.81	4.52+2.34	1.86
Stability (C)	6.13+1.44	4.28+2.40	4.12***
Aggressiveness (E)	6.10+1.06	5.58+1.84	1.53
Excitatory (F)	7.14+1.83	5.46+2.14	3.74**
Persistency (G)	4.56+1.45	3.98+2.10	1.40
Daring (H)	7.01+1.24	5.98+1.63	3.08**
Sensitivity (I)	4.78+1.60	4.41+1.96	0.89
Suspicion (L)	4.74+1.62	4.43+1.99	0.76
Fantasy (M)	4.81+1.54	4.77+2.19	0.13
Sophistication (N)	5.67+1.16	5.14+2.27	1.36
Anxiety (O)	5.62+1.38	5.01+2.42	1.35
Experimental (Q1)	5.71+1.35	4.77+2.03	2.42*
BJ (Q2)	5.14+1.53	4.51+2.35	1.37
Self-discipline (Q3)	5.07+1.59	4.32+1.90	1.86
Tension (Q4)	5.09+1.57	4.98+1.59	0.35
Adaptation and Anxiety (X1)	4.85+1.53	5.26+1.12	-1.35
Emotional and Vigilant (X2)	6.70+1.67	6.38+1.54	0.85
Introversion and Extraversion (X3)	7.17+1.56	5.75+2.06	3.40**
Timid and Decisive (X4)	5.64+1.20	5.20+2.20	1.14
Psychological Health Personality Factors (Y1)	25.48+4.13	21.78+4.04	2.89**
Personality Factors of Professional Achievements (Y2)	55.04+6.37	45.14+16.03	3.35**
Creativity (Y3)	79.12+9.14	77.74+12.06	0.29
Growth Ability in Fresh Environment (Y4)	18.97+3.41	18.38+4.09	0.79

Note: ***p < 0.05 ***p < 0.01*p < 0.001**

In secondary personality factors, significant differences in introversion and extroversion, mental health personality, and professional achievement personality are observed in the students in the experimental and regular classes. It can be speculated that the students in the experimental classes are more optimistic and pleased to communicate with others, and healthier than those in regular classes.

Additionally, the high scores of professional achievement personality factor of the experimental class students indicate that they have better development prospects. In the professionals in the future, the students in the experimental classes bear more social responsibility and moral requests, and they are obliged to provide professional knowledge, ability, and technology for the society[4]. For engineering technology talents, their society morality is directly related to professional responsibility. Engineers improve life quality of human by utilizing their knowledge and technology[5]. Because every decision of engineers directly or indirectly influences human life, they have to hold strong moral responsibility and make reasonable prediction for the future.

Comparison of students' self-evaluation and class evaluation

According to the comparison results shown in TABLE 4, the differences in the four dimensions (personal ability and attitude, professional ability, professional ethics, and teamwork cooperation and communication) were not observed among the experimental and regular classes. While regarding class evaluation in the four dimensions, the results of experimental class students are significantly higher than those of the regular class student.

TABLE 4 : The comparison student's self-evaluation and class evaluation in the experimental and regular classes (M±D)

Evaluation Object	Evaluative Dimensions	Experimental Class (N=76)	Normal class (N=91)	d f	t
Self Evaluation	Personal Ability and Attitude	3.07±0.09	3.03±0.08	163	0.51
	Professional Ability	2.87±0.12	2.74±0.09	165	0.93
	Professional Morality	3.39±0.09	3.19±0.08	164	1.94
	Team Cooperation and Communication	2.96±0.14	2.99±0.08	165	-0.32
Class Evaluation	Personal Ability and Attitude	3.41±0.08	3.07±0.08	166	2.81**
	Professional Ability	3.21±0.09	2.97±0.10	167	1.67**
	Professional Morality	3.46±0.11	3.08±0.12	167	2.64**
	Team Cooperation and Communication	3.37±0.09	3.01±0.08	167	3.05**

Note: ***p < 0.05 ***p < 0.01*p < 0.001**

Comparison of teachers' class evaluation

Independent t-tests were carried out with the data of CDIO questionnaire for comprehensive abilities of teachers. The results are listed in TABLE 5. It is indicated that teachers give the higher scores for the students in experimental classes than those in regular classes, in terms of the four evaluation dimensions, personal ability and attitude, professional ability, professional ethics, and teamwork cooperation and communication.

TABLE 5 : Comparison of teachers' class evaluation in the experimental and regular classes (M±D)

Evaluative Dimensions	Experimental Class (N=30)	Normal class (N=30)	t
Personal Ability and Attitude	3.27±0.34	2.14±0.42	13.47***
Professional Ability	3.19±0.42	2.12±0.38	12.03***
Professional Morality	3.14±0.27	2.25±0.64	7.02***
Team Cooperation and Communication	3.11±0.35	2.00±0.36	9.54***

Note: ***p < 0.001

DISCUSSION AND SUGGESTION

American psychologist Cattell believes that the formation and development of human personality is determined by biological factor, environmental factor, practical activity, self-education, etc. Apart from the influences of personal factors, after entering the university, the students in the experimental classes are educated according to CDIO engineering education mode, which differs distinctly from the current talent cultivation mode. The CDIO mode is characterized by the education concept of well-rounded development and the education objective of comprehensive ability training for students. In personality establishment, the students in the experimental classes exhibit the better psychological qualities including gregariousness, enthusiasm, activity, amiableness, interpersonal harmony, peace, and generousness. Compared with the students in the regular classes, the students in the experimental ones present distinctly higher scores in personality factors, such as the gregariousness, stability, excitability, social boldness, experimental skill, introversion and extroversion, mental health personality, and professional achievement personality. It is verified to some extent that the CDIO engineering education mode promotes the development of students' personalities.

The self-evaluation of students in experimental and regular classes is slightly different among the four dimensions: personal ability and attitude, professional ability, professional ethics, teamwork cooperation and communication. The difference may be interpreted as follows: students evaluated themselves according to the criteria of their classmates in the self-evaluation. Professional knowledge, technology, and ability are the fundamental difference between the professionals and freshman or ordinary people. An individual will not complete the cognitive process before grasping the professional skill[6]. Moreover, professional skills have strong specialty, and are closely related to the specific field[7]. Therefore, the cultivation of professional talents is a long process. The knowledge, ability, and experience are obtained through long-term or extensive education and training. Even geniuses such as Mozart and Picasso practiced for more than 10 years before they created well-known works[8]. Therefore, for the cultivation of engineering technology talents, the talents can only accumulate sufficient engineering experience and grasp the PLC after long-term practice. This not only requires long term efforts of professional talents but also a preferable developing environment under the sufficient patience from university and the whole society.

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