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The construction and practice of classified talent cultivation system combining with professional certification

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According to the idea of CDIO engineering education, this paper, combing with professional certification, makes training plan of Urban Rail Transit Vehicles Engineering direction in our school on the basis of research on universities at home and abroad. It strengthens the teaching of basic subjects and increases the weeks of practice link in the aspect of course offered to perfect undergraduate tutorial institution in the process of training. Besides, in the process of undergraduate education, it delegates different academic advisor forming the cooperative guidance of ideological and political instructors, professional tutor and academic advisor (Three mentoring) according to students' willingness and potential, which can satisfy the requirements of students with different targets, needs and capabilities so that it helps realize classification of talent training. Allowing the students to participate in scientific research project and scientific and technological innovation activities of different levels and types, it improves students' learning capacity, innovation capability, cooperation capability and engineering practical ability. Through application practice of class 104 of School of Machine-Electricity and Automobile Engineering, it proves that classification talent cultivation system has feasibility and promoting significance which achieved satisfied results.

Keywords: classified talent cultivation, professional certification, CDIO, course offered, practice step

INTRODUCTION

CDIO (conceive, design, implement, and operate) engineering education concept, proposed by the United States in the late 1990s, has achieved corresponding research achievements in recent years. Our country should also absorb the advanced engineering education concept and set up the curriculum system in line with international engineering education consensus including strengthening the basic knowledge, paying attention to the interdisciplinary and integration and attaching great importance to the teaching practice (Cai 2008).

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At present the engineering education of colleges in our country is conducting Engineering Education Accreditation in order to be recognized by the countries of the world (Wang and Zhang 2008; Li 2013; Wu 2010). And to improve the quality of engineering education accreditation, the colleges are revised training program and promote the teaching work strictly in accordance with certification standards and procedures so that the certification work can fulfill the international equivalent requirements of the "Washington Accord". The Mechanical Engineering and Automation (urban rail transit vehicle engineering direction) in our school is our school's new professional direction. And starting from the admissions, according to the CDIO engineering education idea, training plan of Urban Rail Transit Vehicles Engineering direction in our school is set up combing with professional certification based on the investigation and research, which includes the strengthening of the teaching of basic subjects and the increase of the weeks of practice link in the aspect of course offered (Edward 2008, Khalid 2003).

When the Mechanical Engineering and Automation (rail transit vehicles engineering direction) began to recruit students, the students are admitted in different grades, as well as different talent. Besides, the students' planning of education is widely divergent, and some consider current education as the basis of further study, some treat current education as the preparation for jobs, while others want to start their own business after graduation. Aiming at this phenomenon, the paper dominated by CDIO engineering education mode, based on the reality, proposes implement of classified talent cultivation mode through combining with professional accreditation in response to the concept "promote the growth of all students and all taught" which is brought up by the school and combines student status through which everyone can be taught and all of them can develop themselves to meet the different needs of students.

In the process of undergraduate education, it delegates different academic advisor forming the cooperative guidance of ideological and political instructors, professional tutor and academic advisor (Three mentoring) according to students' willingness and potential, which can satisfy the requirements of students with different targets, needs and capabilities. Through allowing the students to participate in scientific research project and scientific and technological innovation activities of different levels and types, it improves students' learning capacity, innovation capability, cooperation capability and engineering practical ability. The students of this professional direction in 2010 are enrolled and graduated in July this year. And through application practice for 4 years, the fact proves that classification talent cultivation system has feasibility and promoting significance which obtained satisfactory results.

State of the literature

- Classified talent cultivation system combining with professional certification has changed the way of education in order to satisfy students' different requirements and potential
- Based on CDIO, classified talent cultivation system combining with professional certification can be considered an innovation for education
- The prior education system has been concerned with strengthening the basic knowledge
- CDIO engineering education concept was proposed by the United States in the late 1990s to improve the development of education and have a broad prospect

Contribution of this paper to the literature

- This study explores CDIO engineering education, and realizes classification of talent training according to different students' needs.
- The teaching of the Mechanical Engineering and Automation (rail transit vehicles engineering direction) in the school applied the CDIO theory to practice.
- Based on CDIO concept, the application results of classified talent cultivation system of urban rail transit vehicle direction showed that it is feasibility and advanced in the profession.

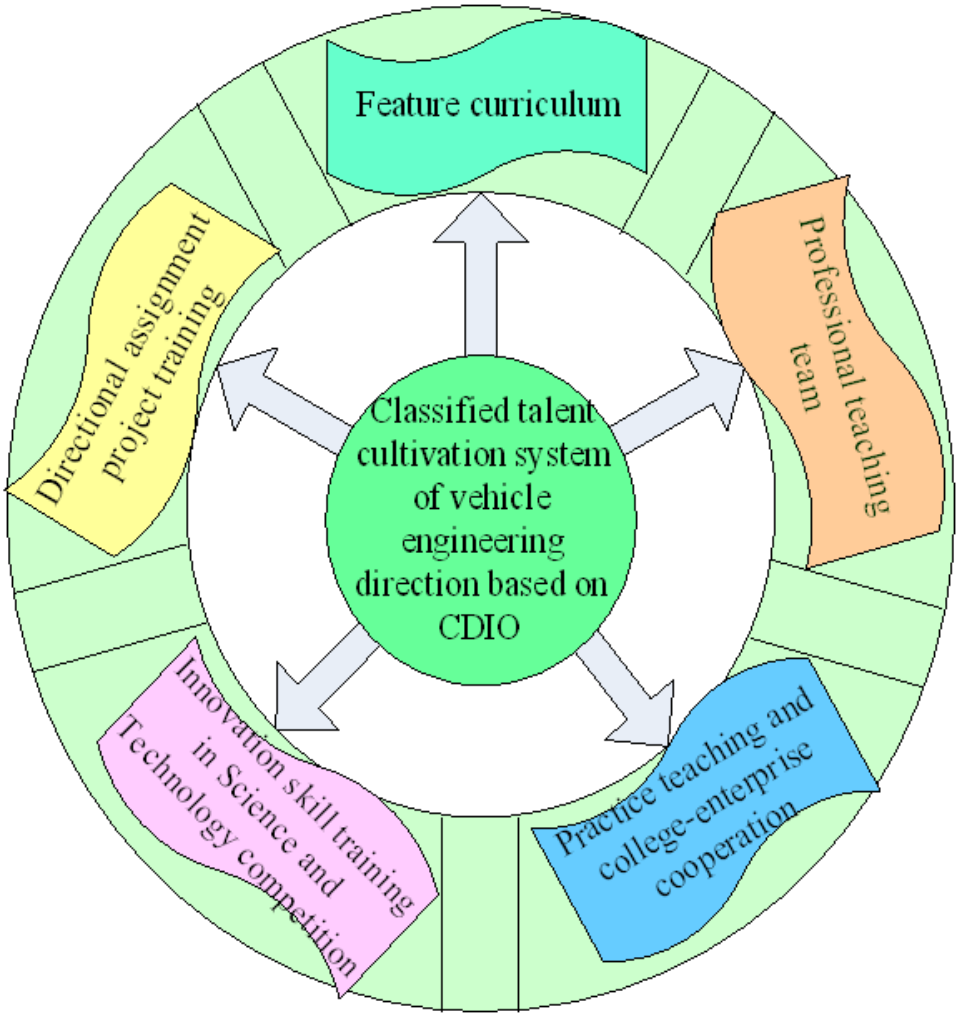

Figure 1. Classified talent cultivation system of urban rail transit vehicle engineering direction based on CDIO

METHODOLOGY

The building of classified talent cultivation system of Urban Rail Transit Vehicle Engineering direction based on professional certification and CDIO concept CDIO engineering education concept regards the whole process as a carrier to cultivate the students' engineering ability which includes personal engineering science and technology knowledge, the students' lifelong learning ability, team communication ability and building capacity of products, process and system in social and business situation(Wu 2010). Combined with professional certification and CDIO concept, classified talent cultivation system of urban rail transit vehicle engineering direction is built, as shown in figure 1. According to students' potential and study willingness, set up special courses to fit different training objectives on the basis of the professional training program(Zhong 2014); through the introduction of cooperation of industry enterprises and research institutes, establish practical teaching base for practice teaching and set up directional assignments for the implementation of project training; encourage students to participate in science and technology innovation competition to stimulate students' interest in learning and cultivate the innovative thinking ability; establish professional teaching team which is dominated by school teachers and in coordination with the industry enterprises, research institutes and other professionals (Wang and Hong 2009).

1) Solid foundation by strengthening basic teaching courses and carrying out the course continuation teaching activities to intensify the cultivation of the basic knowledge and basic skills

Mathematics courses increase class hours of discussion teaching, English and computer courses continue to carry grade and hierarchical teaching, and chemical courses were increased. Compared with training scheme set of other professional direction, the liberal education of urban rail transit vehicle direction accounts for 32.3% of the total credits and other professional direction is 28.57%; basic education percentage of urban rail transit vehicle direction of total credits accounts for 18.3%, while other professional direction is 17.6%; in the construction process of training program, perfect the general and solid foundation to meet the basic knowledge demand of classified talent cultivation system of urban rail transit vehicle engineering direction.

2) Optimize professional curriculum construction and set up characteristic curriculum system

Around the construction of Beijing urban rail transit and the talent cultivation needs of industry chain, this paper, combined with our school' characteristics and discipline advantage, builds knowledge and ability structure of the goal of talents training, refines course content and integrates the related courses to avoid repeating course content through the team' extensive research of domestic and overseas, and further optimizes the curriculum system structure on the basis of basic teaching plans

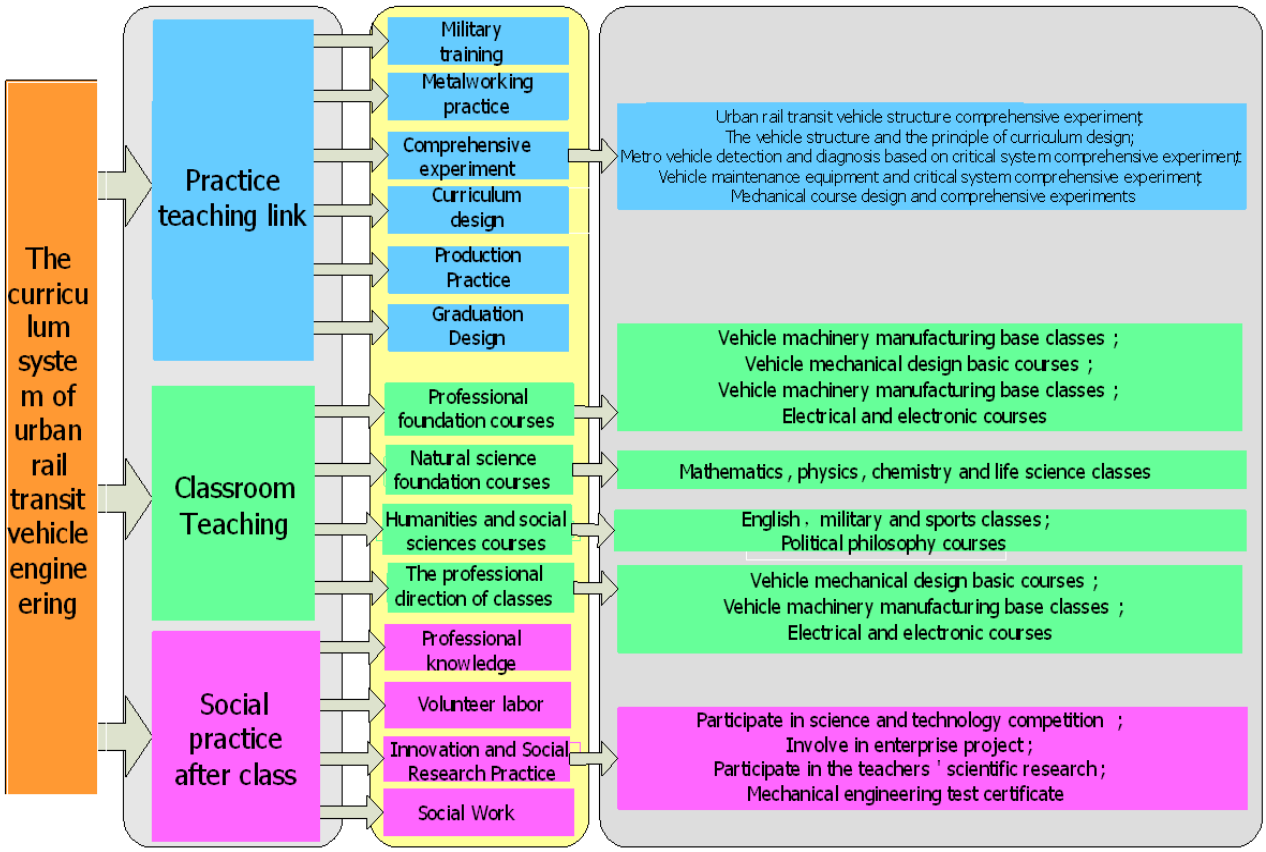

Figure 2. Curriculum system structure of urban rail transit vehicle engineering direction

(Armarego 2013). Set characteristic practice course modules to enhance students' technical ability, engineering consciousness and academic interests, teach students in accordance of their aptitude and take classified cultivation of students to respect

students' personality. The specific curriculum system structure is shown in figure 2 (Liao 2010).

The set of characteristic practice course, the engineering talent training module, for example, fully combines with industry characteristics and construction development needs of Beijing urban rail transit formed on the basis of in-depth investigation and research on industry enterprises and specialist demonstration. The corresponding relationship between characteristic practice course and training objective (ability) is shown in table 1.

3) Set directional subject to improve students' science and technology innovation ability

It determines students' academic advisor, subject advisor and extramural academic advisor through two-way selection (where, the subject advisor and extramural academic advisor are known as professional tutors). Academic advisors come from specialized teachers who are responsible for guiding students to learn professional knowledge and practical skills, and subject advisors are chosen according to the students' characteristics and the future development demands; subject advisors who are consists of young and middle-aged teachers or graduate students train students in four aspects which include engineering elementary knowledge, personal ability, team ability and engineering system ability to the expected goal (Lu 2009; Wang 2009). Organize college students to participate out of class science and technology practice and the activities of teachers' scientific research subject to improve students' awareness of innovation, innovation and engineering practice ability in technology and practice activities; hire some science and technology staff from industry enterprise of Beijing Subway Rolling Stock Equipment Company, Beijing Erqi Locomotive Factory and Beijing subway operating company as extramural academic advisors who can aim to cultivate students' ability through the school curriculum designs, graduation design and academic report. Through the combination and complementation of academic advisor, subject advisor and extramural academic advisor, it carries out the effective personal cultivation for students owning different objectives, potentials and needs.

4) Encourage to carry out practice teaching based on base construction

Combining requirements of theoretical innovation and independent innovation of collaboration enterprises, the practice base construction of urban rail transit vehicle direction establishes a relatively independent experimental teaching system based on Beijing finance special projects "urban rail transit laboratory". By strengthening the cooperation with enterprises and research institutes, it establishes off-campus production and practice base as the effective extension and complement of platform to deepen professional cognition, broaden the industry view and stimulate students' enthusiasm and initiative of learning. At present, the stable cooperative relationship has been established among our college, Beijing Erqi Locomotive Factory, Beijing subway operating company and other enterprise which set up off-campus production and practice base. At the same time, it not only implements students' practice teaching and professional practice teaching link, but also improves quality of subject choosing of the professional curriculum design and graduate design of the urban rail transit vehicles direction which fits closely actual production needs through the establishment of enterprises subject and collaborative training of intramural advisors (Liao 2010).

Table 1. Corresponding relationship between the characteristic practice course and training objectives (ability)

Course name	Humanistic quality/social responsibility/professional ethics	Math/natural science knowledge	Vehicle engineering basic knowledge / basic theory	The ability to solve actual problem of Vehicle Engineering	Vehicle Engineering Basic skills / computer application	Innovation/research/development/design skills	Relevant industry policy/policies/law/regulations	Organization management/language express/interpersonal/team cooperation	Ability to adapt and self-learning ability
Scientific research innovation and social practice	√	√				√	√	√	√
Professional cognition practice			√				√	√	√
Metal working practice			√	√	√	√		√	√
Mechanical innovation design course			√	√	√	√		√	√
Comprehensive experiment mechanism			√	√	√	√		√	√
Mechanical course design and comprehensive experiments			√	√	√	√		√	√
Comprehensive experiment of urban rail transit vehicle structure			√	√	√	√		√	√
Comprehensive experiment of vehicle electronics and train network			√	√	√	√		√	√
Vehicle structure and design course			√	√	√	√		√	√
Comprehensive experiment of detection and diagnosis based on metro system		√	√	√	√	√		√	√
Comprehensive simulated experiment of urban rail transit vehicle maintenance key system		√	√	√	√	√		√	√
Maintenance practice of urban rail transit vehicle equipment			√	√	√	√		√	√

5) Establish a professional teaching team to ensure the quality of students

Urban rail transit vehicles is an rising profession, and it is serious deficient compared with mature professions in terms of the reserves of professional teachers,

for which, there are two kinds of methods to solve at present: relying on Beijing talent advantage, recruited leading experts and outstanding teachers from China Academy of Railway Sciences and Beijing Jiaotong University to teach the students in our school through Beijing hired masters project; introduce young teachers. Some new teachers just graduated from Dr. who are lack of the new professional practice experience of urban rail transit, are sent to practice in the front line of the enterprise to enrich practical experience of teachers, so that the quality of young teachers and students can be developed simultaneously in engineering classification of education.

RESULTS

The practice of classified talent cultivation system of urban rail transit vehicle direction based on CDIO

Classified talent cultivation system of urban rail transit vehicle direction set According to the CDIO engineering education concept was specifically applied by the students of class 104 in our school, and specific measures and methods are as follows (Dong 2009).

1) Realize the cooperative guidance of "Three mentoring"

After students enrolled, the school allocates ideological and political instructors and academic advisor for 104 class being responsible for students' career planning through the new pilot project to guide students' training direction and corresponding elective courses combining students' willingness and potential. When they enter the school, there are 14 students to prepare for Masters, 3 students to want to go to study abroad and 11 students to expect employ or start a business. And through the tutor training and guidance of ideological and political instructors and academic advisor for a year and a half, there are 9 students to test the graduate exam, 3 students to go abroad and 16 students to employ or start a business. Assign different professional tutors who can coach different project for students with different desires which realized the cooperative guidance of ideological and political instructors, professional master and academic advisor (Three mentoring) and completed classification of talent cultivation.

2) Advance research-centered teaching

Advance research-centered teaching to taking students' initiative. Advocate actively heuristic, inquiry, discussion and participatory teaching requiring the core curriculum teaching mode to transform into heuristics and discussion direction to build good atmosphere of encouraging thinking and exploration. And turn teaching method which mainly instructs students' knowledge into the method which mainly guides students to learn, analyze mentally, explore and practice to cultivate the students' learning ability and skills of putting forward, analyzing and solving problem.

3) Build environment benefiting CDIO

Set up the innovation credit and strengthen the cultivation of innovation spirit and the preliminary innovation capability. Continue to promote college students' scientific research training, and encourage students to participate in competition of all kinds of subjects, scientific and technological inventions and teachers' scientific research; promote the interaction between scientific research and teaching and convert the scientific research to teaching content in time; encourage the experimental teaching demonstration center and key laboratory to open to undergraduates and provide project and technical support so that the students can have opportunities and conditions of independent research and learning (Wang and Hong 2009).

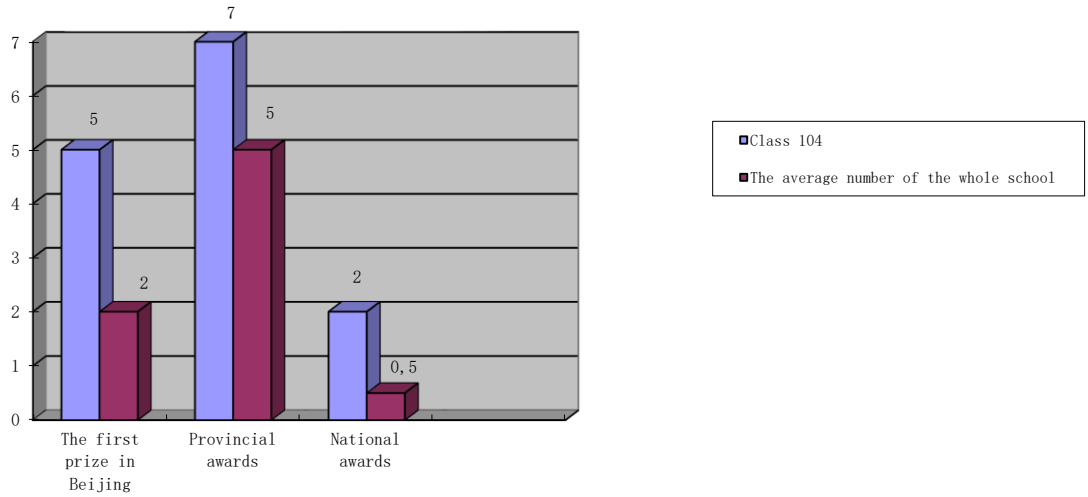

Figure 3. The comparison of the average number of award-winning of the whole school and the number of winners of class 104 in science and technology competition

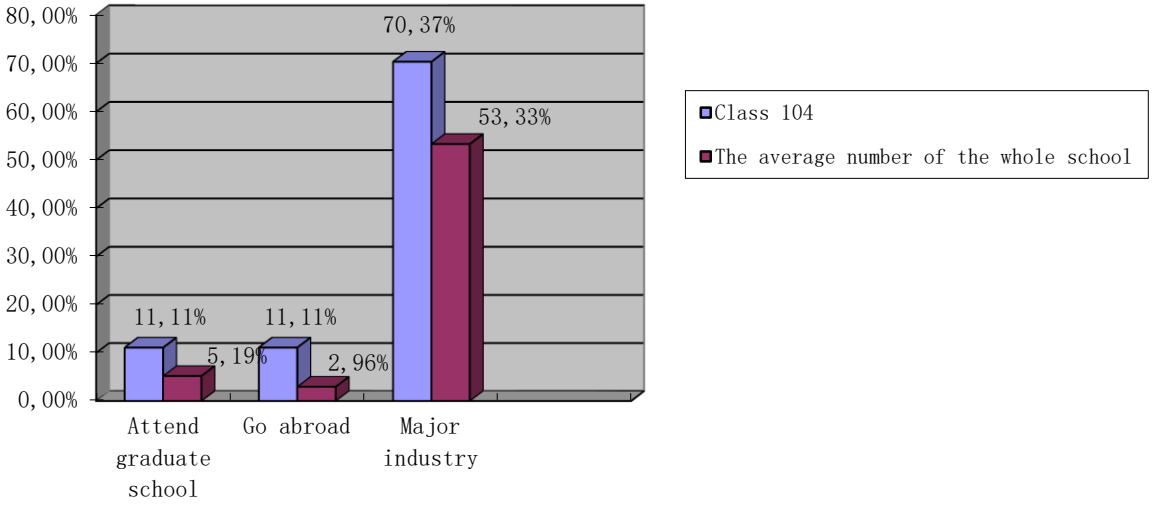

Figure 4. The comparison of the average employment situation of graduating class of the whole school and class 104

4) Implementation and results

According to students' potential and willingness to study, the system sets up special practice course modules to respect students' personality, teach students in accordance of their aptitude and take classified cultivation of students to respect students' personality. The students, under the cooperative guidance of academic advisor, subject advisor and extramural academic advisor, participate actively in directional project survey and research and extracurricular innovation practice activities (Max 2009). It achieves gratifying achievements including: "Mechanical Design Innovation Competition the second prize at the national level in 2012" once, "Mechanical Design Innovation Competition the second prize at the national level in 2014" once, "Mechanical Design Innovation Competition the first prize in Beijing in 2012" three times, "Challenge Cup the first prize in 2013" once, "Transportation Science and Technology Competition the third prize in 2013" twice and "Mechanical Design Innovation Competition the first prize in 2014" once. The scientific and

Figure 5. The students' photos participating in entrepreneurial project "repair tools and self traction vehicle project"

technological achievements achieved by students exceed the average level of all college, and the comparison of the number of class awarded projects and the college average winning projects is shown in figure 3.

Through the participation in the investigation and research of directional project and entrepreneurial project, the students' understanding of professions is no longer limited to lectures, and becomes more concrete, more in-depth and more practical; students choose the interested projects which suit themselves to take advantage and broaden the horizons, solid theory and cultivate the ability of engineering practice through project practice. Figure 4 is the students' photos when they participated in entrepreneurial project which is "repair tools and self traction vehicle project". After four years practice of the classified talent cultivation system, employment situation of class 104 is gratifying. There are 27 students in class 104, three of whom receive graduate admission notices, three people go abroad for further study, and 21 students sign up major enterprise and industries. The employment rate and signing rate is 100%, and the employment situation is shown in figure 5. In addition, the students of class 104 at the undergraduate stage apply for two patents including a patent for invention and publish 2 academic papers.

DISCUSSION

Through the on-campus and off-campus education for 4 years, it focuses on cultivating advanced engineering applied talents with high humanistic quality, solid theoretical foundation, thick specialty foundation and strong practice ability so that the students' ability including lifelong learning ability, group communication ability and system construction ability of product development can be improved.

CONCLUSION

Based on CDIO the classified talent cultivation system constructed by the paper is a ways exploring classified education. The combination of classification guidance and science and technology practice activity can purposefully guide students to take part in science and technology practice activities according to students' different requirements and potential so that students can take full advantage of the time and resources to do matting for future development. For example, students who have a postgraduate aspirations can be allowed to actively participate in provincial and

ministerial research projects focusing on improving their theoretical level and laying the foundation for subsequent postgraduate training; students who want to directly obtain employment can be allowed to participate in academic competition, science and technology development and enterprise commissioned projects paying attention to the cultivation of engineering skills practice , innovation, and cooperation ability. Through the combination of academic advisor, subject advisor and extramural academic advisor, it implements "Three mentoring" to form CDIO cultivating mode which is suitable for the present situation of our school. It proves that classified talent cultivation system of urban rail transit vehicle direction based on CDIO is not only feasibility and advanced in the profession, but also has certain promoting significance and a huge space for development.

RECOMMENDATIONS

The approach of this study, combing with professional certification, can satisfy the requirements of students with different targets, needs and capabilities so that it helps realize classification of talent training. According to the study, it proves that classification talent cultivation system has achieved satisfied results which has a huge application significance.

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REFERENCES

Armarego, J. & Roy, G. G.(2013). Curriculum assessment for professional accreditation: A modelling framework. *Australasian Journal of Engineering Education*, 19(1), 1-11.

Cai Y. H. (2008). The cultural harmonious idea in the reform process of higher engineering education mode. *Journal of Technology College Education*, 27 (2):6-9.

Dong Q. Z. (2009). Exploration of professional practice teaching reform of railway vehicle. *Chinese Vocational and Technical Education*, 05.

Edward, F. C., Doris, B. R. & Diane, H. S.. (2008).The Education of Future Aeronautical Engineers: Conceiving, Designing, Implementing and Operating. *Journal of Science Education and Technology*, 17(2), 138-151.

Khalid E. G. (2003). Reforming engineering education: the CDIO initiative. *Industry and Higher Education*,17(6), 431-434.

Li P. F., Liu W. P. (2013). "3+1" research and practice of Vehicle Engineering applied talent. *China science and Technology Innovation Herald,* 13:58

Liao Z. H. (2010). The quality characteristics and cultivation of technology innovative talents of University. *Journal of Hefei Normal University*, 01.

Lu M, Wang W. J. (2009). Management mode analysis of urban rail transit construction. *Journal of Beijing Jiaotong University Social Sciences Edition,* 05.

Max, L., Thiringer, T., Undeland, T. & Karlsson, R. (2009).Power Electronics Design Laboratory Exercise for Final-Year M.Sc. Students. *Education, IEEE Transactions on*, 52(4), 524-531.

Wang G. (2009). The interpretation and thinking on CDIO engineering education mode. *China Higher Education Research*, 05.

Wang S. W. & Hong C. W. (2009). CDIO: The education classic model of Massachusetts Institute of Technology Engineering - based on the interpretation of the CDIO course outline. *Journal of Technology College Education*, 04.

Wang T & Zhang C. P. (2008). Improve some of the exploration on the quality of graduate design of vehicle engineering. *Journal of Taiyuan University of Technology (Social Sciences Edition)*, 38(2):66-68.

Wen X. X. & Du Z. X. (2011). The thinking on professional training mode of Urban rail transport. *Journal of Chongqing University of science and technology*, 1:186-187.

Wu M & Xiong G. J. (2010). The research of engineering education reform Guided by the training of engineering ability training. *Journal of Technology College Education*, 29: 54-59.

Zhong, S. Y., Chen, Y. Z., Li, R. Y. & Chen, H. B.. (2014). Application of CDIO Idea in Engineering Training. *Advanced Materials Research*, 915-916, 1479-1482.