Application of "Reverse Design" in Reconstructing Curriculum Systems on NC Major

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Abstract—Because the essential differences on the personnel training pattern between university students and vocational college's students, the depth and breadth of the reform on certain curricular design would also be quite distinct. This paper puts forward an innovation in reconstructing curriculum systems in vocational colleges by using the theory of "reverse design". Taking NC major as an example, it is illustrated that occupation capability standards, supporting curriculum systems and occupation capability evaluation on the basis of occupational groups and position capabilities. The curriculum system reform should reflect the requirements of profession position, and "reverse design" methods of curriculum system should be closely integrated with job orientation and occupational capacityand. This work uses "reverse design" theory as the standard and starting point of curriculum design and provides detailed elaboration with vivid examples.

Keywords—Reverse Design; Vocational Education; Curriculum System; Education Reform; NC Major

I. INTRODUCTION

Employment-oriented and skill-targeted, are the concept of vocational education and also the talent training positioning of higher vocational college. While talent-supporting course training system always focus on the students' position orientation and capability orientation, the curriculum system reform targets on job capability standard, supporting curriculum system and position capability assessment. This would make the curriculum system of higher vocational education more adaptive to the training objective for higher vocational students, and eventually meet the purpose of cultivating vocational college students' comprehensive ability to solve actual problems.

II. NECESSITIES OF REFORM

Due to the essential differences on the talent training pattern between university students and vocational college's students, the depth and breadth of the reform on certain curricular design would also be quite distinct. For undergraduate students, curriculum systems design basically focus on the frontier pioneering on subjects, and exploration of theories and sustainability of application, specifically, to foster students' correct judgment ability, analytical skills and problem-solving ability on theoretical and engineering application problems, as well as the ability to learn how to creatively solving hard problems in the research project [1-4].

On the other hand, for higher vocational college students, curriculum systems design would mainly focus on practical skills, hands-on skills and operational skills on to solve specific practical problems, specifically to develop students' independent ability to solve a practical problem and to learn how to perform actual operation in real situation.

To sum up, the reform direction of curriculum system in higher vocational colleges should be guided by the employment, targets on occupational skills as its principal structure, professional curricula should be divided based on job orientation and occupational ability requirements, and the course amount, class number and teaching steps should be designed specifically for teach course. Cultivation of students' professional skills, operation skills and comprehensive quality should run through the entire course system, so as to form a complete and sustainable higher vocational education curriculum system with appropriate basic theory, strong technical ability and operation skill skills operation as well as high comprehensive quality.

III. "REVERSE DESIGN" APPROACH OF CURRICULA SYSTEM REFORM

Famous American curriculum and education expert offered "reverse design " pattern of curriculum system，its purpose is to make course system design process a way to cultivate students' practical application ability[5-9]. The essence of curriculum system "reverse design" is to design the curriculum system's application skills according to a clear the talents cultivation objectives. The whole design process could be divided to three stages as shown in table1.

TABLE Ⅰ. THREE STAGES IN PROCESS OF REVERSE DESIGN

Stage 1	Determining the technical ability target and creativity target,
Stage 1	Determining how to prove students have achieved the desired objectives,
Stage 1	Arrangement of teaching practice opportunities for reconstruct curriculum systems

It is very important that determining the technical ability target and creativity target, determining how to prove students have achieved the desired objectives, and

the arrangement of teaching practice opportunities for reconstruct curriculum systems.

Although Grant's "reverse design" pattern has now been widely used in foreign education system of primary, secondary and undergraduate schools, it's worth noticing that it's hardly reported that on how to improve Chinese higher vocational education curriculum system with the help of "reverse design" pattern [10-12].

Meet the needs of talents training is a measure of the success of higher vocational education, to test whether talent cultivation mode of higher vocational education is innovative and characteristic, the first and most important thing is the design and reform of talents training mode and talents scheme. Reform of curriculum system in higher vocational colleges is the focus of talent training mode reform. The reasonable construction of curriculum system in higher vocational colleges will not only determine the reform direction of talents training standards on knowledge, ability and quality, it will also improve teaching content, methods and models.

This article uses "reverse design" theory as the standard and starting point of curriculum design. Curriculum system reform should reflect the requirements of profession position, and "reverse design" methods of curriculum system should be closely integrated with job orientation and occupational capacity. Examinations and position capability evaluation could provide further theoretical basis for defining and allocation curriculum system, and since the system is oriented with capability cultivating and exercising, certain basic technical courses and professional courses need reintegration. New position capability assessment system and certain supporting curriculum system need to be established with key assessment focus on students' understanding and practical skill—this is the essence of "reverse design" method of curricular system.

IV. ESTABLISHMENT OF "REVERSE DESIGN" CURRICULA SYSTEM REFORM

The principle of the "reverse design" is requested to think about the target, and to determine the corresponding evaluation, finally to carry on the curriculum system. Application of the "reverse design" can greatly improve teaching effectiveness.

In the following part, the essay would take the NC major in our school as an example, first determine occupational groups and occupational ability requirements, and then establish curricular system of the major using "reverse design" approach.

A. *Determining the Occupational Groups*

In order to meet the demand of society and requirements for numerical control talents, here is our polytechnic's occupation groups orientation on numerical control: numerical control machine operators, numerical control machine programmers and NC machine maintenance and repair technicians.

The cultivation targets for these occupation groups are to train students into practical talents with knowledge of machining and NC technology as well as skill of technology of NC machining, CNC programming, CNC equipment installation commissioning and maintenance.

B. *Determining the Objective for Position Capabilities*

Based on the occupational groups and characteristics of position capabilities and technical resources required by certain occupational groups, we could thus determine the objective for position capabilities. They are namely: separately surveying and mapping and overall assembly ability , design and calculation ability for common machinery parts, second dimension figure , assembly figure and three dimensional blasting figure drawing ability using CAD software on machinery parts and products, ability on actual operation technology, processing technology and tooling technology such as skilled drawing ability on processing machinery parts of loaded clips, positioning, and processing route set and processing parameter adjusting ability. General machine operation and machinery parts processing ability, NC lathe operation ability on complex parts for processing stepped axis, surface forming and thread, operation NC milling machine ability on processing parts for plane profile, slot shaped, drill, and boring, analysis judgment and problem tackling capability on processing program and knowledge on NC processing technology and programming ability, installation, maintenance, debugging and daily maintenance ability on NC device, translation ability on simple foreign professional NC information, basic automatically programming ability with CAM software such as Master Cam and Pro/E.

V. EMPIRICAL STUDY ON CURRICULAR SYSTEM USING "REVERSE DESIGN" APPROACH

In order to make people better to understand the principle of straighter forward to apply it, researchers have been given based on the framework and process of "reverse design". The basic frameworks of the "reverse design" on NC major are shown in table 2.

TABLE II. FRAMEWORKS OF "REVERSE DESIGN"

Framework 1	What is the key problem to the "reverse design" on NC major
Framework 2	What kind of factors on "reverse design" should be considered on NC major
Framework 3	What is the standards of "reverse design" on NC major
Framework 4	How to construct the curriculum system through "reverse design" on NC major
Framework 5	What courses need to be done through "reverse design" on NC major

The frameworks on the whole and "reverse design" on NC major are given in the five stages and the corresponding need to pay attention to the problem, is the earliest about the frame of the theory of the curriculum designer pointed out the application of the theory of curriculum design process.

On the foundation of orientations for occupation groups and position capabilities, we summarized six main features on NC occupation ability, and elaborated the relation among standard on position abilities and skills, curricular system backed by position ability, and position ability assessment targets. Our goal is to illustrate how to direct the curricular system reform by "reverse design"

approach with occupation assessment target in an empirical way.

A. Surveying and Mapping Capabilities

Occupation ability and skill standards: using of measurement tools, surveying and mapping on parts and assembly, technology processing on measurement data, the national standard of Mechanical Drawing and Technical Drawing, graphic drawing and dimensioning methods, basic skills of drawing and reading mechanical drawings, identification of complex parts and assemblies, two-dimensional computer CAD drawing , three-dimensional Pro/E drawing.

Supporting curriculum system: mechanical drawing, computer CAD drawing technology, and Pro/E drawing and its application.

Occupation ability assessment target: surveying and mapping of parts and mapping of assembly independently, drawing parts and assembly diagram correctly, marking measurement and technology correspondence on parts technical drawings correctly, correctly drawing two and three dimensional pattern using drawing software according to national standard.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Electric and Electronic Knowledge

Occupation capacity and skill standards: common use of electrical instruments and electrical tools, identification of common components in the circuit, familiarity with basic law, calculation analysis and suitable application range in circuit, problem tackling ability using the circuit line, check lines to solve simple faults, designing and manufacture of simple electronic device, mastering of machine control circuit installation and common faults eliminations methods.

Supporting curriculum system includes electrician and electronic technology, machine tool electric control.

Occupation capacity assessment target: recognition of circuit schematic figure and electrical control principle figure independently, analysis and calculations on simple circuit, ligature, debugging and troubleshooting of the circuit correctly, design and manufacture of simple electronic devices independently and obtaining certain certificates according to the National Ministry of technician standards.

C. Mechanical Design Capabilities

Occupation ability and skill standards: correctly identification and selection of standard parts, and function and structure design for common mechanical facility and common parts, material recognition and function identification of the mechanical parts, stress and strength calculation of mechanical parts and strength failure analysis, improving materials properties through heat treatment.

Supporting curriculum system includes principle of mechanical parts, metal material and heat treatment, mechanical design basis, engineering mechanics, mechanics of materials.

Occupation capacity assessment target: accomplishing structure design of mechanical bodies and common parts independently, correct selection of mechanical parts and materials and identification the main performance targets, correct calculation of the mechanical parts strength, strength failure analysis of shaft parts, and correct selection on different heat treatment process for different materials performance improvement.

D. Process Analysis Capabilities

Occupation ability and skill standards: analysis combined with tolerances, tolerance inspection of the hole axis dimension, shape and position error detection, theory of metal cutting and machining, machine processing surface quality and processing accuracy, machining processing technological flow and route development design , Jig and cutter, Assembly process design.

Supporting curriculum system includes interchangeability and surveying technology, metal cutting principle, mechanical manufacture basis, mechanical manufacturing technology.

Occupation capacity assessment target: independently accomplishment of dimensional tolerances of mechanical parts testing, surface finish, error detection, shape and position error detection, determining the reasonable processing technology and route according to machining requirements, correct selection of processing machine tool, fixtures, tooling, and determining reasonable cutting amount and cutting speed.

E. NC Programming and Operational Capabilities

Occupation ability and skill standard: numerical control processing technology design for machine tools and technology card preparation, NC machine milling cutting, NC machine milling processing programming.

Supporting curriculum: machine tools and numerical control machine tool, NC programming and operation, NC processing technology.

Occupation ability assessment target, accomplish of typical parts of NC processing technology analysis and technology card writing independently, correct understanding the material and application range of NC machine, correct selection on tools, correct understanding of NC machine tool fixture type, and correct selection on fixture according to different parts and different loaded clips ways, skilled master of common program instruction and automatic programming in NC machine, correct design of typical parts of car milling processing program,

Correct actual operation on NC car milling machine, independent car milling processing operation on more complex parts according to the technology requirements in figures.

F. NC Repair and Testing Capabilities

Occupation ability and skill standards: different interface constitution and signal of NC system, main movement of NC machine tool and troubleshooting for feed motion system, common electrical appliances and electrical system of NC machine tool, Troubleshooting and fault diagnosis for feed servo system and spindle servo system in NC machine tool, PLC Fault diagnosis for NC machine tool and its hydraulic and pneumatic system.

Supporting curriculum system: electric control and PLC, electric control of CNC machine tool, principle and application of sensors, hydraulic pressure and pneumatic.

Occupation ability and assessment target: correct master of the interface composition, location and signal meaning in NC system, Maintenance and fault diagnosis for electrical equipment control in NC machine tool, correct recognition of NC machine tool electrical principle figure, fault diagnosis and maintenance for basic electrical control line in NC machine tool, correct selection of PLC products, master of basic PLC instruction and programming, fault diagnosis and maintenance for simple hydraulic and pneumatic system in NC machine tool.

VI. CONCLUSIONS

Change traditional professional orientation course system design model, by using the theory of "reverse engineering" to reform curriculum system design in higher vocational colleges. In determining the position, on the basis of professional group of positioning, clear orientation of covered by job skills standards, post ability appraisal target and curriculum system, supported by corresponding to highlight the characteristics of higher vocational education from the essence and the personnel training mode of higher vocational education, to cultivate professional skilled application of popular with industry and business goals.

ACKNOWLEDGMENT

The financial support from the key course of construction project by Shanghai Municipal Education Commission (SZDKC13001) and Specialized Research Fond for Shanghai Private University Teacher Development is gratefully acknowledged.

REFERENCE

[1] Elena Y. Zakirova,Stanislav V.“A Technology for Designing a Vocational Module in Vocational Education,” Review of European Studies, vol.7 no.3, 2015, pp.23-26

[2] Roland Andersso.“The impact of advanced vocational education and training on earnings in Sweden,” International Journal of Training and Development, vol.18 , no.4, 2014, pp.256-270

[3] Nicolette Lee.“Systems models in educational research: a review and realignment in the context of curriculum,” Studies in Higher Education, vol.40, no.10, 2015, pp.1844-1858

[4] Seema A. Tarnekar.“Framework for a Knowledge Management System for Curriculum Development Process,”Journal of Information and Knowledge Management, vol. 13, no. 04, 2014, pp.1-18

[5] Wiggins G. P. & Mctighe J.“Understanding by Design: Study Guide”, Association for Supervision and Curriculum Development, 2000.

[6] Lin Min.“Assessment-Prioritized Backward Teaching Design,” Jiangsu Education Research, vol.12, no.2, 2013, pp.40-43.

[7] Ye Hai-long.“Reverse Design on Teaching,” Contemporary Educational Science, vol14, no.6, 2011, pp.23-26.

[8] Xia Jing-biao. Comparison of Reverse Design of Teaching and Traditional Teaching Way, Journal of Chengdu College of Education, vol.18, no.1, 2004, pp.41-41.

[9] Justin B-Leaf, Andrea Mountjoy.Toby. “What Is the Proof? A Methodological Review of Studies That Have Utilized Social Stories,” Education and Training in Autism and Developmental Disabilities,vol.50, no.2, 2015, pp.127-141

[10] Paul R. Lehma. “ Professional Notes: Reforming Education Reform,” Music Educators Journa,l vol.101, no.3, 2015, pp.22-32

[11] Tachelle Banks. “Teacher Education Reform in Urban Educator Preparation Programs,” Journal of Education and Learning, vol.4, no.1, 2015, pp.60-63

[12] REVILLE, PAUL.“Education Reform: More Work to Do,” BusinessWest ,vol.31, no.21, 2015, pp.12-15