The Study and Practice of Online Education for Large-scale Cultivation of Engineering Staff

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Abstract: With Internet technology advancing globally, online education has been applied to various fields. China, whose economy and society have been developed dramatically, is putting more demand on high-quality engineering staff. The needs for on-service training for millions of them are increasing prominent. Based on its accumulation and practice in the field of distance education for more than 20 years, Tsinghua University is taking the lead in exploring online education and training of engineering staff in China. Abiding by the basic ideas of Analysis, Design, Develop, Implement and Evaluate, Tsinghua University has formed a set of education and training patterns, including MPOC (Massive Private Online Courses), SPOC (Small Private Online Courses), PMTD (Pyramid Model of Talents Development), and so on. On account of its strict management of the whole closed-loop process from education design to assessment, meanwhile learning results can be enhanced through course introduction, conclusion, discussion, practice and self-test which can be combined with offline workshop, on-site teaching, and the continuous iteration, modification and improvement in the process of practice combined, the online training of engineering staff has gained excellent teaching results and prestigious social reputations. Tsinghua University's online education has been widely used for engineering staff training in different fields and on different scales, more than 300,000 people have been trained, including business management, energy conservation, safety production, as well as technological innovation.

Part I Research background

Since the 1970s, Chinese technical professionals have been expanding. According to statistics, its total number has reached 55 million by the end of 2014. China has attached great importance to the training of technical professionals. Since 2011, the Ministry of Human Resources and Social Security has issued the National Plan for Long-and Medium-Term Construction of Technical Professionals (2010-2020) (referred to as the Plan below) .According to the Plan, while construction of Chinese technical professionals has seen considerable progress, on the whole "its scale, quality, structural distribution, system and mechanism and the environment for its development still lag behind the need for socioeconomic development and the construction of an innovative nation"; "its capability of independent innovation is still not strong"; "there is a shortage of technical professionals on the basic line and the professional skills need badly to be improved"; "training of the talent cannot match the rapidly developing economic and societal need" ; "institutional barriers still exist for the development of the talent; there is a shortage of investment and the engineering staff needs to be further motivated".

The Plan also iterated that large-scale knowledge renewal and continuing education should be carried out in twelve fields including information, finance and accountancy, ecological and environmental protection, energy and resources as well as disaster prevention and disaster relief, training one million technical professionals each year. In nine fields in the modern service sector such as consultancy, accounting, intellectual property and food security, 0.8 million urgently needed engineers should be trained, highlighting knowledge renewal, mastery of advanced technology and enhancement of professional skills. This will fully rely on higher education institutions, research institutions and training agencies of large enterprises, and some national sites for technical professionals' continuing education need to be established.

Given the urgent need for engineering staff to match the economic growth and the demand of training nearly two million annually, short-term face-to-face training can hardly satisfy this need since it is limited by the expenses and can only benefit a limited number of people. Besides, its teaching content has become stale and its effects will be hard to strengthen. As such, it has become all the more necessary to rethink engineering staff training in terms of distance education.

Part II   An overview of the non-diploma, non-degree online education in Tsinghua

Tsinghua university began its non-diploma, non-degree distance education in 2004, which was the earliest among all universities in China.Online education has advantages of convenience, efficiency, openness and flexibility. It breaks the limitation of time and space at low cost and has a wide coverage to reach those who are unable to attend face-to-face training. Through online education, Tsinghua has been making beneficial attempts to solve the problem of large-scale talent training in the same industry since 2014. Tsinghua has established "Web Learning for PLA Cadres Transferred to Civilian Sector" in cooperation with the Ministry of Human Resources and Social Security and the State Council Head Office of Resettlement of PLA Cadres Transferred to Civilian Sector, implemented the Construction Program of Independent Training Systems for China's Innovative Growth Enterprises in cooperation with the National Development and Reform Commission, conducted distance training for the Qualification of Management Skills for Leaders of Central Enterprises in cooperation with the State-owned Assets Supervision and Administration Commission, and launched distance training for employment instructors for the disabled in cooperation with China Disabled Persons' Federation. All these programs have achieved satisfactory teaching results and social benefits.

After years of exploration and practice, Tsinghua university has gradually summarized the customized mode of distance training, namely to conduct specific training design according to the different levels and categories of learning groups in a single industry. Based on the diversified demands of different trainees, Tsinghua University can customize the content, management mode, service system, visual experience and other aspects of online education for precise cultivation. Meanwhile, Tsinghua university has accumulated rich experience in teaching and management, and has established a set of strict and standardized teaching quality control system, including teachers, teaching processes, educational affairs, administrators, etc., to ensure the quality of teaching.

Part III   Theories and Main Models of Online Education for Engineering Staff

1. Designing training objectives based on performance gap

The basic approach is to first identify the gap between the expected performance of the organization and the current performance, and analyze the causes. Second, design and develop appropriate performance improvement methods based on the causes analyzed above. Finally, implement the plan and evaluate the effect. The ultimate goal of the approach is to improve the performance of organizations and individuals. When their performances fail to meet the initial expectations, the reason may either be the environment or the lack of personal ability. Educational intervention for individuals proves effective to solve the lack of personal ability, i.e. the lack of knowledge, skill and attitude. Therefore, performance gap is one of the sources of demand for training.

2. Designing training process based on ADDIE model

ADDIE is a system model for Analysis, Design, Development, Implementation and Evaluation. It has two major characteristics. First, its basic assumption is that there is demand for training, but it is based on the demand analysis that the content of training is decided, so training begins with the analysis of the content of the work. Second, the model is divided into five stages, i.e. analysis, design, development, implementation and evaluation, which constitute the most recognized procedures of training development.

To be specific, demand analysis is the basis of the following process of design, implementation and evaluation. Demand analysis in training ensures that appropriate training is assigned to appropriate people. Its main purpose is to identify training objectives. Demand for learning is an important concept in teaching design. It refers to the gap between the current level and the expected level of knowledge, skills and attitudes. In the design procedure, the organizers identifies the curriculum system, determines the training implementation strategy, and selects the teaching media based on the demand analysis. The development procedure is to screen the lecturers, compile training materials, and select teaching media according to the characteristics of learners and requirements of training objectives on the basis of analysis and design. Evaluation runs through the whole training process, and teaching evaluation includes process evaluation and result evaluation.

3. Teaching based on whole process closed-loop design and customization

1) Whole process closed-loop design

Design teaching processes that include process assessment and result assessment. Examinations are organized as an effect test of learning, and course-completion certificates are issued as an efficient incentive for online learning. This design serves as the precaution so that online learning will not be reduced to a mere formality.

2) Private

Private means that all the procedures are designed and implemented according to the characteristics of the learning group. It refers to organization of specific course contents, integration of specific faculty members, provision of specific service support systems, organization of teaching on specific distance learning platforms, and specific assessment and certification according to specific training objectives and trainees under specific course design philosophy. Therefore, customization is embodied in the following aspects: overall design, learning resources, learning management, learning support services and learning evaluation.

4. Main models

1) MPOC

Massive Private Online Courses. It provides large-scale customized online courses for junior managers in central ministries and commissions and national associations to improve the quality of grassroots employees in a short period of time.

2) SPOC

Small Private Online Courses. User group: junior managers in small and medium-sized enterprises and local governments. The model of SPOC is almost the same with that of MPOC, and the major difference lies in the relative scale of the project.

3) PMTD

Pyramid Model of Talents Development is a comprehensive talent training model combining distance teaching, face-to-face teaching and other educational and training products. Designed for ministries, associations, enterprises above designated size, local governments, public institutions above designated size, etc., the PMTD provides comprehensive training for talents in the whole industry or organization. The model consists of three levels. The first level is intended at the massive grassroots personnel

in the industry, and combines distance learning with free face-to-face training, which is adopted as incentive. The second level is intended at the mid-level managers which constituted a modest proportion of the industry. It adopts customized face-to-face training, and introduces online courses as a supplement. The third level is intended at a small number of high-end management talents, and organizes training through face-to-face lectures and self-study of online courses.

Part IV   The Design and Implementation of the Online Education of Engineering Staff: A Case Study of Distance Training Program for Energy Conservation Personnel for Public Institutions

1)   Pre-training research

Since 2012, before each distance training program, Tsinghua University would organize nationwide researches. The researches focused on training targets, training demands and curriculum settings, covering central state organs, as well as public institutions of education, science, culture, health and sports at the provincial, municipal and county levels. By means of literature research, questionnaire, discussion, telephone interview and other methods, the research promptly sorted out the types of jobs concerning energy conservation business of public institutions, and analyzed the nature, functional orientation and diversified requirements for professional skills in different jobs. The designers gradually mastered the knowledge reserve status and the training demands of the employees, and extensively solicited opinions regarding the training system, teaching organization, supporting system, etc. Through research, the designers confirmed the focus of the curricula in each distance training program.

2)   Customized content

In order to provide more targeted and useful distance training curriculum, Tsinghua University divided the trainees in training program into 5 categories, and designed curriculum for each group accordingly. The categories included management staff of energy conservation in regional public institutions, heads of energy conservation in public institutions, heads of energy management department, energy conservation statisticians and professional operators of energy utilization systems and equipment. Except for general compulsory courses which were the same for every

trainee, Tsinghua also designed positional compulsory courses and elective courses. The positional compulsory courses were designed according to the job requirement of each position, while the elective courses intended to satisfy the trainees' personalized interests.

3) Strict selection of faculty

The faculty of the program included professors with profound theoretical background and rich teaching experience in Tsinghua University and other prestigious universities, experts with rich practical experience in energy conservation research and service institutions such as China Academy of Building Research, and personnel engaged in energy conservation management in public institutions. The syllabus, depth of the content, and the effect of teaching of each teacher were evaluated by students in an evaluation form designed by the university, which would serve as an important basis for the entry and exit of the teachers.

4) Strict teaching management

First, fully utilize the big data management platform. The learning data of trainees in each program were incorporated into the big data management platform, so as to track and return the data of individuals and their locations. The real-time statistical data can effectively reveal the learning characteristics of trainees both as a group and as an individual, which provide accurate and reliable data supporting the development of energy conservation management. Second, establish a hierarchical management mechanism. According to the different levels of energy conservation management in public institutions, Tsinghua set system administrators at the provincial (Central Government departments) and municipal levels. By incorporating distance training management with actual work, administrators of all levels could supervise the learning status and promptly collect the opinions of trainees. Third, select exemplary trainees. Through the inspection of daily training and recommendation at different levels, the organizers selected exemplary trainees who are conscientious and well-performed. Tsinghua University organized face-to-face training and study tour for them, which successfully mobilized the enthusiasm of the trainees.

5) Extension of the form of training

While conducting distance training, Tsinghua University actively explored the

extension of the connotation of training, and actively promoted the transformation of distance training products. Tsinghua has gradually developed a pyramidal talent training model with distance training as the main body and face-to-face training as a supplement, and a comprehensive service system including grass-roots research, scientific research topics, talent exchange, case collection, customized courses, etc.

6) Enhancement of the interaction and communication through new technology

Based on the original functions of the Modern Distance Education and Training Platform of Tsinghua University, Tsinghua improved such functions as online homework and self-test, course Q&A, material download, simulation test and course evaluation to better assist the online learning of trainees. Meanwhile, the development of mobile learning terminal, learning forum, QQ groups, contribution email and other functions further enhanced the interaction between course management and trainees' learning. With these functions, the platform provides high-quality teaching services for numerous trainees, as well as a channel for public institutions to publicize energy conservation policies and display their achievements. More importantly, it provided a platform to share and exchange working experience, which exerted a positive influence on practical work.

Moreover, faced with the development of mobile Internet technology since 2013, Tsinghua University developed a mobile learning app that facilitated the offline learning on mobile phones, tablets and other mobile terminals. Meanwhile, Tsinghua made full use of new media means like WeChat subscription, WeChat service account, H5, video livestream, voice livestream courses, etc., so as to release the cutting-edge development trend of energy conservation in public institutions, and to publicize energy conservation.

Part V   Obstacles and Challenges for Distance Training of Engineering Staff

During preparation and implementation, we gradually identified certain problems of the distance training of engineering staff, which are both current obstacles and chances of potential breakthrough. For instance, there is still room for improvement in

the engineering staff's initiative in continuing education. At present, most of the trainees participate because they are required to do so, for which they normally lack motivation during the training. Moreover, the development and setting of continuing education curriculum for engineering staff have to be more scientific. Currently, it mainly depends on the research on targeted positions and the guidance of experts in related fields. During the research on engineering personnel, however, we found out that due to the confinement of the relatively small working unit, the front-line technicians could hardly grasp the overall projects, the prospects of the industry and their relationship with the industrial development. Meanwhile, the professionalism of engineering personnel training imposes further requirements on the implementation staff, whose professional knowledge exerts a considerable influence on the quality and prospect of the engineering personnel training. Furthermore, there are still important tasks to solve for the distance training of engineering staff, including the verification of the actual training effect, as well as the comprehensive performance evaluation of both the trainees and the trainers.