

Applying the CDIO engineering education standards to optimise services provided by subject librarians

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ABSTRACT: The CDIO (conceive, develop, implement, operate) engineering education standards are an example of continuous improvement of engineering education methods and resources. The introduction of the CDIO engineering education standards into subject library services in engineering colleges aims to improve design, development and creative abilities of subject librarians and to optimise the service quality of libraries. This article analyses the inherent meaning of the CDIO engineering education standards and proposes several measures to optimise library services. Through construction of a CDIO engineering education outline and the setup of service platform and collection system, the service quality of subject librarians in engineering colleges can be considerably enhanced. As a result, the overall effectiveness of college libraries can be optimised.

INTRODUCTION

The college library is a repository of a range of scientific knowledge. It serves a vast number of students and academic staff, and is a significant element of the innovative chain [1]. The introduction of the CDIO (*conceive, design, implement and operate*) engineering education standards into subject librarian services can optimise service quality. The period from product research and development to product operation represents the product life cycle. It is a systematic learning mode that implements an organic connection between students and courses [2].

The CDIO engineering education mode makes students participate personally in each step of product research and development, so students' awareness is high and their engagement boosted by direct involvement.

The CDIO outline includes the qualities and knowledge, which should be possessed by a modern engineer, involving four aspects: 1) professional ability, personal qualities and attitude; 2) inferential capability, knowledge and skills; 3) conception-design-implementation-application ability in the society and working environment; and 4) interpersonal communication skills and teamwork spirit in work.

The CDIO standards embody engineering education reform concepts from the US and have been applied in numerous American and European institutions for many years. The standards put forwards 12 criteria about ability training, comprehensive implementation, examination and evaluation in an optimal and systematic way [3]. They are one of the most progressive and widespread international engineering education reforms. In recent developments, the advantages of this mode have become increasingly obvious [2].

The introduction of CDIO engineering education standards into China has been relatively recent. In 2008, the Science and Engineering Office of the Higher Education Department under the Ministry of Education of China and Shantou University co-hosted the *2008 Seminar for China CDIO Engineering Education Mode* and set up the Research Group for Research and Practice of China CDIO Engineering Education Mode [4].

The Research Group studies international engineering education reforms and the CDIO engineering education standards, surveys Chinese engineering education reforms and guides some colleges in pilot work and exchange activities for CDIO engineering education [5].

In September 2008, the Ministry of Education convened the second working conference of research and practice research and practice for CDIO engineering education at Beijing Jiaotong University. Researchers' experience showed that the CDIO education standards are feasible and suitable for each link in engineering education and the teaching/learning process [6].

IMPROVEMENT OF SUBJECT LIBRARIANS' SERVICE AWARENESS IN ENGINEERING COLLEGES UNDER CDIO ENGINEERING EDUCATION STANDARDS

CDIO education outline: Part I of the CDIO outline introduces basic knowledge and relevant operating skills of engineering technology. Part II presents personal skills and qualities. Part III emphasises the importance of interpersonal communication. Part IV of involves conception, analysis, implementation and application system in the relationship between enterprises and the society (see Table 1).

Table 1: CDIO education outline.

First-class requirements	Second-class requirements
Technical expertise and reasoning	<ol style="list-style-type: none"> 1. Relevant scientific knowledge 2. Basic engineering knowledge 3. Advanced engineering knowledge
Personal vocational ability and attitude	<ol style="list-style-type: none"> 1. Engineering reasoning and solutions 2. Experiment and knowledge discovery 3. System thinking 4. Personal vocational ability and attitude
Interpersonal skills	<ol style="list-style-type: none"> 1. Teamwork 2. Exchange
Conception, design, implementation in social background	<ol style="list-style-type: none"> 1. Understanding of social background 2. System conception 3. Design 4. Implementation

Participate in the project implementation process in the project organisation and make contributions to the target achievement: the CDIO outline is concerned with analysis, implementation and application as the development route, considers overall basic theory, personal skills and qualities, as well as teamwork and communication ability, and goes through the CDIO process in the context of social relations and product implementation enterprises.

Combine fundamentals of CDIO and practical work: theory is the foundation of practice and practice verifies theory. Only when the two are organically combined can one thoroughly master basic skills. It is expected that subject librarians should have the following professional capabilities: comprehensive analytical ability and deep knowledge of various systems; clear and full understanding of the service process and culture; well-developed client relations at the information inquiry point and communication skills, especially in writing, verbal expression and graphical representation; adaptation and flexibility to change and work in new environments; ability to work independently and give consideration to different views or opinions; innovation ability and critical thinking; diligence, work commitment, teamwork skills; and profound understanding of the importance and indispensability of work. Subject librarians should mainly develop and demonstrate system thinking in the process of information service, i.e. all-round thinking.

Ability requirements of the CDIO outline coincide with service ability optimisation: Part I of the CDIO outline focuses on basic theory and skill derivation, while Part II puts emphasis on rigorous system thinking, scientific thinking and engineering thinking. System thinking is a precondition to the development of service thinking. During the implementation stages of CDIO, subject librarians working with college students or academic staff can be required to form new thoughts and ideas in regard to resource discovery, analyse problems, come up with creative solutions and resolve problems successfully.

Part III of the CDIO outline stresses teamwork and communication ability, which are basic abilities for subject librarians working in teams and supporting the needs of students engaged in CDIO-based projects. In modern product implementation, significant emphasis is placed on creating an excellent team and improving at a personal level, and subject librarians could also have a positive role in that development. Part IV introduces the conditions and rules, which should be followed in the product implementation process. It requires product implementation and considers environmental conditions, social relations and change. The term *expression of sociability* concentrates the meaning of this idea, which could be realised with the active participation of subject librarians.

Personnel training requirements for the cultural aspect of engineering education and establishment of the library collection system that constructively supports the implementation and application of CDIO standards: CDIO advances and promotes continuous social development. Subject librarians trained according to the social imperatives of the standards are not pure theorists and ideologists, but possess comprehensive personal integrity, humanistic qualities and scientific capacity.

Scientifically integrate library collection resources and strive to construct a collection system suitable for cultural education demanded for engineering students and future engineers: referring to the idea of CDIO and the corresponding education modes, the following three modules could be identified: engineering education module (engineering knowledge, engineering thinking and engineering ability education); scientific education module

(scientific knowledge, scientific thinking and scientific spirit education) and humanistic education module (humanistic knowledge, humanistic thinking and humanistic spirit education). In combining subject-specific features and industrial features, relevant other characteristics are also fused. Therefore, the library collection system at engineering colleges can be described as *3+X engineering education resource system*, i.e. 3 (engineering education resource, scientific education resource and humanistic education resource) + X (characteristic feature) (see Figure 1).

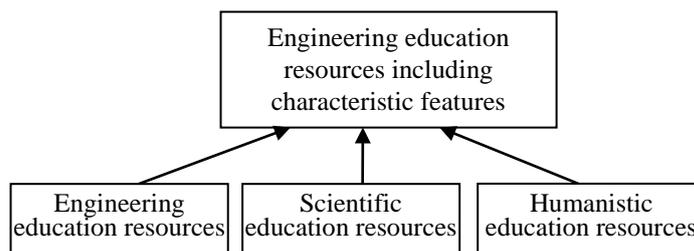


Figure 1: 3+X resource system architecture.

METHODICALLY SET UP INFORMATION RESOURCE PLATFORM AND SERVICE OPTIMISATION, QUALITY IMPROVEMENT OF SUBJECT LIBRARIANS' WORK IN COLLEGE LIBRARIES

Set up scientific education popularisation platform: the coverage of this platform has to relate to all students enrolled in the college. The resource development direction should cover basic concepts in science and scientific principles, basic methods applied in scientific work and resources related to scientific education, as well as the science-society relationship.

Set up humanistic quality expansion platform: again, the coverage of this platform should relate to all students in the college. The resource development direction in this case should cover knowledge acquisition and learning, methodology, and principles related to humanistic education. In particular, resources related to the state, nation, society, morality, ethics and emotional development should be included in the platform.

Set up subject-specific (e.g. atmospheric science) resource sharing platform: the coverage of this platform should be comprehensive, and should include all resources relevant to the teaching and learning of a given subject, e.g. in relation to atmospheric science, the platform should include electronic information engineering, communication engineering, atmospheric probing, etc.

Set up national defence - green cultural application platform: this platform is also specific and mainly covers the education of national defence students. However, it is generally suitable for national defence and political education of all the school's students.

FORM SERVICE OPTIMISATION MEASURE OF SUBJECT LIBRARIANS IN THE NEW MODE BASED ON CDIO

The subject librarian service mode at engineering colleges is a dynamic, integrated and comprehensive system. Based on the structural analysis of existing system, comparison of alternative modes, inner links, service processes of subject librarians and system operation rules, a new mode based on a *subject librarian graph teaching* cooperative mode supplemented by a *subject library branch - subject librarian combination* mode has been constructed. At the initial stage, it was crucial to focus on its advantages and, if possible, address the shortcomings, so as to finalise the implementation, and prepare subject librarians for service work as soon as possible (see Figure 2).

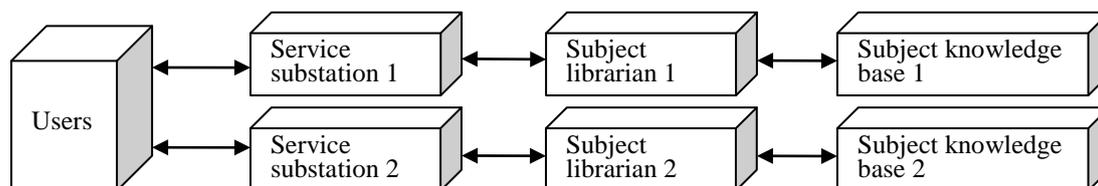


Figure 2: Flow chart of library branch service intelligent information desk.

On the whole, subject librarians understand user information problems through conducting reference interviews, during which they analyse user inquiries, assess the situation, the type and level of information required and, then, retrieve that information from the relevant service intelligent platform at the subject library branch. When subject librarians obtain the relevant information from the knowledge base of the subject library branch, they supplement it with other information in the service intelligent platform of the host library to provide a comprehensive solution to the user's problem.

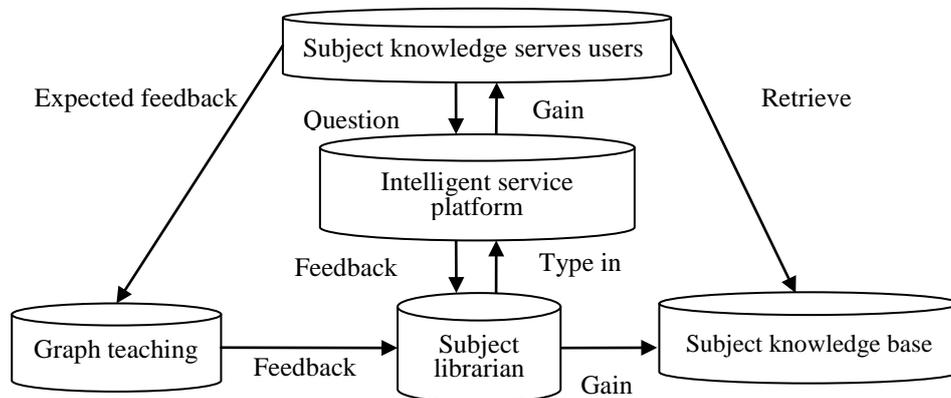


Figure 3: Diagram of *subject librarian graph teaching* cooperative mode.

Figure 3 illustrates the *subject librarian graph teaching* cooperative mode, which is part of a net structure. Users approach the subject knowledge service and make inquiries through the subject knowledge service intelligent platform to gain the information needed. Users communicate with subject librarians through graph teaching and provide feedback on the problems encountered to subject librarians. Subject librarians understand the problems through analysing user query and gain additional information from the knowledge base of the subject library branch, etc.

SNAPSHOT OF THE OPTIMISATION OF SUBJECT LIBRARIANS AT ENGINEERING COLLEGE LIBRARIES - BRIEF INVESTIGATION

One engineering college was selected and the CDIO engineering educational standards were introduced to subject librarians at its libraries with a view to improving the librarians' capacity for design and innovation, as well as optimising library services and improving their quality. The study covered library service quality and satisfaction assessment by users before and after the CDIO engineering educational standards had been introduced. In the first instance, 100 questionnaires were sent to college students and 93 valid responses were received, with a recovery rate of 93.0%.

Two months later, questionnaires were re-sent to these 93 students and 93 valid responses were received. In doing so, the quality of service provided by subject librarians was rated twice. A Likert 5-point scale was used to evaluate differences in service quality before and after the CDIO engineering educational standards had been introduced, i.e. 5 points referred to very good and 1 point indicated rather poor service provision. Statistical analysis was carried out for data using the SPSS 15.0 statistical package (see Table 2).

Table 2: Comparison of service quality.

	Average scores	<i>t</i>
Before experiment (n = 93)	2.17 ± 0.92	0.853*
After experiment (n = 93)	3.66 ± 0.84	

* $p < 0.05$

Through analysis of the data collected, the service quality of subject librarians was established as 2.17 ± 0.92 before the CDIO engineering educational standards were introduced. After the CDIO implementation, the service quality scored, 3.66 ± 0.84 ($p < 0.05$). There was a significant difference between the quality before and after the CDIO implementation, indicating that the service quality of subject librarians as perceived by the surveyed students improved considerably after the CDIO introduction. Thus, introducing the CDIO engineering educational standards to engineering colleges' library service can optimise the delivery of library services and improve the overall quality of subject librarians at such schools.

CONCLUSIONS

Subject librarians at college libraries can open up new and effective practice approaches under the guidance of scientific theory, cultivate engineering awareness comprehensively, optimise services and efficiently provide information services for study and scientific research. The subject librarian service optimisation mode is a complex system project and a substantial amount of time is required to demonstrate its full effectiveness. The application of advanced management methods may be a practical and effective way to aid the implementation of such a project.

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