ISSN: 2688-8653

Design and Construction of Integrated Curriculum System under CDIO Engineering Education Mode

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Abstract

This paper explores the talent training mode of CDIO engineering education from four aspects: the connotation of the integrated curriculum system, the analysis of the characteristics of the integrated curriculum system, the design approach of the integrated curriculum system and the construction of the integrated curriculum system.

Keywords

CDIO Education Mode; Integrated Curriculum System; Design and Construction.

1. Introduction

Traditional subject-based courses are constructed in accordance with the logical structure of knowledge, mainly focusing on the integrity and systematicness of knowledge, ignoring social life and production reality to a certain extent, and paying little attention to the interest and acceptance ability of learners in learning [1]. Integrated curriculum plan should provide learners with learning experience, not only to learn various disciplines that support each other, but also to have a clear plan to acquire abilities in all aspects during the whole process. A clear plan is to combine these abilities with methods of multidisciplinary knowledge [2]. In the CDIO mode, the curriculum plan is readjust and constructed according to the logical structure of ability development. Such adjustment in the curriculum system fully considers the parallel development of knowledge and ability, and achieves the minimization of learning cost and the maximization of resource allocation efficiency. No matter from the perspective of cognitive theory or practical needs, the design of integrated curriculum system has significant advantages and effects.

2. Connotation Analysis of Integrated Curriculum System

The integrated curriculum system is a curriculum plan designed by combining professional courses with clearly integrated personal and interpersonal skills [3]. The integrated curriculum system is one of the keys to the implementation of CDIO engineering education, which directly affects whether learners can achieve the learning output listed in the CDIO syllabus and is also related to the implementation at the teaching level.

The integrated curriculum system focuses on the integrity of the curriculum plan, that is, related courses of the discipline should support each other, and the setting of each course should correspond to the requirements of the CDIO syllabus one by one. In terms of the cognition of content, the integrated curriculum system regards the curriculum as an integrated whole, which requires the establishment and development of the relationship between courses to achieve the cultivation of relevant abilities and qualities. Through integrated curriculum design, learners' abilities in subject knowledge, personal cognitive and emotional development, and systematic implementation in enterprise, business and social environments are realized. In the aspect of curriculum design, the effect should be achieved: the learners realize the knowledge they should

ISSN: 2688-8653

learn and the ability they should have at the time of graduation, and the cultivation of talents by the school meets the needs of the society for talent cultivation. The core content of the integrated curriculum system is to construct the relevance between courses and to carry out curriculum reorganization and optimization on the basis of exploring the supporting relationship between curriculum and ability. The construction of integrated curriculum system can not only realize the parallel development of ability and subject knowledge, but also make efficient use of the existing time and resources of curriculum plan. On the basis of integrating existing learning resources, the quality of course teaching should be improved so that the implementation of CDIO syllabus in the course can be implemented and guaranteed.

3. Analysis of the Characteristics of Integrated Curriculum System

3.1. Curriculum Relevance of Integrated Curriculum System

In the integrated curriculum system, the courses are the coordination of various factors supporting each other, and each course in the curriculum design corresponds to the training requirements and training abilities. Each course or learning experience has specified in detail the learning output of the four types of engineering abilities that students need to develop, which is an indispensable step in training engineers [3]. This integrated curriculum design realizes that the whole effect is greater than the sum of its parts. Through the re-combination and optimization of various courses, strengthen the relevance of various courses.

Under the construction of this curriculum plan, each course needs to support certain ability training, and to achieve a one-to-one correspondence with the training requirements. Courses are no longer simply mechanical combination without connection, but organic combination and optimization of various courses. The overall effect of integrated curriculum plan is the integration and upgrading of course optimization of various parts. Based on the systematic and procedural training requirements of CDIO teaching mode, the integrated curriculum plan integrates and optimizes the curriculum elements of all parts so as to make the links between courses closer and realize the overall effect of the integrated curriculum greater than the teaching effect of the sum of all parts. In the process of integration of curriculum design, due to the recombination and optimization of the curriculum between teaching order and the process has changed, and students during the course, is no longer a simple machines of various curriculum learning, but the associated practice.this course of study system, in order to achieve the CDIO syllabus required by the cultivation of ability and training standards.

3.2. Teaching Suitability of the Integrated Curriculum System

1) Flexible setting enables students to achieve flexible learning

The standard of "Integrated Curriculum Plan" in CDIO requires that curriculum design should be based on the learning output determined in the CDIO syllabus, so as to ensure the learning effect in the teaching implementation process. As with all well-defined systems, lesson plans should be designed with a reasonable balance between flexibility and efficiency in mind, and it would be completely wrong to design courses entirely according to defined learning outputs without giving students room for choice [3]. Therefore, on the basis of considering existing conditions and available resources, the design of CDIO curriculum plan also provides certain choice space to support students' scheduled learning plan. When designing students' in-class and extra-curricular activities, there is no conflict between project activities and students' self-study schedule in the time integration and parallel integration plans. The integrated curriculum design is not a comprehensive design in accordance with the learning output. It reserves flexible learning space for students and provides an important guarantee for the all-round development of students' ability.

ISSN: 2688-8653

2) Stimulate interest in learning and form a virtuous cycle effect

An important part of the integrated curriculum design of CDIO Standard 3 is the course of introduction to Engineering, which plays an important role in improving the learning effect of engineering students. In the traditional education mode, due to the specialty and characteristics of engineering major itself, many engineering students lack interest in the course of learning, leading to the status quo of mechanical learning.

The standard of "Integrated Curriculum Plan" in CDIO requires that curriculum setting should lay more emphasis on real engineering experience. Through a more "vivid and realistic" learning process, students can learn specific engineering practice required in follow-up study. On the basis of mastering the basic abilities required by the follow-up courses, the students will have a more real and professional understanding of engineering and stimulate their interest in the follow-up study of engineering.

3.3. Project-based Teaching of Integrated Curriculum System

In order to achieve a specific goal, some resources together, through a series of related activities to achieve a specific purpose is the project. A project is a group of tasks or activities under a specific goal. The definition of a project contains three meanings: first, a project is a future task, and its completion requires certain environmental requirements; Second, it requires a certain amount of material resources, human resources and other resources in a specific practice to complete; Third, the task completion requirements are strict, need to meet the quality, efficiency and other requirements. Project-based teaching means that students, under the guidance of teachers, acquire learning knowledge through the whole process of project implementation in the implementation of real projects so as to master the corresponding ability of the knowledge. Compared with traditional classroom teaching, Project-based teaching can increase students' active participation in learning, help students understand the depth and breadth of knowledge, improve and optimize the learning effect, and finally achieve the teaching purpose of cultivating students' ability.

4. The Design Approach of Integrated Curriculum System

4.1. Subject Content and Knowledge System Support Each Other

The integrated curriculum system needs the relevance and systematicness between curriculum design. The choice of the organization form of subject content is directly related to whether the subject content can realize the correlation between courses. This requires that in the integrated curriculum design, the corresponding relationship between the professional characteristics of the curriculum and the ability should be fully considered, and the timing of the curriculum should be adjusted and recombined in accordance with the cognitive rules of learners. The subject knowledge of each course should have a corresponding relationship with the cultivation of ability, and the courses that have no correlation with the requirements of ability cultivation should be restructured and optimized. In terms of curriculum connection, it is different from the traditional design based on subject knowledge, while the integrated curriculum system requires that the existing curriculum be reorganized and classified under the guidance of ability, and the supporting relationship with ability cultivation be established, so as to realize the mutual support of subject content and knowledge in curriculum design. In the process of knowledge learning, learners are no longer passive receivers of irrelevant knowledge, but under the leadership of the integrated curriculum system, gradually achieve the corresponding cultivation ability through the mastery of relevant subject knowledge in the learning process.

4.2. Reform of Teaching Methods and Optimization of Teaching Process

In the traditional training process of engineering talents, teachers train learners of a certain major in a unified way, and most of the teaching methods are based on traditional classroom

ISSN: 2688-8653

teaching. In the process of integrated curriculum design, the teaching place and teaching method of the teacher to the learner is not fixed, it should be a variety of ways of mutual adjustment and combination. CDIO engineering education mode emphasizes the cultivation of comprehensive engineering ability of learners. Therefore, different teaching methods and locations should be adopted to realize the cultivation of engineering ability according to the requirements of different engineering ability required by different courses. If the engineering practical ability of learners is cultivated by relying on off-campus practice bases, the core basic engineering knowledge required by learners is learned in school. In order to realize the integrated design and guidance of teaching and learning, different learning methods and practice forms are adopted for different engineering abilities required by learners.

As the main participants in curriculum design, teachers play a key role. As two important factors, the design and teaching methods of curriculum are reflected in the learning effect of learners. In the aspect of teachers, first of all, the idea of curriculum design should be systematized. One of the teaching objectives is to impart knowledge, and the other is to accumulate knowledge, develop ability, inspire thoughts and improve realm [4]. Secondly, teachers should explain to learners the importance and rationality of cultivating engineering ability in all aspects in engineering, and consciously cultivate engineering reasoning and problem-solving abilities that engineering learners should have. Finally, teaching can be carried out in a variety of ways in the course of teaching, and cooperative teaching can be carried out for different courses. At the same time, the teacher should explain to the learners the importance and rationality of each link in the integrated curriculum for the cultivation of learners' ability, so as to improve their objective understanding of the ability required by engineering talents, so as to focus on the cultivation and exercise of this ability in learning, and improve their active learning awareness of the cultivation of engineering ability.

4.3. Project-based Teaching Runs through the Whole Process of Curriculum System Design

CDIO engineering education mode focuses on cultivating the comprehensive ability of engineering talents. In this teaching mode, practical operation ability and operation skills required by engineering talents can be integrated into project design and implementation, so as to realize the cultivation of comprehensive ability of engineering talents. On the basis of mastering theoretical knowledge, learners can practice practical engineering projects to comprehensively improve their professional quality in all aspects [5]. The integrated curriculum system is not to weaken the learning of basic subject knowledge, but to reorganize and optimize the existing knowledge. The realization of this ability is inseparable from the mastery of the basic knowledge of the subject, but different from the traditional single emphasis on subject knowledge, it emphasizes the deepening of subject knowledge to achieve the ability requirements of the CDIO syllabus rather than single learning.

Based on the organization principle of project, integrated curriculum design can be realized by integrating subject contents on the basis of necessary knowledge through formal or informal teaching methods [6]. Project-based teaching is an inquiry-based method, which is suitable for learning various practical and operable knowledge and skills [7]. In the process of Project-based teaching and design of integrated curriculum, there are also some challenges: on the one hand, colleges and universities have formed fixed teaching plans, and it is necessary to readjust and optimize the existing teaching plans to Project-based integrated curriculum system; On the other hand, the CDIO syllabus requires the cultivation of comprehensive ability, but the organization principle of Project-based teaching no longer emphasizes the technical subject knowledge, which conflicts with the goal of deepening the working knowledge of technical basis.

ISSN: 2688-8653

5. Construction of Integrated Curriculum System -- Take Internet of Things Engineering as an Example

5.1. Integrated Teaching Process

In the reform of integrated curriculum teaching process, first of all, the narrow professional education thought should be reformed, and comprehensive and holistic quality education should be emphasized to increase the adaptability of learners to the society. Secondly, study the teaching content according to the requirements of CDIO syllabus and determine a concise and accurate teaching scheme combining with the requirements of the integrated curriculum system. Finally, the teaching method of non-fixed, combined with the process of practice. The main body of practice teaching is students, and teachers play a supporting role. By organizing in-school Internet of Things skills competition, Internet of Things design competition and other forms, learners' engineering practical ability, expression ability and communication ability can be enhanced [8]. Through the Internet of Things skills, the contents of the Internet of Things design competition, such as the basic operation of the Internet of Things experiment, the Internet of things application solutions proposed according to the given topic, stimulate learners to use the knowledge to deal with engineering problems.

5.2. Integrated Teaching Content

Textbook is an important carrier for the implementation of integrated courses, and its selection directly affects the realization of knowledge and ability required by CDIO syllabus. The construction of course materials should reflect the progressive principle, and the selection and use of materials should conform to the relationship of pre-study and follow-up in integrated textbooks. For example, the courses "ARM Embedded System Structure" and "Embedded System Advanced Programming" are offered after the professional courses, which is more in line with the cognitive process of students. Courses such as "Situation and Policy", "Career Planning and Employment Guidance", "Foundation of Entrepreneurship" and "Mental Health Education for College Students" have been added to the Internet of Things Engineering major to improve students' humanistic quality. Learn from the teaching experience of foreign advanced courses and adjust the content system in time. Compiling and selecting systematic teaching materials to optimize the structure of intellectual education and improve its quality and efficiency.

5.3. Integrated Teaching Place

To explore the construction of integrated teaching places, we must change the isolation of traditional theoretical courses and practical training courses. Construction can satisfy the theory teaching, and can have both training integrated teaching place. Internet of Things Engineering takes "Internet of Things Engineering Practice Training Center" and in-school and off-campus practice teaching as the platform to cultivate compound and application-oriented professionals in Internet of Things engineering. In terms of "industry-learning" combination, students are organized to participate in practice training. In the aspect of the combination of "study and research", let senior students take the initiative to participate in the teachers' scientific research plan; Through the combination of production, learning and research, an internship platform is constructed to strengthen students' comprehensive application ability and cultivate their engineering practice ability[8]. At the same time, the major will cooperate with enterprises to build a joint laboratory. The signing of these cooperation agreements meets the needs of students in teaching and helps students to comprehensively apply knowledge.

5.4. Integrated Teaching Staff

The implementation subject of the integrated curriculum design is the teacher, which is the main factor affecting the integrated curriculum. In the construction of teaching staff, teachers not only need to teach basic knowledge, but also to guide students in practice. Through active

ISSN: 2688-8653

introduction, internal training and other ways, pay attention to echelon structure, in the age of the teacher team to make it more reasonable. Actively introduce academic leaders and employ experts with rich practical engineering experience to join the teaching team to improve the engineering teaching ability of teachers. For example, through in-depth cooperation with Wuhan Chuangwei Co, Ltd. and Guangzhou Yuehua Technology Co, LTD., the department has created a talent training mode of "resource integration, project cooperation, research, production, learning and application", especially some young teachers' training in the lack of engineering practice background. The introduction of personnel with engineering practice experience and rational allocation of traditional academic teachers and practical teachers make the professional knowledge and engineering practice background structure of Internet of Things engineering faculty more reasonable.

5.5. Curriculum Design of Project-based Teaching

The curriculum design of Project-based teaching, in which learners are the subject of the curriculum system of Project-based teaching, teachers are the dominant and engineering ability cultivation is the goal, is the main line running through the system is the rich and diverse project systems [9]. The design and implementation process of project teaching is inseparable from the construction of the curriculum. Each level of the project needs the corresponding curriculum support, that is, the curriculum learning is carried out around the project. The Internet of Things engineering program uses a project design approach to connect all curriculum systems. Through the way of the project as the core curriculum, established by practice, general practice, professional specialty practice teaching platform of three modules, on the curriculum setting is multi-level, innovation and practice, the Internet of things connected to the three elements of the engineering required to develop, it cultivates the good character persons talented in the technical aspects of the project provide a fundamental guarantee.

6. Summarize

Integrated learning output and integrated curriculum design and construction need to be combined with the school's own professional characteristics. Different schools have different orientation and emphasis on talents, and different professional implementation structures and difficulties are also different. Although integrated learning outputs and integrated construction methods are universal to a certain extent, specific reform measures are rarely involved, so they should be supplemented in subsequent studies.

Acknowledgments

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