

The Exploration of the Teaching System for the Training of Computational Thinking of New Medical Engineering Talents

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Abstract. To meet the needs of new engineering training and improve the research level of computer education. This paper studies the theories and key problems related to the teaching system of Computational Thinking Training for medical professionals in the context of new engineering. Study the elements of computational thinking, expression system and other theories, This paper focuses on the measures and programs that meet the training standards of new engineering talents and are applicable to the training of Computational Thinking Ability of medical workers. The transformation from theory to practice between the theory of Computational Thinking and the training plan is solved. It has realized the construction of the teaching plan for the cultivation of the ability of computing thinking, including the public computer, the basic professional course of integrating computing thinking, and the course of computing + professional expansion. The PBL + MOOC / SPOC teaching method is constructed. The evaluation system of three-layer effect on the cultivation of computational thinking ability has been preliminarily completed. At last, the paper investigates the teaching effect and verifies that the teaching system has a good effect.

Keywords: Teaching system, Computational Thinking, New engineering, Combination of medicine and Engineering.

1. Introduction

In order to serve the development of the new economy, solve the contradiction between the supply and demand of talents and deepen the reform of engineering education, since February 2017, the Ministry of education has actively promoted the construction of new engineering, made every effort to explore and form a Chinese model and experience leading the global engineering education, and helped the construction of a strong country in higher education. New engineering is an important strategic plan for the reform of China's higher engineering education. Its ultimate goal is to enable students to have good humanistic quality and scientific thinking habits, and to achieve innovative thinking soil [1]; it especially emphasizes the intersection and integration, cooperation and sharing of disciplines, in which computing science has become the most active discipline. The cultivation and education of computing thinking determines the future of the people Basic information literacy level [2].

In 2006, Professor Zhou Yizhen, Department of computer science, Carnegie Mellon University, defined "Computational Thinking". Since then, the academic community has gradually reached a consensus: Computational Thinking is a kind of conceptual thinking, facing all people and all fields, a thinking of complementary integration of data and engineering, which is considered to be a basic skill for college students in today's society [3]. With the continuous development of information technology, the concept of computing thinking, which originally belongs to computer science and technology, has a profound impact on the development of other disciplines. The emergence of new research fields such as computational physics, computational finance, computational biology and computational social science is a good example [4]. Subsequently, the United States, the United Kingdom, Australia, all take computational thinking as an important part of their new information technology curriculum [5]. In China, the joint statement of the nine universities Alliance (C9) in 2010 [6], the university computer curriculum reform project approved by the Department of education and higher education of the Ministry of education in 2012 [7], and the Declaration on computer teaching reform issued by the University Computer Curriculum Teaching Steering

Committee of the Ministry of education in 2013 [8] all reflect the attention of the educational community to the education of computational thinking ability.

With the development of information technology in medical institutions and the wide application of computers in clinical and basic research, higher requirements are put forward for employees' information literacy and computer application ability [9]. In the field of medicine, computing science has gradually developed from the application of medical information engineering technology to computational medicine and intelligent medicine, which play an increasingly important role in the development and research of medicine. However, there are still some common problems in the front line of medical industry, such as the low level of information awareness, weak information processing ability and limited information exchange ability of medical talents. This is a sharp contrast with the requirements of talents in the new information era represented by artificial intelligence and big data, and the cultivation of compound medical talents who understand both IT application and medicine For the needs of the times. Whether medical students, especially medical engineering students, can have the ability of computing thinking and master the ability of using advanced computing technology to analyze and solve medical related problems is a major challenge for the computer teaching of health medicine major, and also a difficulty in the construction of new medical engineering.

As a way of thinking, computational thinking has not only the basic characteristics of general education, but also unique advantages in medical research and clinical practice. Therefore, whether as an important part of general education or an effective way to improve students' comprehensive quality, it is an inevitable choice for computer teaching to develop to a deeper level to introduce the cultivation of computational thinking into computer basic teaching. On the basis of Denning's "great computing principle", academician Chen Guoliang constructed a hierarchical computing thinking expression system framework with the core of computing and the basic concepts of abstraction, automation, design, communication, collaboration, memory and evaluation. By analyzing the research progress in the field of molecular biology in recent years, he demonstrated that computing thinking is helpful to health care The importance and criticality of learning [10].

With reference to the basic requirements of University Computer Course [11], the author makes full use of academician Chen Guoliang's expression system of computational thinking, aiming at meeting the requirements of new engineering talents training, discusses and constructs the teaching system of Computational Thinking Training for medical engineering talents, and makes contributions to the comprehensive training of application ability, information literacy and thinking ability of medical engineering students.

2. Composition and Structure of Teaching System

Taking the training of new engineering talents as the goal, this paper studies and constructs the teaching system of the training of Computational Thinking of medical engineering talents, and discusses the basic knowledge structure and teaching content, teaching means and methods, and teaching effect evaluation of the teaching process (Fig.1.).

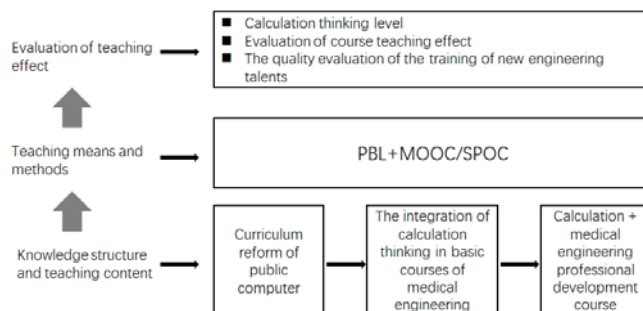


Fig.1. Teaching system structure and content

2.1 Knowledge Structure and Teaching Content

Based on the training of Computational Thinking Ability and the aim of meeting the training requirements of new engineering talents, this paper discusses the basic elements of training computational thinking ability of medical engineering talents, and then deduces the knowledge structure and framework, teaching content and resources. It focuses on the reform of the public computer course serving the general education of the medical and medical related majors, aiming at the cultivation of the ability of computing thinking, focusing on the teaching of computer knowledge and general skills. This paper studies how to integrate computational thinking into specific basic medical engineering courses, and how to embody the training of Computational Thinking through the integration of computational technology and specialty. This paper studies how to develop professional development courses such as "computing +", "Internet +" and "big data +", and cultivate computational thinking ability from the perspective of computing power and discipline innovation(Fig.2.).

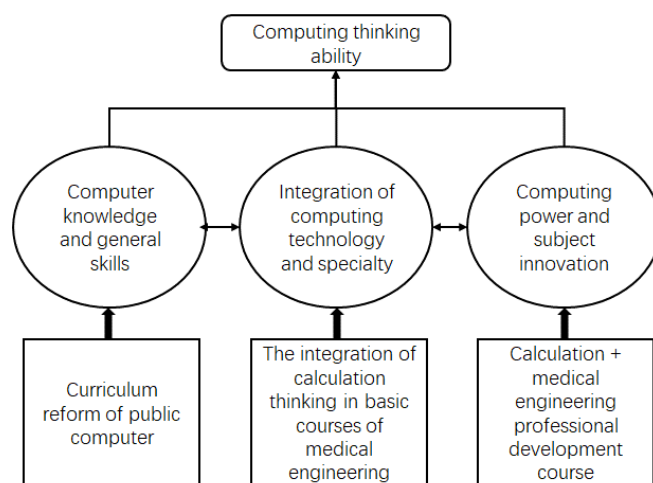


Fig.2. The knowledge structure and teaching content of the training of computing thinking ability of medical engineering professionals

2.2 Means and Methods of Training

PBL (problem based learning) is a complete method of designing learning situations, also known as problem-based learning. This method has been widely used in the field of medical education for many years and achieved good results. MOOC (massive open online courses) is a large-scale open online course, and SPOC (small private online course) is a small-scale restricted online course. It has been proved that the teaching method of online courses has obvious advantages in promoting students' active learning and optimizing the allocation of teaching resources. It is also recognized by many education experts as the best way to cultivate the ability of computational thinking. In this paper, the teaching method of MOOC / SPOC, which runs through PBL thought, is proposed to be the main means and method of training the computational thinking ability of medical professionals. Among them, the public computer course is in the form of MOOC, and the "calculation +" series courses are mainly in the form of SPOC.

2.3 Evaluation of Teaching Effect

Teaching evaluation is the inspection and evaluation of the structure of computing thinking ability to be constructed. It is not only conducive to timely understanding of teaching results, but also can have an impact on future teaching work. This project plans to build a three-layer effect evaluation system for the cultivation of Computational Thinking Ability of medical engineering talents: the first layer is the evaluation of students' computational thinking level; the second layer is the evaluation of curriculum teaching effect; the third layer is the evaluation of the cultivation quality of new engineering talents.

3. Construction and Realization of Teaching System

The research focuses on the knowledge structure, teaching content, teaching means and methods, and teaching effect evaluation of the training of Computational Thinking Ability of medical engineering professionals. The overall research technical route is shown in Figure 3.

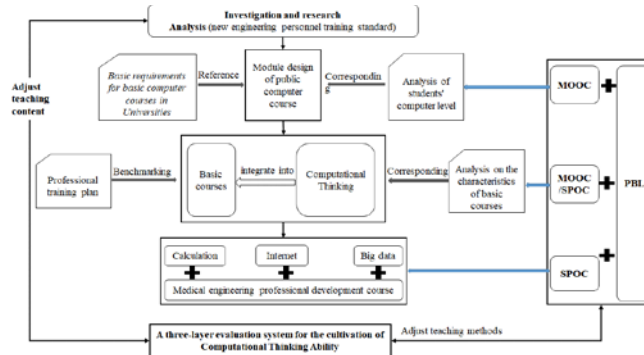


Fig.3. System construction technology roadmap

3.1 Teaching Content Organization and Teaching Method Design

(1) This paper investigates the current teaching situation of the public computer course of the target object, analyzes the computer level of the students, analyzes the training standard of the new engineering talents, and designs the public computer teaching scheme applicable to the medical engineering students according to the *Basic Requirements of College Computer Basic Course*. The course content is designed in a modular way according to the PBL project guidance, with the main task of training computer knowledge and general skills. The main teaching method is MOOC.

(2) Based on the study of public computer courses, this paper analyzes the basic professional courses of various medical engineering majors, selects the courses with the attribute of "calculation", further analyzes the characteristics of the courses, reorganizes the teaching contents of the courses according to the requirements of the talent training plan of the standard majors, and fully integrates the calculation thinking into it. In the process of course content organization, it follows the three-tier mode of computing thinking: the first tier has "computing" as the center; the second tier "abstraction, automation and design", which describes "computing" from different sides; the third tier "communication, collaboration, memory and evaluation", which serves "computing". Fully reflect the integration of computing technology and specialty, and the teaching can be in the form of MOOC or SPOC.

(3) According to the new engineering talents training standard and professional personnel training requirements, aiming at different specialties, highlighting professional characteristics, developing "Professional Computing +", "Internet +", "big data +" and other forms of professional development courses (elective courses). The curriculum design takes computing thinking as the main line, uses professional knowledge, faces the needs of the industry, and takes the innovation ability of computing thinking as the core goal to achieve the cultivation of computing ability and discipline innovation ability. SPOC is the main form of teaching.

(4) Use the evaluation system of the training effect of computational thinking ability (Fig.4.) to periodically evaluate the above three courses and their teaching, analyze the problems of teaching content and teaching methods, and adjust and optimize them in time.

3.2 Construction of Evaluation Index System

The first level is the evaluation of students' computational thinking level, which includes nine dimensional indicators, including data collection, data analysis, data representation, problem decomposition, abstraction, algorithm process, automation, simulation, and parallelism. The second level is the evaluation of teaching effect, mainly for the comparative analysis of students' learning effect and teaching objectives. The third level is the quality evaluation of new engineering

personnel training, mainly for the comparative analysis of the training effect and talent training plan of medical engineering professionals, as shown in Fig.4.

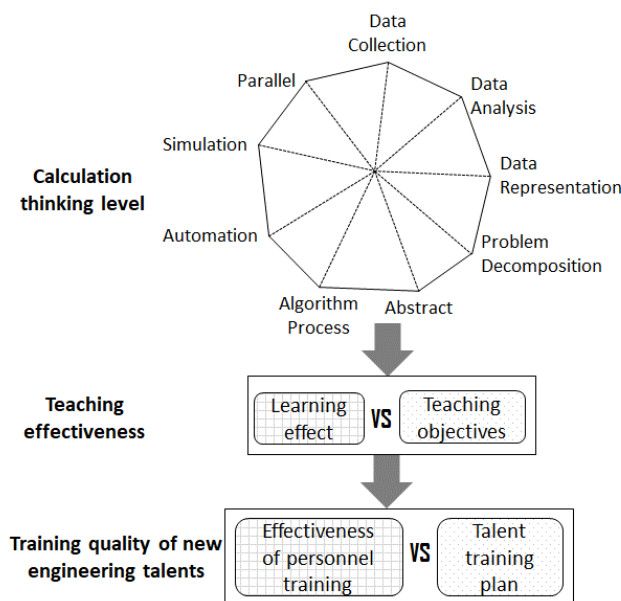


Fig.4. Road map of evaluation system construction

3.3 Impact Assessment

This program is the first medical university named "health" in China to conduct one-year teaching pilot in five undergraduate majors, including biomedical engineering, clinical engineering technology, medical testing technology, medical imaging technology, and rehabilitation physical therapy, and respectively start the "computing / Internet / big data + health care professional development course" (hereinafter referred to as "expansion course"). For the general course public computer and each expanding course, a questionnaire survey is carried out from six aspects: the difficulty of the course, the size of the knowledge range, the coincidence with the training objectives of the students' major, whether there is support for other courses, the proportion of teaching theory and practice distribution, and the degree of students' satisfaction with teaching aids or teaching methods. 242 valid questionnaires were received. After weighting and quantifying the survey data, convert the hundred mark system and divide it into six categories, as shown in Table 1.

Table 1.Overall statistical results of survey data

Class	Interval of value	Number of students	Ratio
1	[90,100]	120	5.0%
2	[80,90)	430	17.8%
3	[70,80)	980	40.5%
4	[60,70)	580	24.0%
5	[50,60)	220	9.1%
6	[0,50)	90	3.7%

The following figure is the curve distribution diagram of questionnaire scores. It can be seen from the diagram that the scores basically conform to the law of the distribution of the positive and the negative. The number of people in the 70-80 score range is the largest, which shows that the program has better teaching effect, and the students are relatively recognized.

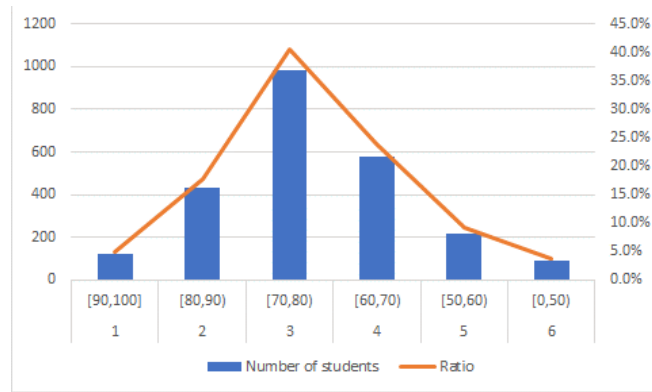


Fig.5. Effect evaluation score distribution chart

4. Conclusion

With the implementation of the "healthy China" strategy, there are emerging medical and industrial integration specialties in the field of health and medical education, such as clinical engineering technology, medical product management, etc. At the same time, these new medical engineering majors are often positioned in the training of "intelligent medicine" and "intelligent medical equipment". The ability of computing thinking is very important to them! However, the research on the cultivation of Computational Thinking of medical professionals has not been reported in literature, and the author of this paper took the lead in making a preliminary attempt. It is the author's innovation to design the advanced teaching content and the new teaching method of PBL + MOOC / SPOC. And in the advanced teaching content design, it is in line with the three-level expression system framework of Computational Thinking proposed by academician Chen Guoliang; PBL + MOOC / SPOC teaching method, the former conforms to the characteristics of medical education, the latter is one of the mature training methods of computational thinking ability, and the combination of the two will become the best method of Computational Thinking Training for medical professionals. There have been a lot of literature reports about the evaluation of the level of computational thinking or teaching effect, but there are few comprehensive, multi-dimensional and systematic evaluation systems about them and the quality evaluation of new engineering personnel training. The evaluation system of this paper makes quantitative evaluation from the connotation of the training of computational thinking ability to the extension of the training of new engineering talents, which will better reflect the objectivity, comprehensiveness and practicability of the evaluation. From the evaluation results, it has good results, and there is room for further improvement.

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