Teaching Reform and Practice of "Algorithms and Data Structures"

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Abstract—"Algorithms and data structures" is an important professional basic course to computer and electronic information professional courses. The article around teaching reform of "algorithms and data structures" course, comprehensive introduction to the reform contents and achievements of the " algorithms and data structures " course in teaching contents, implementation plan, curriculum design, network teaching, practice teaching, etc.

*Keywords- algorithms and data structures, teaching reform, curriculum design, network cours*e

I. INTRODUCTION

Along with expansion to the information technique application areas and changing of talents training mode, how to adapt to the new situation for cultivating the innovative talents that meet the requirement of the informatization construction, so we are faced with the following three problems in "algorithms and data structures" course teaching.

(1)How to further improve the curriculum structure and reflect extensibility of   knowledge system.

(2)How to use the knowledge of algorithms and data structures as the carrier, which cultivate the students' innovative thinking ability and realize effective integration to the way of thinking and curriculum teaching.

(3)How to improve the students' learning style, highlight the autonomous learning and innovative learning.

In view of the above problems, we study design method of innovation thinking, formulated the new teaching program, preparation of new materials and development of network curriculum on the principle of spirit of innovation, truth-seeking, high standards and around "algorithms and data structures" course teaching reform. At the same time we carry out various types of competitions, education and teaching research and implement various forms of teaching practice in the classroom.

II. "THREE IN ONE" KNOWLEDGE SYSTEM

The aim of education is cultivate ability, improve quality, especially on training thinking ability, practice ability and innovation ability. According to CC2005 and CC2006 and the professional personnel training requirements, we research teaching characteristics which use modern education thoughts and solid education idea as the instruction, training students thinking consciousness, modeling ability and skills to solve model in the point of view of computer, so as to achieve the purpose of inheritance knowledge, development intelligence, ability cultivation and quality upgrading.

How to further improve the curriculum structure, embody knowledge system extensibility and construct a system of knowledge structure for students, we put forward three-dimensional integrated knowledge structure, i.e. problem, algorithms and data structures, which emphasized on the basis of knowledge, pay attention to expand view and way of thinking training and improve the students' knowledge structure from multi-level and multi-angle. Specifically, we reveal the existence of inherent difficulty and NP problems in the problem level so that students not seeking algorithms better than the inherent difficulty and doing. Through the algorithm complexity and evaluation method in the level of algorithm, students can understand what is effective algorithm, what is good and best algorithm, as well as how to design a good algorithm. In the data structure level we introduced the characteristics of data structures and how to configure appropriate data structures in order to obtain the desired treatment efficiency. At the same time, we show program design techniques for students through a large number of sample algorithm procedures, thus algorithms, data structures, program design organically fuses in together.

Teaching plan is systematical, comprehensive, scientifical on the basis of the above formation, which elaborated the basic content of education from knowledge matrix, teaching hour distribution, teaching tips, key and difficulty, experiment content and requirements, curriculum design, basic requirements and performance evaluation, etc.

III. STEREOSCOPIC MATERIAL CONSTRUCTION

The stereoscopic teaching material is defined based on the concept of modern education and modern information network technology platform, with the traditional paper material as the foundation, to the curriculum as the center, is teaching publications collection to multi-media, multi-form, multi-purpose, multi-level teaching resource and to multi-service teaching print, is a kind of comprehensive teaching resources, it is to form the teaching ability, promote teaching reform, to maximize meet the

needs of teaching goals. The stereoscopic teaching material mainly include paper materials, audio and video products, electronic and network publication, etc. Electronic and network publication include electronic teaching plan, electronic books, CAI courseware, case library, database, network courses. Stereoscopic teaching materials of algorithms and data structures what we build include paper textbooks, electronic teaching plan, algorithm visualization, network courses, etc.

A. textbook

Textbook is the base element of stereoscopic teaching material, is the representation of concepts, rules, norms based on text teaching. New textbook-Algorithms and Data Structures (Higher Education Press, 2010) combined of "three in one " idea is education and teaching reform and practice project research achievement.

Algorithms and Data Structures expand and improve appropriately some knowledge on the basis of useful, practical, enough. It considers seriously and arranges reasonably to key points and difficulties. The main features are as follows:

1)Systematicness. Carry out the "three in one" thinking, construct multi-level and all-round knowledge system.

2)Progressiveness. Strengthening the basic theory and experiment links; adjustment to teaching focus on file organization and index so as to highlight the practical; weakening table structure extension teaching, increase introduction to algorithms design, complement new tree structure application; appropriate to add C++ knowledge in the relevant content, closely follow the frontiers of the discipline.

3)Uniqueness. Use search, insert, delete operation as the main line, we introduce feature, storage method, time and space efficiency in table, tree, graph and other basic data structures. Because search, insert, delete operation is not only the most basic and most commonly used, and often also indivisible (usually joint use, is rarely used alone). The set of three operations constitute as a whole, we can reach a conclusion of space and time efficiency from the overall structures.

4)Application. Strengthening practice link, use in company with study, further digested teaching theoretical content, carry out the thought of learning in order to practice. Through multiple kinds of questions (for example, fill, single-choice, reading, algorithms design, computer practice, etc.), integrated exercise training of multiple difficulty levels (especially computer practice), effectively deepen students understanding of basic concept, strengthen the students' ability to design program. In addition, we give a part of reference answer to the exercises, which are instructive to the typical questions, it is convenient for the teachers teaching, but also for student self-learning, self-testing and review. In short, the overall structures, main

contents and distribution, key and difficulty, exercises with aspects for consideration. Take into account both the gradual transition to difficult, also taking into account the systematic knowledge and integrity.

B. electronic teaching plan

Electronic teaching plan is courseware and the basic tools serve for the teaching, which should reflect the teachers' teaching ideas, the points of knowledge grasp and clear teaching method, reflect the essence of material content. Electronic teaching plans are also available for students to review. Algorithms and data structures electronic teaching plan not only have these characteristics, but also links to images, animation, video and rich media material in some key or difficult the interpretation of knowledge, and effectively strengthen and enrich teaching contents.

C. network course

Algorithms and data structures network curriculum use modern network programming techniques to build, which provides an open, interactive, flexible, rich cube teaching environment. Algorithms and data structures network course including Web, video teaching materials, algorithms animation, exercises, FAQ, notebook, homework, automatic test paper generation, auxiliary teaching books, teaching reference books, data structures development history and characters, which collect scientific knowledge and human education as a whole (as shown in Figure 1).

Fig 1 algorithms and data structures network course

Especially strong interactive visualization algorithms animation demonstration using visual programming technology, graphics demo process is driven by algorithms, independent user input data dynamically, the system automatically demonstrate algorithms implementation process. The animation driven by algorithms have the very strong and flexible interaction, allow students to participate in them, reveals vividly algorithms thought and steps to

achieve. The part of history and figures further improve students' passion to pursuit scientific knowledge, greatly improve the students' learning enthusiasm, arouse students' learning potential.

IV. OUTSTANDING CREATIVE THINKING TEACHING DESIGN

How to use algorithms and data structures knowledge as the carrier, cultivate the students' innovative thinking ability, realize effective integration the way of thinking and knowledge of curriculum teaching. We were thinking and practice.

A. *fusion macroscopical and microcosmic curriculum design*

In curriculum design, course orientation, teaching goal and content positioning, teaching material selection or compiling, teaching pattern of the course conform to certain standards, has certain regularity and definiteness, adjustable space is very limited, which can be called macro design. Different teaching levels, teaching object, teaching requirements are different, so the specific teaching plan and course teaching plan writing has a certain degree of adaptability, this part is called the micro design. Around the important curriculum design link, we propose the undergraduate education curriculum design should include six links: course orientation, teaching goal and content orientation, teaching materials selection or compiling, teaching mode regulations, teaching planning and teaching plan writing.

B. *Embody advanced top-level design organization structure*

We divide course teaching organization mode into three levels (as shown in Figure 2). Inspirational education based on characters and computer history as the core, expand to method and training based on algorithms and data structures (DS) selection, and radiation to behavior experience based on experiment, Project and second class as the platform, cultivating students ability and quality.
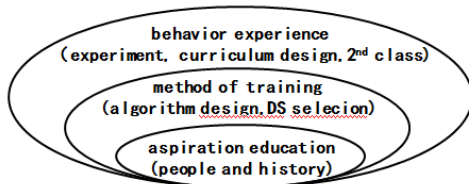

Fig 2 the teaching organization chart

The mainly aim to obtain the theory knowledge, in order to improve the students' application ability, innovation ability and comprehensive quality as the goal. In general, explain in accordance with the easy first, briefly after complex ideas. For the three basic structures: table, tree, graph, in accordance with the logical structure, physical structure, basic operation, basic algorithms, algorithms

evaluation, study each kind of structures characteristics, giving students a clear research process, according to the characteristic of the problem so that students can choose a suitable data structure, further understand data structures.

Specifically, correspond to basic concepts, many examples are given to illustrate the connotation of the concept, emphasize the role of standard terms and words, training scientific style. Correspond to the algorithm design, we can outstand key and fan out from point to area, enable students to gradually establish a good algorithm design consciousness by contrast.

In teaching practice, we focus on knowledge points: first analysis the characteristic of the problem, abstract the data and relationships among data, then guide students to find the problem-solving ideas and methods and considering how to programming, lets the student experience the problem solving process, highlighting innovative thinking.

Here we explain teaching organization and implementation process through the minimum spanning tree. In teaching preparation time, we studied process and the background of algorithm produce for Kruskal algorithm and Prim algorithm. In the course of teaching design, restore Kruskal and Prim design process as the breakthrough point, guide the students to think of ways to solve the problem, show scientists thought process. Specifically, the first set a problem scene, lets the student to analyze and solve the question, but does not tell the students this is the Kruskal algorithm, finally, in the conclusion of the time we tell the students that you just solve the problem of the thinking process is Kruskal's thought in a project in order to solve the minimum spanning tree, then introduced the Kruskal 's main contribution, present work and contact, close with the distance of live celebrity, further, let students design other algorithms from two angles of imitation and correction algorithm difficult, when students think this idea "let algorithm does not appear loop", we can draw out the Prim algorithm, tell them that in project Prim found Kruskal algorithm weakness, then improved Kruskal algorithm.

The students back to the historical scene, setting up students' self-confidence, enhance the sense of mission, culture innovation and the courage to go beyond consciousness.

Teaching design based on calculation thinking use reduction in history and details of the carved process, use methodology to guide practice, humanistic knowledge upgrading connotation

V. OUTSTANDING STUDENTS TECHNOLOGICAL INNOVATION ACTIVITY

Teaching is not only a job, but also is a system, which is built to finish the teaching task and is compose of teachers, students, and teaching media, with the overall function of the aggregate.

On improving students learning style, highlight the autonomous learning, innovative learning, the teacher's leading role and students' main role of unifying principle, increase students' learning autonomy, increased student participation consciousness, continuously from the grasp of knowledge to master the ability to obtain knowledge, from the simple to obtain knowledge to cultivate their innovative ability.

We expand the auxiliary teaching from three aspects in the autonomous learning, practice teaching, design competition.

A. Autonomous learning

The teaching philosophy of strengthen the self learning, promote ability cultivation is to meet the requirements of quality education. Learn to study has gradually become the most ictus in educational circles.

On teaching method, we adopt guide, inspire, research, discuss, question driven forms, give full play to students' main role, inspire each student's strengths and potential, raises student's imagination and innovation ability.

In the means of teaching, we adopt multimedia and blackboard combined form, all-round and multi-angle expounded teaching content in classroom. We use multimedia animation to reveal the connotation of the thought of the algorithm, make algorithm idea more vivid, direct-viewing and improve students' learning interest and desire. By network video teaching system, we can communicate about problems, assignments and submitted, exercises, self evaluation and other content, the video teaching take the knowledge as the clue, around the point of knowledge offers a number of related resources and links. Through proposing the learning task to the student, let the students complete specific tasks through rich information search, screening, analysis, sorting in the network, which give full play to the students' learning enthusiasm and initiative, improve the students' ability to knowledge selection and acquire, is advantageous in the student comprehensive knowledge structure formation. It opened another class in the teaching and learning, giving the teacher and the students exchange to open a window, at the same time it provides a means of the self-learning and knowledge development

B. Practice teaching

A saying "I hear and I forget, see and you remember, do and you understand", understand in order to better application and have more innovation. Take example by foreign practice mode on computer related professional, we have adopted a variety of ways in practice. We set practice course and curriculum design teaching in practice, practice course time divided into planned hours and extra hours (not occupied by the regular time). The experiment in class (planned hours), realize the hierarchical (three level

experiments), embody the step-by-step process; the extracurricular experiment (extra hours) set the Project operation, intensive computational thinking training, improve the students to apply the theoretical knowledge to solve the actual problem ability; through curriculum design cultivate students the rigorous style of study and innovation consciousness.

C. second class

Actively encourage students to participate in competitions, in the international and national mathematical modeling contest, the students use computer to solve the problem, we have been recognized to the way of training. A mobile phone software "Hush" by developed by students won first-rate award in the 2010 china technological cup, a number of software by designed and developed by students won various awards in the school's outstanding cup. In addition, we make use of ACM/ICPC mode in teaching, expand students of the second class and improve students programming level. Therefore, the school has already held 4 programming contest continuously for the school programming enthusiasts, which get a positive response and welcome by students.

Through teaching reform and practice of the algorithms and data structures course, we reform current teaching mode based on the knowledge, faculty to teach and instill, make the teaching process is to be based on the students' independent activities and promote their subjectivity and creativity through comprehensive, diverse subject practice activity. Lay the solid foundation for the field of information technology, through autonomous learning education in information technology and comprehensive literacy, which can continuously improve the overall students' quality, to cultivate students' creativity, promotes the student to own individuality development and better integrate into the development of the times, make the school become the cradle of cultivating innovative talents.

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