Application of Concept Maps-based Anchored instruction in Programming Course

Liu Li
Instructional Division of Computer Technology
Zhejiang Sci-Tech University
HangZhou, China
liuli@zstu.edu.cn

Haijun Mao, Licheng Xu
Instructional Division of Computer Technology,
Zhejiang Sci-Tech University,
P.R.China
maojh@zstu.edu.cn

Abstract—In need of interesting material and effective teaching approach in programming learning, students were more likely to drop out of the course for the abstract concepts and complex structure. Despite the fact that they had spent much more time on programming syntax study, it was common for them to fail to construct an application independently.

To overcome these disadvantages, a new teaching strategy, named as “concept map-based anchored teaching”, was proposed in this paper. With the anchor as core, students launched inquiry learning. To support concept learning, concept map was assigned to students for better understanding of the concepts relationships. Also it facilitated teachers to grad students in the learning process as a tool.

In this paper, we also present the implementation of the teaching design with a real application of “Employee salary management system” as anchor.

Keywords—concept-map; anchored-teaching

I. INTRODUCTION

Programming is commonly designed as an introductory computer course by most universities. It is of great importance in the science and engineering education mainly for its relationship with computing skills, logical thinking, creativities as well as problem-solving abilities which would affect students engineering career.

However, programming learning is difficult [1,2] for many novices for abstract concept, complex syntax, logical structure, creative thinking and most of all, several technical skills. As a result, storing detailed syntax for students as the main teaching task is far from satisfactory. Even when many students had learnt programming knowledge by the common step, they failed to construct a basic application with their own programming knowledge.

To solve the problems both in teaching and learning, a new teaching design was presented in the paper, named as “concept map-based anchored instruction”; with an anchor as the main learning task and a supplementary concept map tool to facilitate syntax learning. Since the anchor is a concrete problem such as “employee salary management system”, new programmers are willingly to solve it by inquiry learning of programming knowledge and applying them on it. So it is natural to connect the abstract knowledge to the concrete application, facilitating the development of programming skills. In support of concept learning, concept map is a powerful tool in building the concept network.

Since the anchor is the key of new teaching design, the knowledge coverage and fulfillment of anchor should be comprehensively considered. In this paper evaluate method based on psychology cognition theory was proposed to analysis the fulfillment of an anchor.

The paper is organized as follows. Section 2 is about an overview of the related literature. Section 3 gives the background of anchored instruction, concept map and anchor evaluation theory. The new teaching design is proposed in section 4 and implementation of this program is introduced in section 5. Section 6 contains conclusions.

II. RELATED LITERATURE

Programming is difficult [3] not only for compound syntax but also for application skills. Researches on the problem are comprehensive.

To facilitate syntax learning, tools and teaching techniques were developed, including “role-play technique” by Guillermo Jiménez-Diaz [4], “Cha Pedagogically Effective Cross-Platform Interpretive C/C++ Computing Environment” by Harry H. Cheng [5] and “Teaching Model Construction Based on Concept Map” by Zhao boshu [6].

However, the research by Essi Lahtinen and his partner gave the conclusion that the real difficulty in programming learning is the construction of a concrete application rather than syntax details [2]. The view is also supported by A. Lawson [7]. The main reason lies in the lack of concrete and interesting material to practice.

To overcome this main problem in programming learning, some new teaching methods based on constructivism are proposed, such as “task driven” [8], “Project-base teaching” [9,10] and “inquiry learning” [11]. All these methods to some extent help students in the top-down view of application construction and problem solving skills. With much effort on the real problem solving, there is relatively little effort left for students to systematically construct the concept net in their mind. As a result, the theory knowledge foundation may be instable.

So a cross method is needed for compensation of both syntax learning and skill construction.
III. THE BACKGROUND OF THE CONCEPT MAP-BASED ANCHORED INSTRUCTION

A. Anchored instruction

Anchored instruction is on the basis of constructivism. Constructivism is in the belief of experience from real world or situation as the best way to learn rather than from textual knowledge. Introduced by cognition and Technology Group at Vanderbilt (CTGV), anchored instruction has become one of the most popular teaching strategies on constructivism base. The main strategy of the method is to supply a full and concrete problem which will guide students to experience and inquiry material, achieving problem solving skill and cognitive knowledge by themselves.

The anchor here in the teaching method refers to the concrete problems or events familiar with students. Once the anchor, or real material, is decided, the whole context and the progress of the course are fixed. Since anchored method is on the basis of real problem, it is more likely to arouse the enthusiasm for inquiry knowledge and experiencing of problem solving.

The design of anchored instruction is on the base of 5 steps below:
1) To propose an carefully prepared anchors
2) To decide which content around anchor to be studied
3) To analyze anchor and make plan according to the division of problem
4) To solve the branch of problems by inquiry learning of relative knowledge and skills
5) To grad students by teacher

The anchor is considered to be satisfactory only when the knowledge and skills incorporated in it is full for the course study.

B. Concept map

Concept map [12] is introduce by J. D. Novak on the concept assimilation theory, acting as an advanced cognition tool in the constructivism. It is comprehensively applied in teaching, learning and evaluating.

The diagram of concept map consists of three kinds of components. One composition is nodes which indicate the concepts. Another is linkages which indicate the relationship between concepts. The last composition is the linkage labels which indicate the word such as “is”, “consist” and “include” etc.

There is a hierarchical frame in the concept map. An example map is shown in the Fig.1.

![Example Concept Map](image)

In construction of such a concept map, students would experience a brain storming with explicit recognizes of the concepts. Further more, relationships between concepts in concept map help to construct knowledge net in students brains.

C. Psychology cognition classification and the concept map-based anchored Instruction

According to the theory of modern psychologist J·R·Anderson, knowledge is classified as declarative knowledge and procedural knowledge. Declarative knowledge answers questions of “what” and “why”, relating to the issues of concepts, syntax, principles and theory, while procedural knowledge answers questions of “how”, relating to the issues of method or program.

The expansion of knowledge and skills integrated in an anchor means the coverage of declarative knowledge and procedural knowledge in programming course. A perfect anchor should have an expansion of both knowledge and skills in course satisfactory. Method based on psychology cognition theory is facilitating to evaluate the fulfillment of an anchor.

IV. THE DESIGN OF THE CONCEPT MAP-BASED ANCHORED INSTRUCTION

A. top-down view on the design of the approach

In this paper the teaching method is designed as following:

Firstly, 2-3 anchors are carefully designed by the teacher, taking both programming knowledge expansion and students interests into consideration.

Then, students decide the anchor they prefer. Teachers will help to analyze the problem and divide it into smaller tasks. On each task which may cost several classes, students will launch inquiry learning about declarative knowledge to solve the problem. During the process, the construction of procedural knowledge is expected. After each task, a concept map is assigned to express their mind of programming knowledge.

2197
In the end of the semester, teachers grad students by the concept map, the project performance and the final test as well.

B. Principle of the anchor design

A perfectly designed anchor is the key point of the successful teaching method which may arouse students enthusiasm for learning.

However, to design a full-knowledge-covered anchor is not easy for the complex contents of programming. In evaluation of an anchor, method based on psychology cognition theory will help.

The declarative knowledge and procedural knowledge are described as the set of \( \{ K_1, K_2 \} \). \( K_1 \) represents the declarative sets of knowledge while \( K_2 \) represents the procedural sets of knowledge. \( K_1 = \{ d_{k_1}, d_{k_2}, \ldots, d_{k_n} \} \), with \( d_{k_i} \) as the \( i \)-th declarative knowledge sets. Similarly, \( K_2 = \{ p_{k_1}, p_{k_2}, \ldots, p_{k_n} \} \), with \( p_{k_i} \) as the \( i \)-th procedural knowledge. The sets are show as Fig.2.

\[
K_1 = \begin{pmatrix}
D_{k_1} \\
D_{k_2} \\
\vdots \\
D_{k_n}
\end{pmatrix} \\
K_2 = \begin{pmatrix}
P_{k_1} \\
P_{k_2} \\
\vdots \\
P_{k_n}
\end{pmatrix}
\]

Figure 2. Sets of knowledge

An anchor is divided into several tasks as \( f_1, f_2, \ldots \) by function, each of which consist of the subset of \( K_1 \) and \( K_2 \). The hierarchical frame between \( K_2 \) and \( K_1 \) is shown as Fig.3.

Figure 3. Hierarchical frame between subset of problem and \( K_2, K_1 \)

Considering the an example of bubble sort which is \( P_{k_i} \), coverage the declarative sets of knowledge is evaluated by the \( D_{k_i} \) set of \{ storage of data, definition of array, loop control, input and output \}.

According to the Fig.3, the anchor is preferable only when the number of arrowhead of every \( D_{k_i} \) and \( P_{k_i} \) is not null.

C. Arrangement of concept map assignment

As anchor is fixed, the whole teaching process can be divided into several stages according the functions of problem, of which there are explicit and concrete tasks.

On each task, the inquiry activities are all about the materials, including concept learning and application of them. To construct the concept knowledge net, the concept maps are required as an assignment for students. The assignment is to be handled and discussed in the class just after a piece of task is accomplished.

To draw such a map consists of concept understanding and the relationship net construction. It is the process of reviewing and conclusion of learning. Given enough time, a discussion class can be designed as a chance of exchanging ideas of their own by concept map. Fault can be picked out through the discussion so that understanding of concepts is expected to be enhanced. Each map can be graded according to the performance.

D. Evaluation system of the course

Since programming is related to creativity and application, paper test is limited to reflect the whole learning performance. We design a complex evaluation system including final text, project performance and concept map grading.

V. IMPLEMENTATION OF CONCEPT MAP-BASED ANCHORED INSTRUCTION

A. The anchor applied in programming course

In VB course, we design an application "employee salary management system" as one of the example anchor.

With demonstrative analysis of this real problem, teachers help to divide application into modules such as login module, data input module etc.

In order to evaluate the fulfillment of the anchor, the anchor modules, declarative knowledge and procedural knowledge are indicated by the table.

<table>
<thead>
<tr>
<th>Function</th>
<th>Procedural knowledge</th>
<th>Declarative knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Login system</td>
<td>Logical flow of Select control; Object : application of text, label, command button, and timer; input and output</td>
<td>Concept of issues about objects. Syntax of select structure</td>
</tr>
<tr>
<td>Statistics of employment salary</td>
<td>Application of computing</td>
<td>Concept of data and their storage</td>
</tr>
</tbody>
</table>
From the table above, we can see the comprehensive coverage of declarative knowledge and procedural knowledge by this anchor so that we consider it a considerable anchor.

B. The learning process around anchor

After division of problem into explicit tasks which will cost several classes to learn the relative knowledge, students begin their problem solving learning including inquiry of programming syntax by themselves and application of the knowledge.

The whole learning process also consists of several stages. On each stage, teachers illustrate the programming principles on “how to do” and students are encouraged to make clear “why to do”. In the end of each task, there is a concept map to be discussed and handled. During this process new learners can make clear of the inner relationships between concepts and principles. More over, students achieve the problem solving skills by the task.

Some faults can be pointed out in discussion of concept map. It may lead to deeply acknowledge of the right concept. For example, after the task of login module, a misunderstanding is shown as Fig.4.

Fig.4 shows the misunderstanding of attribute of “forecolor” as the common attribute that all objects own. In fact the object of “timer” has no such attribute.

Discussion concept map in the class will help students to gain deep thinking about concept by exchange their ideas and make a more explicit view of the knowledge net.

C. Evaluation of the course

In the practice of new teaching, we design an assessment system including performance on the test, project and concept map as well.

The assessment system structure is shown as table 2.

<table>
<thead>
<tr>
<th>index</th>
<th>Project assessment</th>
<th>Concept map</th>
<th>Final test</th>
</tr>
</thead>
<tbody>
<tr>
<td>student</td>
<td>30%</td>
<td>20%</td>
<td>50%</td>
</tr>
</tbody>
</table>

D. Teaching effect of the concept map-based anchored Instruction

In the concept map-based anchored instruction, students are faced with an interesting real problem so the enthusiasm for learning is greatly enhanced. After experiencing each tasks about problem, skills are developed with declarative knowledge constructed. On making the concept map, students have the chance to make conclusion of concept so as to gain the deep understanding of them. It seems for teachers to spend more little effort on declaring knowledge while there is more effective achievement gained by students.

VI. CONCLUSION

Programming is hard to learn both for complex concept and skills. To overcome these disadvantages, a new teaching strategy, named as “concept map-based anchored teaching”, was proposed in this paper. With the anchor as core, students launched inquiry learning and incorporated detailed syntax into a real application, which meant the construction of application skills and problem-solving abilities. To support concept leaning, concept map was assigned to students for better understanding of the concepts relationships. Also it facilitated teachers to grad students in the learning process as a tool.

Evaluation of anchor is necessary so the psychology cognition theory is explored in this paper to Analysis the knowledge coverage and fulfillment of anchor.

In this paper, the implementation of the teaching design was also proposed with a real application of “Employee salary management system” as anchor. In teaching practice, we have seen great improvement in programming skills by students.

REFERENCES
