Promoting Acquisition of Programming Skills by Reuse of Active Diagrams

Hiroshi Taguchi, Fumiko Harada, Hiromitsu Shimakawa

Ritsumeikan University, Japan

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Research Background (1)

- The lack of IT engineers who carry an advanced information society is a serious problem today.
  - This problem demands high-quality IT education from univ.
  - Information science department of many univ. provide programming courses.

In the present state of affairs, ...

- A considerable number of students don’t acquire programming skills when the course is over.
  - A teacher teaches dozens of students at a time.
  - A teacher cannot get round to provide remedial education for students who have come to a deadlock.
To solve this problem, ...

- It is supposed to be effective to give know-how of students who have already acquired programming skills to other students.

- The know-how will promote acquisition of programming skills effectively.
  - A student can review a lesson by himself with the know-how, without the help of a teacher.
Clues to understanding (1)

- A programming course in a university are made up of lecture class and exercise class.

- The time until mastery of a new technique which a student learns in a lecture class differs in individuals.
  - Once a student can use a new technique, he is often able to make good use of it afterward.

- The reason is because explanations which promote understanding are different among students.
  - A teacher provides many explanations of a new programming technique in both classes.
  - There are a wide variety of ways to explain one technique.
Clues to understanding (2)

- We refer to explanations that promote student’s understanding as **clues to understanding**.
  - Clues to understanding common to many students who have already understood will be clues also for other students.

*Until now, ...*

- We have proposed a method to find clues among **lecture slides** a teacher uses in a lecture class, and applied it to actual university courses.
  - The results have proved that the method can pick out slides effective to improve student’s understanding.
  - If clues are found from teaching mediums other than slides, students will be assisted more effectively.
Active diagrams

- A teacher often uses diagrams to teach programming techniques lucidly.
  - A teacher represents each component of a transaction as a diagram and explains the transaction with their movement.
  - We refer to a diagram which moves as time advances as an active diagram.

- We propose a method to find and reuse clues to understanding from active diagrams which a teacher drew extemporaneously.

- It supports the learning process of techniques to realize various data structures and algorithms.
  - There are many students who meet setback in this process.
**Collection of active diagrams**

- The first step is to collect several kinds of data to grasp contents and effects of each active diagram.

**In a lecture class**, a teacher draws active diagrams on a display as a supplementary explanation. Movement of diagrams is recorded as time series data. And, a screenshot of the desktop is recorded. The method identifies a slide which is shown when a teacher draws an active diagram.

**Active diagrams**

**Corresponding techniques**

**Responses from students**

**Usefulness of diagrams**

**In an exercise class**, a teacher draws active diagrams on student’s computer when he provides personal coaching. Movement of diagrams is recorded as time series data. And, a screenshot of the desktop is recorded. The method identifies an exercise which a student doing when a teacher provides personal coaching. A student replies whether the coaching was useful for him.

A student chooses an option which is nearest to his feelings: *Got it!, Ah-ha, Don’t understand!, Wait a minute!* The method collects exercise results which a student does shortly after the lecture.

The method collects exercise results which a student does when a teacher provides personal coaching.
Guidance sheet

- The guidance sheet is software to record active diagrams which a teacher draws on computer desktop.
  - It records a process of drawing and a screenshot of desktop.
  - It considers a diagram is a whole series of points.

```c
for (current = top, i = 1; i < n; i++)
    current = current->next;
newNode->next = current->next;
newNode->prev = current;
(current->next)->prev = newNode;
current->next = newNode;
```

Guidance sheet

Computer desktop
Collection of active diagrams

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- In a lecture class, a teacher draws active diagrams on a display as a supplementary explanation.
- In an exercise class, a teacher draws active diagrams on student's computer when he provides personal coaching.

- Movement of diagram is recorded as time series data. And, a screenshot of the desktop is recorded.
- The method identifies a slide which is shown when a teacher draws an active diagram.
- A student chooses an option which is nearest to his feelings: Got it!, Ah-ha, Don't understand!, Wait a minute!
- The method collects exercise results which a student does shortly after the lecture.

- Active diagrams
- Corresponding techniques
- Responses from students
- Usefulness of diagrams
- Movement of diagrams is recorded as time series data. And, a screenshot of the desktop is recorded.
- The method identifies an exercise which a student does when a teacher provides personal coaching.
- A student replies whether the coaching was useful for him.
- The method collects exercise results which a student does when a teacher provides personal coaching.
**Button terminal**

- The button terminal enables a student to register a response to teacher’s explanation in a lecture.
- A student can use it by a web browser on a PDA.
Collection of active diagrams

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In an exercise class, a teacher draws active diagrams on student's computer when he provides personal coaching.

- Movement of diagrams is recorded as time series data. And, a screenshot of the desktop is recorded.
- The method identifies an exercise which a student doing when a teacher provides personal coaching.
- A student replies about whether the coaching was useful for him.
- The method collects exercise results which a student does when a teacher provides personal coaching.
Identification of corresponding programming techniques (1)

- A teacher sets corresponding techniques for each slide and each exercise previously.

Technical items:
- Defining a node of a single-linked list
- Making up a single-linked list
- Inserting a node in a single-linked list
- Removing a node in a single-linked list

Fundamental components:
- If-else statement
- For statement
- Declaration of a pointer
- Assigning pointer values
- Declaration of a structure
- Referring to a member
- malloc() function
Identification of corresponding programming techniques (2)

- In a lecture class, an active diagram inherits technical items and fundamental components corresponding to a slide which is shown when a teacher draws it.

- In an exercise class, an active diagram inherits ones corresponding to an exercises which a student is addressing when a teacher draws it.
Picking out diagrams which are likely to be clues

- If a student achieves mastery of a technical item after he is given a diagram, it is highly likely that the diagram is a clue to understanding.
Sifting out true clues

- The method opens picked out diagrams to other students temporarily in a state of reproducible.

- The method determines usefulness of an active diagram when a certain students reproduce it.
  
  ✓ If the percentage of students who replied “effective” and had good results in them is more than a certain threshold, it considers the active diagram is a true clue.
  
  ✓ True clues are opened to other students continuously.
There are cases that lack of understanding about fundamental components is a cause of deadlock.

- In this instance, a review with clues is ineffective.

- It can reuse active diagrams which a teacher drew extemporaneously to support other students.
Conclusions

- We proposed a method to reuse effective active diagrams to assist students in acquisition of C-language programming skills.
  - It can reuse active diagrams that a student cannot note down with the same movement.
  - It identifies programming techniques corresponding to each active diagram in two kinds of viewpoints.
  - To increase the effectiveness, it sifts out true clues and adds helpful information.
- We plan to verify effectiveness of the method by application to an actual university course.