

A proposal for teaching programming through the Five-Step Method

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Abstract

We have proposed a new method of advancing from CS Unplugged through the new process of CS Plugged to full-fledged computer programming languages, as a means of deepening understanding in computer programming education. We also have proposed a new Five-Step Method consisting of the following steps: Step 1, A CS Unplugged activity; Step 2, A CS Plugged activity; Step 3, A trace table, Step 4, Preparing pseudocode; and Step 5, Writing Java source code.

Keywords: CS Unplugged, CS Plugged, Programming, Five-Step Method.

1. Introduction

The course we teach has about 40 students per class, aged 17 through 18 years. Since the students' major field of study is Management Information, they need to learn programming [1] techniques. However, the results of the survey described below show that not a few students consider themselves to have insufficient

understanding of programming or think that they are not good at programming. We are examining ways to improve this situation. CS Unplugged [2] is a method of teaching information science without using computers, first proposed by Tim Bell of the University of Canterbury in New Zealand. While CS Unplugged is said to be effective in teaching information science [3], there have been concerns that its success or failure may be an effect of the skill and experience of instructors. To

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address this topic, we implemented CS Unplugged for a group of students of a different age group, from fifth through ninth grades, and looked at their responses. The results showed that after first making sufficient preparations the method could generate results without necessarily depending on the skill or experience of instructors. Other research underway in Japan includes a study on use of teaching aids in learning about algorithms through CS Unplugged [4] and a study on learning the fundamentals of computer programming through a programming learning environment for beginners [5]. A study by Y. Feaster et al [6] concerns practice in teaching high-school students, and it has been reported to have had some, albeit limited, success. However, at present almost no research has been conducted on advancement from CS Unplugged to full-fledged programming languages. Accordingly, we propose a new method of advancing from CS Unplugged to full-fledged programming. The proposed method begins with conducting a CS Unplugged activity, and then continues on to writing a program on the same theme and further to its abstraction in Java. Accordingly, we propose advancing from CS Unplugged to full-fledged programming through a new Five-Step Method. The proposed method consists of the following steps: Step 1, A CS Unplugged activity; Step 2, A CS Plugged activity; Step 3, A trace table, Step 4, Preparing pseudocode; and Step 5, Writing Java source code.

2. Background of this study

Every year we conduct a survey following our first-term course of two 90-minute sessions per week held over 30 weeks. Here we will look at numbers of students who answered “yes” or “no” to this survey’s question, “Do you think you largely understand Java?”

As seen in Fig. 1, the survey’s results show that not a few students consider themselves to have insufficient understanding of programming or think that they are not good at programming. As such, there is a need to improve this situation.

3. CS Unplugged in practice

For about 50 minutes on August 2, 2014 we used the CS Unplugged method for approximately 30 students from

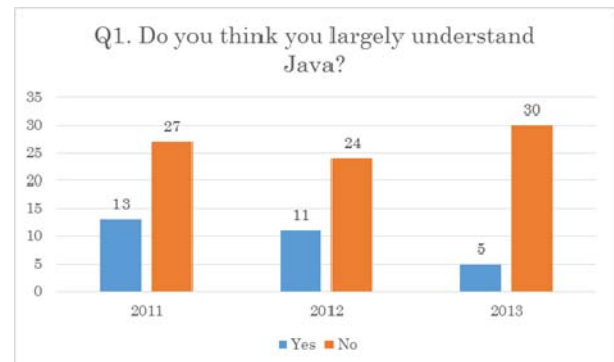


Fig. 1. Survey results on understanding of Java.

fifth through ninth grades as part of a summer-vacation junior science course. The activity we implemented was CS Unplugged’s Image Representation activity. Fig. 2 shows examples of students’ work.

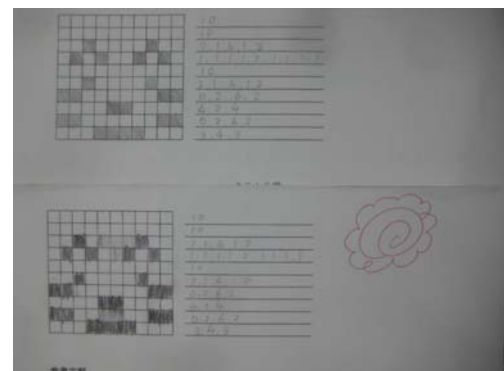


Fig. 2. Examples of students’ work

4. The Five-Step Method

In this paper, we use the name CS Plugged to refer to implementing a CS Unplugged activity through a computer program. The goal is to advance to computer programming through using a computer program to conduct the work done by human beings in a CS Unplugged activity.

Accordingly, we propose advancing from CS Unplugged to full-fledged programming through a Five-Step Method. The proposed method consists of the following steps: Step 1, A CS Unplugged activity; Step 2, A CS Plugged activity; Step 3, A trace table, Step 4, Preparing pseudocode; and Step 5, Writing Java source code.

4.5. Step 5: Writing Java source code

In this step students create a program by converting the pseudo-language from the previous step to Java source code. The subsequent debugging process is handled by going back and examining each previous step depending on the content of the error messages.

- Java source code

```
public class Image2Code {
    public static void main(String args[]) {
        char[][] image = {{'□', '■', '■', '■', '□'},
                          {'□', '□', '□', '□', '■'},
                          {'□', '■', '■', '■', '■'},
                          {'■', '□', '□', '□', '■'},
                          {'■', '□', '□', '□', '■'},
                          {'□', '■', '■', '■', '■'}
        };
        // Iterate only number of lines in an array
        for(int i = 0; i < image.length; i++) {
            char previous = '□';
            int count = 0;
            // Display the image in pixels
            for(int j = 0; j < image[0].length; j++) {
                System.out.print(image[i][j]);
            }
            System.out.print(" ");
            // Count number of adjoining pixels of same color and
            display in numerical form (code)
            for(int j = 0; j < image[0].length; j++) {
                if (image[i][j] == previous) {
                    count++;
                } else {
                    previous = image[i][j];
                    System.out.print(count + " ");
                    count = 1;
                }
            }
            System.out.println(count);
        }
    }
}
```

- Results of running the above program

```
□■■■■ 1, 3, 1
□□□■ 4, 1
□■■■ 1, 4
■■□□ 0, 1, 3, 1
■■□□ 0, 1, 3, 1
□■■■ 1, 4
```

5. Conclusion

We have proposed a new method of advancing from CS Unplugged through the new process of CS Plugged to full-fledged computer programming languages, as a

means of deepening understanding in computer programming education. We also have proposed a new Five-Step Method consisting of the following steps: Step 1, A CS Unplugged activity; Step 2, A CS Plugged activity; Step 3, A trace table, Step 4, Preparing pseudocode; and Step 5, Writing Java source code. Topics for the future are those of putting together detailed procedures for abstraction of pseudocode from trace table as well as continually implementing the proposed method and measuring its results.

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