Project-driven Transfer Learning for Computer Programming Teaching

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Keywords: computer programming teaching, project-driven transfer learning, student-centered practice teaching

Abstract. Computer programming teaching is important for computer technology education. Traditional teaching methods focus on the teacher-centered pattern, where teachers are the major subject in the class and students have little time to digest knowledge. In order to address this issue, we propose a novel project-driven transfer learning for computer programming teaching. In this method, multi-level projects are designed for student-centered practice teaching. Project-based transfer learning instructs students to master the fast learning skill for new application scenarios or learning new knowledge. Furthermore, test results show that our approach can considerably improve teaching effectiveness.

1. Introduction

With the rapid development of computer technology, computer programming teaching has become more and more important for education. Different from other courses, computer programming courses have two special characteristics [1]. First, content in computer courses needs be updated because computer technology is developing fast every day. Second, computer courses strengthen the practice of the programming ability. Traditional teaching methods focus on teacher-centered teaching, where teachers are the major subject in the class and students have little time to digest knowledge. How to effectively conduct computer programming teaching remains a difficult and challenging thing.

There are several typical related researches to improve teaching effectiveness. For example, Chen and Cheng [2] presented a method with game programming for object-oriented programming teaching. Similarly, Corral et al. [3] proposed a game-based method for computer programming teaching. In addition, Li et al. [4] put forward a project-based teaching method in Java teaching. These methods can promote teaching to some degree. But facing with new applications or new knowledge, students are usually confused. Different from existing researches, we focus on providing a more scalable method to guide students.

Object-oriented programming is one typical kind of computer courses [3]. So we take the object-oriented programming course as example for improving the teaching method. In accordance with the characteristics of computer courses, we employ transfer learning for teaching. Transfer learning can transfer existing knowledge to help learning in the future [5]. The goal of transfer learning is to learn the knowledge from an application scenario to help the learning tasks in the new application scenarios [6]. Though computer knowledge may be updated daily, transfer learning can be used to address this issue. What's more, transfer learning has been proved as an effective way in several other domains [6]. In this paper, we incorporate project-driven transfer learning for computer programming teaching.

The remainder of the paper is organized as follows. First, section 2 presents the proposed project-driven transfer learning method. Then, section 3 shows the results and discusses the effect of our method. Finally, section 4 concludes the paper.

2. Project-driven Transfer Learning for Teaching

Computer programming courses include some basic theory and need more practice to reinforce theory knowledge. Traditional theoretical teaching is abstract, leading to unsatisfactory teaching effect. To deal with the issue, we teach knowledge by project-driven transfer learning way, in order to help student understand knowledge more easily. Multilevel concrete projects are employed in teaching classroom. What's more, transfer learning is used to instruct student to learn new knowledge based on existing knowledge.

According to the content features of computer programming courses, we propose a novel project –driven transfer learning method. The main procedure of the project-driven transfer learning method is described as follows.

Step 1: First, give the project application and draw out the theory knowledge.

Step 2: Explain the knowledge from the project viewpoint.

Step 3: Conduct practice and implement projects according to different levels.

Step 4: Transfer knowledge to another new application project.

Step 5: Keep why-what-how transfer learning idea to understand new latest knowledge or multiple complex knowledge.

The details about transfer learning and project designing will be further presented in the following paragraphs.

2.1 Factors of Transfer Learning

Transfer learning is a learning mechanism to instruct student how to fast interconnect knowledge. Factors of our transfer learning include two aspects. One factor is the project similarity. Similar projects usually involve same knowledge, and thus instruct students to transfer existing knowledge for new application projects. Another factor is the cognitive structure of students. Different students have different levels of knowledge structure. Projects should be designed to meet various needs. In addition, computer knowledge is updating every day. Facing with new knowledge, it's better to keep the main why-what-how idea in the mind. In other words, to comprehend knowledge, it's better to know why it is proposed, what it is, how it works and how to implement it. Teaching student how to master knowledge is much more important than just telling knowledge.

2.2 Project-driven Transfer Learning

Multi-level projects are designed for teaching as shown in Table 1. Firstly, basic projects are simple for students to understand the concepts about class and object. Secondly, middle projects are more complex than basic projects, for students to deepen the knowledge. Thirdly, high projects are most comprehensive for students to proficiently use knowledge.

Table 1. Multi-level project examples for transfer learning knowledge.

Project Level	Project Examples
Basic	Person class
	Student class
	Teacher class
Middle	Login module
	Student management module
	Selection course module
High	Student Management System
	Teaching Management System
	Test Management System

Encapsulation, inheritance, and polymorphism are three important features of computer object-oriented programming courses [1]. Nowadays, Java is one kind of typical widely-used object-oriented programming languages. Here, we take java language as example.

Encapsulation wraps the entity data such as person, student and teacher, which can effectively help to reuse the code. The common properties and methods of entities are also described in classes. Person has some properties such as name. In addition, a person class has some construction methods and other methods, as shown in Fig 1. Similarly, we can easily transfer the knowledge to other classes such as employee, manager, police, network police, etc.

```
Person.java

    package com.zj.test.bean;

    public class Person
    {
        String name;
        public Person()
        {
            name= "";
        }
        public Person(String tname)
        {
            name=tname;
        }
        public void print()
        {
            System.out.println("Person: name "+ name);
        }
    }
```

Figure 1. Fragments of the Person class.

In object-oriented programming, inheritance is a mechanism to own certain attributes and methods from another class without redefining. The previous defined class is called parent class, and the last defined class is called sub class. For example, student class can inherit from person class (Fig.2).

```
Student.java

    public class Student extends Person
    {
        int stuNo;
        public Student ()//construction method without parameters
        {
            stuNo=0;
        }
        public Student (String stuname,int stuno)//construction method with
        {
            name= stuname;
            stuNo = stuno;
        }
        public void print()//rewrite the print method of the parent class
        {
            System.out.println("student: "+ stuNo + name);
        }
        public static void main (String args[])
        {
            Person p= new Person ("tom");
            p.print();
            Student s = new Student ("lily",2021);
            s.print();//call print method
        }
    }
```

Figure 2. Fragments of the Student class.

Polymorphism is another important mechanism. It's an ability to refer to different types of objects at different time. With such reference, the called method can be bound according to the type of referred object and different methods at different time. For example, Person pl = new Student (); pl.print (); Overloading of methods and rewriting of methods are the embodiment of Java polymorphism.

According to the above three features, simple projects are designed. Each student is required to finish the projects and master the basic conceptual knowledge. Then, students try to finish middle projects, in order to consolidate knowledge. After that, team-based students attempt to finish comprehensive high projects in groups. Interactive discussion is sponsored for each level. Good-performed students share their thinking, and bad-performed students can present their

problems. Mutual help is encouraged in studying. When one project is finished, we usually give a similar new project to instruct student to transfer learning. In summary, we focus on project teaching and learning method teaching, not just theoretic knowledge.

3. Results

In order to demonstrate the effect of our method, we compare our method to the common methods without project-based transfer learning. We analyze the teaching results of the object-oriented java programming course from the 2015, 2016, and 2017 year. There are 90 students studying this course in each year. In 2015, we do not apply the project-based transfer learning method, and just adopt the common teaching method. In 2016, we employ the transfer learning method without multi-level projects. In 2017, project-driven transfer learning method is adopted in teaching. We carry out two tests after teaching every semester. The maximum score is 100 for each test, and the maximum time is limited to 2 hours. We take average score and average finish time as evaluation criterion. Figure 3 and 4 report the comparison results.
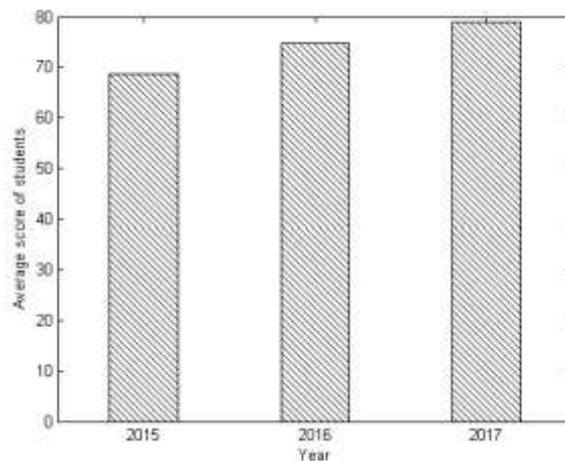

Figure 3. Comparison of average score for 2015 (using the common teaching method), 2016 (using the transfer learning method), 2017 (using the project-driven transfer learning method).
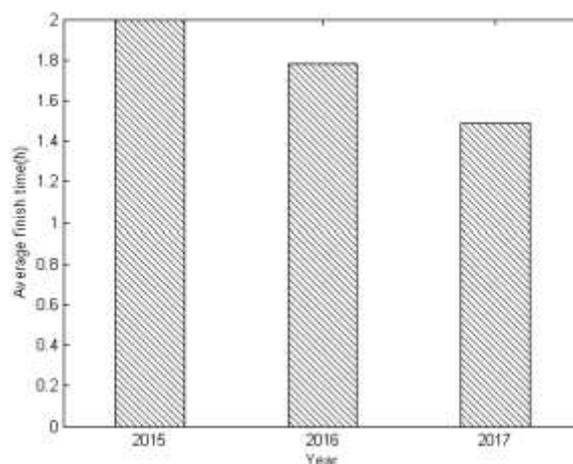

Figure 4. Comparison of average finish time for 2015 (using the common teaching method), 2016 (using the transfer learning method), 2017 (using the project-driven transfer learning method).

From the figures, we can find that using project-driven transfer learning method outperforms other methods. 2017 refers to our project-driven transfer learning method. Our method achieves better

average score and costs less average finish time than other methods. The test results prove our motivation that the proposed method can improve the teaching effectiveness. Using our method, the programming ability of students has made great progress, and the average finish time of projects is considerably shortened.

4. Conclusion

This paper proposes a project-driven transfer learning method for computer programming teaching. In this method, multi-level projects are designed for practice teaching. Project-based transfer learning instructs students to master the fast learning skill to learn new knowledge. Test results indicate that the proposed method can improve the teaching effectiveness.

In our future work, we will try to further improve current method. For example, we will enrich the real projects to meet more students' needs. In addition, we will compare our method with other methods using more test data and more evaluation standards.

Acknowledgement

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