Implementation and Practice of Pair Learning Based on Pair Programming

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Keywords: Pair Programming, Pair Learning, Knowledge Transfer, Knowledge Memory

Abstract. As a new mode of cultivating innovative talents in modern universities, pair learning is an important innovation in the reform of traditional teaching methods. Pair learning modes require students to work together by pairing to accomplish the same task or solve the same problem. Under the atmosphere of cooperation, consultation and exploration, knowledge exchange, transmission and application are carried out to achieve the purpose of knowledge memory. From the perspective of computer programming courses, this article analyzes the factors that affect the pairing and puts forward a set of process and methods to carry out pair learning. Pairing teaching practice shows that pair learning has achieved good effects on developing learning initiative of students and improving teaching quality.

Introduction

One of the basic requirements of computer science and technology, software engineering and other related majors is to master programming. But a lot of students think that the computer programming courses are relatively difficult to learn, which contributes to poor academic performance, or high withdrawal rate. The reason is that these courses require strong cognitive ability, rigorous logical thinking and abstract conceptual understanding, etc. [1]. Some researches indicate that most students have low scores of computer programming courses. Also, a growing number of students will withdraw from the course halfway because programming courses require students to spend more time practicing so that students’ academic motivation will be weakened. This has been the main difficulty on teaching and learning computer courses. One way to solve this problem, from a pedagogical point of view, is attempting to use a variety of teaching strategies, such as project-based learning methods to improve students' cognitive ability or learning interest [2]. Previous researches have revealed that some effective factors such as self-efficacy or learning intention have positive effects on programming and learning, and how to improve the effective of these factors has become one of the hot issues of pair learning.

1. Pair Learning Methods based on Pair Programming

Pair programming is one of the main practices of extreme programming. It means that two programmers working on the same programming task with the same computer and keyboard. Among them, a programmer acts as a "driver" role, responsible for coding with keyboard while another one acts as a "Navigator" role, observing and judging his partner's code, then searching for possible solutions or committed to solve the case in other ways. During the period of pairing, the parties are required to exchange roles on a regular basis to play their respective advantages [4]. Pair programming is a way for two individuals to carry out collaborative learning, which has been confirmed by many researches that it can significantly improve students' active learning and the efficiency of programming. Pair programming also improves the quality of the code, reducing errors and enhancing communication between the two parties. It has a positive impact on academic performance and interests, helping students understand programming concepts and exchange
knowledge. Role exchange is an important behavior of pair programming. Through the exchange of roles, the two sides diverge and fuse knowledge as well as enhancing memory capacity.

Williams et al. summed up the seven kinds of stimulating effects of pair programming. (1) Mutual supervision. Pair learning brought a positive pressure to urge the two sides to be more active using their brains in a predetermined time to achieve the goal. (2) Mutual consultation. The two sides will negotiate how to work together to solve the problem and evaluate more solutions. They share their knowledge and experience, making a painstaking investigation to go deep into the core of the problem and ultimately come up with a more perfect solution. (3) Mutual encouragement. When working with someone else, we will put knowledge together and have faith in what we do. (4) Mutual review. In the case of learning pair programming, the review can be carried out at any time. This continuous review has a faster speed of defect elimination than the traditional review in formal. (5) Mutual correction. When what you are doing is illustrated to other people, the problem has been solved. If there is an error, the partner will explain to you his thoughts and how it is implemented, and the other will listen carefully to find the problem. (6) Mutual learning. In the process of pairing, the two individuals will continue to communicate about all aspects of knowledge and learn to each other's strengths. (7) Mutual trust. Trust between the partners on the completion of the entire project with quality and quantity guaranteed is undoubtedly a great advantage.

Tutor system based on pair programming is developed, combining education and programming techniques used in studying programming courses, the method based on proxy automatically not only implements various teaching strategies, but also can evaluate students' knowledge memory and transmission effect.

Generally speaking, successful collaborative learning methods have the following five important attributes [6]: (1) A common task; (2) Group learning; (3) Collaborative behavior; (4) Interdependence; (5) Personal responsibility. Pair programming has the characteristics of these successful collaborative learning methods that help students learn programming and finish tasks with required quantity and quality. Knowledge memory and transfer are content in which pedagogy research is interested. Early studies have shown that when pair programming is used for a teaching and learning strategy of collaborative learning, the effect of students' knowledge memory, knowledge management and knowledge transfer is obvious that it improves grades of entry-level computer courses and encourages students to become a part of social network [7].

In recent years, the central focus of pair programming has been concentrated in learning methods and knowledge transfer. Pair programming helps to reduce development time and support rapid development, and knowledge transfer between the pair can be enhanced through the design pattern and the exchange of roles. When they conduct pair programming, the partner evaluates their understanding of each part of the task so as to facilitate knowledge transfer. Meanwhile, a comprehensive understanding of the knowledge in programming domain helps to consolidate the programming concept and this knowledge can be used to create new programs.

Of course, no matter how much benefits pair programming brought to educational philosophy, there are still some problems with classroom teaching. First, students in the classroom are asked to work side by side on the same computer, while it is not easy to organize in the after-school practices. So, there are problems such as coordination and workplace restrictions. Second, the effect of pair programming is related to factors such as personality of participants, programming ability, task complexity, attitude and behavior. There is difficulty in pairing and compatibility matching. Students' progress, especially in face of complicated pairing tasks, if students do not have enough ability to complete the task, the pairing will be obstructed.

2. Implementation Process of Pairing Learning Methods

To carry out pair learning efficiently in the classroom, this paper summarizes some of the pairing processes and methods.

2.1 Pair Training

Pair learning based on pair programming is a new way of active learning. Students are unfamiliar
with the principles and methods of pair programming, which requires teachers introduce the main points of pair learning including compatibility of pairing and factors that affect the pairing. The two sides should work closely together, help each other and actively discuss. The parties need to exchange roles on a regular basis and accomplish the stated goals together. Students' pairing must be conducted in a regulated environment, and teachers must be actively involved in the implementation and management of pairing, with strict participation and withdrawal rules to protect the interests of students in pairs.

2.2 Pair Assessment

The effect of pair learning is influenced by personality type, individual ability and so on. Reasonable group directly influences the effect of pairing and the accomplishment the task. Personality type evaluation can be carried out with MBTI (Mayers-Briggs Type Indicator) personality indicators, through a set of topics to assess the personality type of each student (introversion and extroversion). Programming capabilities can be evaluated by the quantity of code written to determine whether the ability is high or low.

Many researchers have identified the factors that affect the efficiency of pair programming and pair learning, including personality, gender, programming experience, etc. This paper emphatically discusses the influence of personality types and programming experience on the effect of pairing.

2.2.1 The Influence of Personality Combination on Pairing

Personality has been viewed as a topic in which programming environment and software engineering are interested. Research suggests that selecting and organizing members by personality and ability can improve programming efficiency and code quality. Character is the core element of personality. Good character has a significant impact on learning and working, while a person's character is closely linked with communicative relationship and mental health. Psychology believes that "personality" is a kind of individual behavioral tendency. It has characteristics of integrity, structural property, lasting stability. It is unique to each person, which can provide a unified and internal explanation for the behavior and attitude of the individual.

2.2.2 Programming Experience on the Effect of Pairing

Programmers' programming ability and problem solving ability is the top priority of our software development. Programming experience can be divided into high capacity, medium and low capacity in three. It can be composed of high - high, high - medium, high - low, medium - medium, medium - low and low - low six modes. In the high-high mode, when two excellent programmers are partners, the cooperation between the high-capacity pair will not waste too much time to explain. Only a few words can achieve the effect when they express their ideas. They have high efficiency in solving the problem. In high-low mode, besides guiding the general programmer how to pair programming, high-capacity member also needs to guide him some programming knowledge, programming tools and work habits, which is conducive to knowledge transmission and training new people. In the medium-medium mode, enthusiasm and complementarity of the two can be fully played. Communication can be mutually beneficial and achieved better results. In the medium - low mode, two people are more convenient to communicate and discuss, improving the enthusiasm of learning driven by the medium ability one. In the low-low mode, their ideas of those "inferiority" are much less and will discuss when encountering problems so that knowledge will merge with each other, which is rather beneficial for each other and the team.

2.3 Pair Matching

According to the results of the research, extroversion-extroversion and extroversion- introversion combination is the more appropriate pairing type, avoiding introversion- introversion combination. High-high combination is suitable for completing complex and knowledge demanded tasks. High-low combination is suitable for knowledge transfer, in which high ability of students can act as a mentor role to help students with low ability to improve. The low-low combination is suitable for completing simple tasks and improving self-confidence.
2.4. Pair Implementation

Carrying out pair programming or pair learning in classroom discussion or laboratory, in accordance with the combination of the previous pairs, the teacher arranges for the task or discussion topics and students are asked to discuss and communicate, then puts forward solutions and coding scheme. Teachers are required to observe the pairing behavior of the students and remind them to work closely and clarify the requirements of role assignment, regularly ask students to exchange roles as well. Teachers should record students' communication, task progress or code preparation, role reversal and so on. Finally, the teacher evaluates student's learning outcomes and gives suggestions.

For each semester or some time, the teacher may ask the student to be paired with a different student to reflect the fairness of the pairing and the final score. If a pair rotation system is implemented, the student's harvest will be even greater. It breaks the barriers to communication between students and is a very effective knowledge management strategy that allows each student to learn more about more development tools and solve more problems.

2.5 Analysis of Pair Learning Effect

We conducted pair experiments on the first-grade post-graduate students major in computer technology, from the department of computer science and technology of Nanjing Normal University. We have done a questionnaire on their personalities, mainly to investigate students' introversion and extroversion. The teacher provides the students' previous academic performance and divides the "skill level" into three levels: high, medium and low according to the result. During the experiment, the teacher asked the students to complete the arrangement at the specified time. Among them, the pairing group is randomly assigned. The final results of the pairs are divided into A, B, C, D four levels.

According to "cognitive skills level" and "character" are non-numerical factors, from the qualitative point of view, people are more outgoing in reality may give people a more confident sense, so that the other side think his skill level is high. Introverted people are generally more modest and the phenomenon that a wise head makes a close mouth may appear, which often contributes to being underestimated by the other one. For the purpose to analyze from the quantitative perspective, we set "Low" = 0, "Medium" = 1, "High" = 2; "Introvert" = 0, "Extroversion" = 1. The results will be classified according to "character" and "skills", divided into extroversion/medium + extroversion/medium, introvert/medium +introvert/medium, extroversion/high + extroversion/high, extroversion/medium + extroversion/high, extroversion /low+ extroversion /medium, introvert/high + introvert / high, introvert / medium+ introvert /low.

According to the pairing effect, it is divided into three combinations:

(1) Combination of the best pairing effect: "introvert / medium+ introvert /low". Reason analysis: regardless of the level of skills or personality, it is one of the recommended single factor decided combinations; From the comprehensive effect, the two people not only play a personality advantage to communicate effectively, but also possess coordination in terms of skills. High-level students are willing to help slightly lower-level students to complete tasks together. From the experiment, we can conclude that two single factor combination effect is: positive (character combination) + positive (skill combination) = positive (comprehensive effect).

(2) Combination of the general effect of the pairing effect: "extroversion/medium + extroversion/medium", "extroversion/medium + extroversion/high" and "extroversion/high + introvert/high." Reason analysis: consider from single factor, the combinations involved are recommended by the above. The experimental results show that positive (character combination) + positive (skill combination) = positive (comprehensive effect).

(3) Combination of the worst pairing effect: "introvert/high + introvert/high" and "introvert/medium+ introvert/low". Reason analysis: consider from the single factor, "introvert - introvert" and "high - high capacity" combination are both not recommended. In the "introvert/medium+ introvert/low" combination, though the "medium - low" combination is conducive to compatibility, with two introverted people together, they did not carry out effective
communication, and ultimately led to poor results. Experimental results testify that communication is the key to success, also explain character has a greater impact on the pairing effect on condition that the comprehensive ability is at a general level in the general.

Conclusions

Pair learning based on pair programming is very suitable for programming language learning in computer major and related majors, which can improve students' interest and ability to study. The author has achieved good results in the teaching practice of pair programming and pair learning in computer science and computer technology post-graduate course "Advanced Software Engineering". Pair learning can really improve students' learning enthusiasm, promote knowledge transmission and communication, and constantly enhance learning initiative.

Acknowledgement

This research is funded by project of education and teaching reform from the education department of Jiangsu province, graduate student innovation project on "Implementation and practice of pair learning based on pair programming" (No. JGLX15_133).

References


