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A Study on the Effect of Combination of Pair Programming with Learning Styles on Students Learning Motivation

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Abstract: *Peer tutoring strategy changes the role of instructors no matter what the instructor is an educator or a peer. The well-known method in computer science education, pair programming, is some kind of effective collaborative peer tutoring activity. The advantages of peer tutoring method emphasize similar prior knowledge and languages among peers so as to achieve teaching goals. Data Structure is a very important basic curriculum, regarded as a mandatory course in relevant computer domains of university. However, most of students fail to present their coding skills after learning data structure course. Cooperative learning is an effective learning strategy in which is often applied to education field. Students must work in groups to complete tasks collectively toward academic goals. Pair Programming could decrease errors in coding, increase coding quality and promote programmers confidence, as well as enhance their coding ability. This study incorporates an experimental learning activity, in which the students are asked to write programming codes, which can enhance students' learning motivation. Then, this study compares the performance of the students with different learning styles in learning motivation. According the results of Two-way ANOVA, the proposed intervention could increase students learning performance. The reflective-style students could have better learning achievement than active-style ones.*

I. INTRODUCTION

Cooperative learning is an effective learning strategy in which is often applied to education field. Students must work in groups to complete tasks collectively toward academic goals. Unlike individual learning, which can be competitive in nature, students learning cooperatively can capitalize on one another's resources and skills (asking one another for information, evaluating one another's ideas, exploring, thinking, reasoning and solving problems etc.). Those who have better interactive skills could help others learn interaction skills [1-3].

Peer tutoring is an instructional strategy that facilitates students to help others learn material and then understand better the material being studied [4]. The pairing of higher- and lower- achieving students offers students more opportunities for repeated practice and supplementary learning, which benefit the both parties and save the instructor's time, through one-on-one activities. Learning style is an important factor that affects learning [5]. Learners acquire knowledge in different ways, which forms different learning styles [6]. Study stated that instructors can adjust their teaching instruction to comply with different learning preferences and styles and then enhance students' learning motivation and achievement [7]. Pair programming is a collaborative concept to write programming[8].

Peer tutoring changes the instruction way of both conventional and collaborative learning. Pair programming is an agile software

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development technique in which two programmers work as a pair together on one workstation. One, the driver, is charged for writing code and usually works as the role of a student, while the other, the observer, is responsible for reviewing each line of code as it is typed and usually works as a role of an educator (Forte & Guzdial, 2005). Forte and Guzdial (2005) indicate that it is a tough learning activity to learning programming course but pair programming can be used instead, in which students are able to gain better learning performance actively.

It is often used to the course of computer programming. Thus, the participants are designated as two characters with different characteristics: the driver and navigator in the pair programming activity of this study. This study investigates whether the participants with different learning styles can effectively play different roles or not in the experimental activity.

II. Literature Review

A. Learning Style

Felder and Silverman (1988) divide learning styles into four groups, eight categories- Actively and Reflectively, Sensory and Intuitive, Visual and Verbal, Sequentially and Globally etc., based on four aspects of learning process, information processing, perception, input and understanding. Felder pointed that learning styles denote a learner's learning way of accepting and dealing with outside messages of the world. Classification of learning style is based on the degree of learner's information receiving and information processing. That is, active or reflective, sensing or intuitive, inductive or deductive, and sequential or global are classified to the feature of information processing; while visual or verbal is inclined to the feature of the feature of communication.

In the study, questionnaire of learning style is employed to decide learners' learning style with either active-type or reflective-type, and then decide what role will be arranged to double pair match in the programming game.

B. Pair programming

Pair programming, an important teaching approach in higher education, is a collaborative method for developing software [9]. Learning programming may be difficult to a beginner so as to decrease their learning motivation. With the assistance of collaborative learning, student learning motivation, better understanding of programming, higher morale and more interests could be enhanced.

III. Research Design

This study incorporates an experimental learning activity, in which the students are asked to write programming codes, share ideas, and put what they learn into practice as a pair together at one workstation in a Data Structure course.

C. Participants

This study recruits 90 sophomore college students from the Department of Information Management to participate in the pair programming experiment of this study. The participants with an information management, information technology, or information and electrical engineering measure are randomly selected from the two classes. The participants are paired based on their learning style preferences. The instructor assigns a programming-coding assignment to the participants, which should be completed in each pair programming activity. The participants are also required to complete the ARCS Motivation [10] Questionnaire before and after the experiment and the ILS [11] before the experiment. Table 1 shows the details of the pair programming experiment. The research objectives of this study are as follows.

1. This study investigates the participants' learning motivation before and after the pair programming experiment in the Data Structure course.
2. This study investigates the participants' learning outcomes after the pair programming experiment in the Data Structure course.
3. This study investigates that the effects of the roles that participants with different learning styles play in the pair programming experiment have on learning motivation.

TABLE I
The Details of the Pair Programming Experiment

	Experimental Activity	Time
Preparation	1st-3rd week: Learning about Data Structure in the first two classes and having a quiz in the third class	50 min./each class
Pre-test	4th week: Completing the pre-test (The ARCS Motivation Questionnaire and the Index of Learning Styles (ILS))	20 min. and 20 min.
Experimental Implementation	5th-7th week: Learning about Data Structure in the first two classes and performing the pair programming activities in	50 min./each class

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	the third class	
Post-test	8th week: Completing the post-test (The ARCS Motivation Questionnaire)	20 min.
Outcome	9th week: Midterm exam	50 min.

D. Measuring tools

The Felder-Soloman Index of learning style (ILS) was adopted from Felder and Silverman. Zywno [12] indicated that the reliability and validity were positively examined; in addition, test-retest reliability in four dimensions are .683, .679, .511, and .507, respectively. The reliability and construct validity are all supported. The learning style questionnaire for Felder-Silverman Model consists of four dimensions of learning preference. They are active or reflective, sensing or intuitive, visual or verbal, inductive or deductive, and sequential or global.

E. Activities Processing

The framework of this study is shown as Figure 1. The instructor is the coordinator and determines the specific topics of the Data Structure course for the participants in this experiment. This study investigates that the effects of different learning styles and achievement have on the students' learning motivation and retention. The participants are required to complete the ILS questionnaire before the experiment and then designated as the drivers or navigators based on their learning styles in the pair programming experiment. Active and reflective students in information processing are designated as the drivers and navigators, respectively, in the experimental groups of the pair programming experiment (Figure 2). The remaining participants are paired and designated as the drivers or navigators based on their academic performance in the control groups of the pair programming experiment. Then, the instructor lectures about coding topics related to data structure and encourages the participants to ask questions and provide feedback, which ensure that the students are fully comprehend the coding topics. The experimental and control groups have to complete the coding assignment in class.

F. Experimental design

The three topics of data structures in this study were the stack, the queue, and the binary tree. First, before the learning activity, the ARCS questions were distributed to students to examine their level of motivation. Then, the three learning activities were implemented within three weeks. In the fifth week, students were chosen to complete the questionnaire of motivation and to test their memory retention. Computer program annotation was taken to analyze the research findings and point out any possible limitations. In line with students' programming ability based on their achievement scores, the higher-level students were asked to work with the lower-level students in pairs.

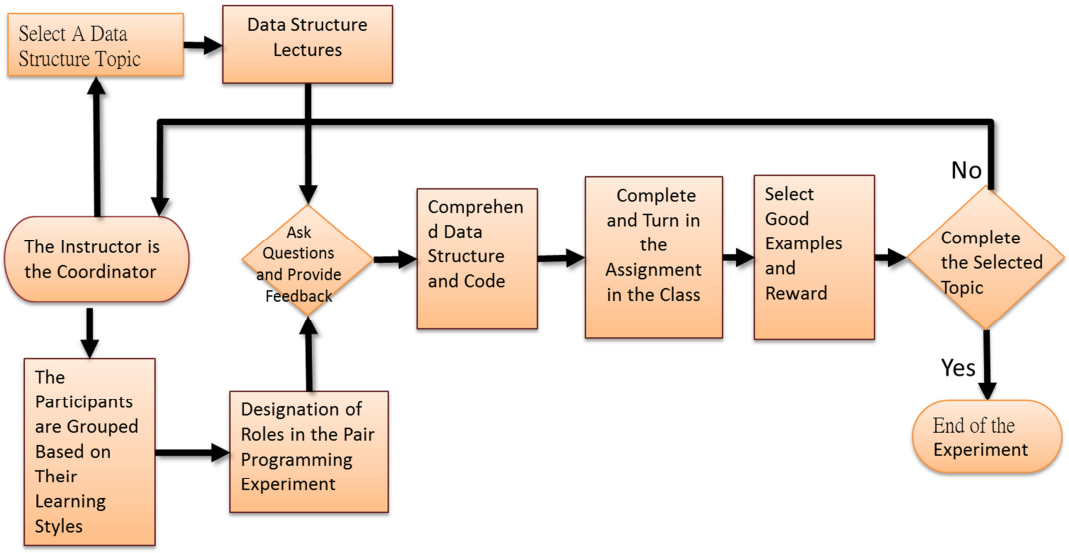

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Figure 1. The Framework of This Study

Figure 2. Pair Programming Activity

IV. Experimental Results and Analysis

The analysis results show that the participants' mean score on the learning motivation is 3.53 in the post-test, which is higher than that of 3.16 in the pre-test and indicates the increase of the participants' learning motivation in the experiment. In considering the four pillars of attention, relevance, confidence, and satisfaction (ARCS), the participants' mean scores on the four pillars all positively increase, especially on satisfaction with the highest mean score of 3.61 and P = <0.001, which indicates that the participants have positive feeling toward the pair programming experiment. The mean score on attention is 3.54 in the post-test with most of the increase in ARCS, which indicates that the participants can better apply what they have learned in class to writing programming codes.

TABLE II
T-test results of ARCS Motivation

	Attention		Relevance		Confidence		Satisfaction	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
pre-test	2.98	.629	3.29	.54	3.14	.62	3.24	.53
post-test	3.54	.702***	3.58	.69***	3.40	.74**	3.61	.56***

**p<0.01, ***p<.0001

In the study, active-type learning style of students were arranged as the drivers, while reflective-type ones as the observers. ARCS were conducted before and after the intervention. Three learning activities, stack, queue, and binary, were involved in the post test stage with paper-based annotation assessment.

The assessment results are shown in Table 3, in which main effect of learning style show significant difference (F = 8.053, p =0.006< 0.01), while main effect of role doesn't reach the significant difference (F = 0.508, p =0.478> 0.1). However, interactive effect between learning style and role reach significant difference (F = 4.476, p =0.038< 0.05), indicating that student with different learning styles could achieve different learning performance based on the different roles of pair programming activity.

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TABLE III
TWO-WAY ANOVA OF POSTTEST WITH LEARNING STYLE AND ROLE

Source	Type III Sum of squares	df	Mean Square	F	p
Learning style	751.025	1	751.025	8.053	.006
role	47.339	1	47.339	.508	.478
Learning style * role	417.474	1	417.474	4.476	.038
Error	6994.836	75	93.264		

V. CONCLUSIONS AND FUTURE WORKS

Many studies show that pair programming can improve students' learning performance and efficiency, such as less mistake, better design, and shorter codes [13-16]. Pair programming is one of the most successful evidence-based collaborative learning methods for programming related courses. However, the motivation issues of pair programming on computer science education studies, especially to data structure courses, are rare explored in the literature. This paper explores issues of student motivation in data structure courses by a pair programming activity with motivation questionnaires. The ARCS questionnaire was used to evaluate students' initial motivation on attention, relevance, confidence, and satisfaction dimensions.

According the results of Two-way ANOVA, the proposed intervention could increase students learning performance. The reflective-style students could have better learning achievement than active-style ones. From the view of role of learning activity, the reflective-style students are suitable to the role of observers because of better achievement, while the active-style students would decrease their performance. As the role of drivers, non-significant difference would occur between two learning styles of students in learning achievement.

The findings suggest that the effects of pair programming activities can be leveraged based on an understanding of students' motivation for and retention of learning. In the future, we will refine the grouping guidelines for pair programming to improve group-learning performance. Furthermore, we will investigate whether other learning styles could provide more precise predication for pair programming.

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