The Study of Heterogeneous Cooperative Learning towards Blended Learning Performance

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ABSTRACT

This study analyzed the effects of two heterogeneous cooperative groupings’ blended learning on programming design learning achievements and attitudes. To achieve the above objective, this study used a quasi-experimental design to conduct the experiment. Additionally, the research instruments used in this study included: Thinking Styles Inventory, cognitive style scale, programming design learning achievement scale, programming design learning attitude scale, and programming design blended learning teaching materials. The research subjects of this study are students from two classes of the first-year required programming design course within the information management department at a university of technology. The two classes were divided into experimental groups A and B. Experimental group A used academic achievement and thinking style grouping while experimental group B employed academic achievement and cognitive style grouping. The t-test, ANOVA and Hotelling's T² were used for statistical analysis. The results and concluding remarks are discussed.

Keywords: Heterogeneous Cooperative Learning, Thinking Style, Cognitive Style, Blended Learning, Programming Design

1. INTRODUCTION

The twenty-first century brings us a high-tech society with explosive information availability through Internet connectivity. The technological development rate has exceeded previous development speeds, surpassing human imagination; new technologies and techniques are constantly advancing. Therefore, in this information-based society, every citizen must have knowledge of and ability with information technology so as not to be drowned in the flood of information technology. Foreman [1] pointed out that programming design is for training essential computer knowledge and skills and also for understanding computer science. Accordingly, programming design is a relatively important computer competency. However, many research findings from European and American researchers have indicated programming design requires problem solving and analytical thinking skills. Unfortunately, many students of programming design courses lack these skills [2]. On the other hand, software development often requires coordinated efforts of multiple members of a team, so teamwork skills are important, such as communication, leadership, negotiation, and team management [3]. Accordingly, blended cooperative learning can be applied to programming design courses.

Sternberg [4] thought that numerous factors affect student performance. These factors can be divided into intelligence and non-intelligence categories. Intelligence test scores can only predict 20% of students’ grade differences in school. As for the non-intelligence factor, the question of how to match the application of personal style has become the key to learning success or failure. In previous research, there have been numerous discussions of learner style, including thinking style, cognitive style, and so on. Therefore, this study mainly focused on exploring the impact of heterogeneous cooperative sub-groups that were formed with different thinking styles and different cognitive styles on blended learning performances. Accordingly, the purpose of this study was to investigate the blended learning performances differences for programming design between “thinking style and academic achievement” within a heterogeneous cooperative group and “cognitive style and academic achievement” within a heterogeneous cooperative group.

2. LITERATURE REVIEW

Cooperative Learning

Cooperative learning is a teaching strategy or approach that places individual students into teams or groups; it is a teaching strategy that is oriented toward accomplishing the teaching goals by encouraging group members to solve problems through cooperation, co-exploration, and discussion; teachers walk among groups to assist and promote students and peers to collectively improve [5]. Accordingly, this study defines cooperative learning as: using heterogeneous grouping to divide students into two or more groups to conduct teaching activities; in order to achieve common goals, group members become cohesive as well as help, share, communicate, and discuss with each another during learning process so as to increase student learning performances and to develop the teaching strategy that encourages team cooperative spirit.

Thinking Style

“Thinking” is the process an individual employs when using existing knowledge and experience as a base, through information processing, to apply his/her intellectual capacity to explore and select when solving problems and exploring new knowledge [6].

“Style” is the group of habits based upon personal preference, that is, a person’s thinking attitude when looking at things. Style is not intellectual capacity but a method of using the intellect, and there is no good or bad style. Everyone has his/her own style and uses different styles for different situations [4]. Thinking style in this study references the score the subject student obtained on
Cognitive Style
Messick [7] defined cognitive style as information processing habit, which the typical personal as an individual demonstrates when exercising perception, thinking, problem solving, and memory functions. Cognitive style influences learners on the choosing, compiling, organizing storage, retrieving, interpreting, and generating information methods of learning effect [8]. Therefore, cognitive style is the habit and characteristic that is exhibited with explicit behavior after an inner process of perception, memory, thinking, and problem solving of an individual when facing a situation [9]. Wu [10] translated the cognitive style compiled and made by Messick into Chinese and then modified the Hidden Figure Test score to be used as the reference of heterogeneous cooperative learning grouping. The higher the score, the more field independent the subject’s cognitive style is, and vice versa.

Programming Design
Programming design is a task that involves creativity and logical thinking skills. Because it requires a wide variety of knowledge, traditional teaching methods cannot effectively help and guide students to come up with a solution to programming design related problems when encountered [11]. Therefore, programmers must use the programming design language set within the programming design software and apply their own logical thinking abilities and programming design skills to solve problems or accomplish tasks and goals. Simultaneously, students of programming should possess: ability to solidly understand programming design language description output/results, ability in programming design specifically oriented toward the specific problem, and ability to find, modify, and eliminate errors.

Blended Learning
Blended Learning is a learner-centered learning strategy, which enables learners to have increased choice and autonomy; learners can autonomously take advantage of digital learning’s strengths and characteristics prior to or after traditional face-to-face courses, in order to enhance learning performances [12]. In other words, this approach combines online learning and face-to-face learning and may become the mainstream teaching model [13].

Curtis et al. [14] proposed three broad hybrid cooperative learning definitions: 1. combination of teaching methods, 2. combination of teaching approaches; 3. combination of online and face-to-face teaching. Even so, Dziuban et al. [15] thought that blended cooperative learning can be considered a social opportunity that combines the effectiveness and the advanced technology of classroom and online learning environments. In other words, blended cooperative learning combines face-to-face teaching and digital learning and can obtain teaching goals more effectively than digital learning alone [16-17]. In addition, blended cooperative learning is a redesign of the basic teaching model and its teaching method is based on the assumption that it has the advantage of face-to-face interaction and also has the advantage of online learning methods [18].

3. METHOD
Research Design & Participants
This study attempted to investigate the impact of heterogeneous cooperative learning on blended learning performances. Blended learning includes online discussions and face-to-face discussions. This study analyzed the effects of the heterogeneous cooperative groupings’ blended learning on programming design learning achievements and attitudes. To achieve the above objective, after reviewing all related literature, this study choose students from a programming design class in a university of technology as the research subjects. This study used a quasi-experimental design to conduct the experiment. The research subjects of this study are students from two classes of the first-year required programming design course within the information management department at a university of technology. There are 92 students in these 2 classes.

Instruments
The research instruments used in this study included: Thinking Styles Inventory (TSI), cognitive style scale, programming design learning achievement scale, programming design learning attitude scale, and programming design blended learning teaching materials. The main purpose of the above scales was to gather the information and data that were related to this study while the programming design multimedia computer-assisted teaching material was used for blended learning.

Thinking Styles Inventory: In a study of TSI, R. J. Sternberg [4] noted the range of the internal validity of the TSI scale reliability was from .56 to .88, with a median of .78. Correlations greater than .50 in absolute value were global with local -.61, liberal with legislative .66, conservative with legislative -.50, conservative with executive .59, and liberal with conservative -.60. In this study, the Cronbach’s α value of the TSI is .86.

Cognitive style scale: In the study of Wu [10], the split-half reliability was .86, and the criterion validity was .51.

Learning achievement scale: After item analysis, the programming design learning achievement scale’s KR-20 value was .82, and the split-half reliability was .72.

Learning attitude scale: In this study, the Cronbach’s α value was .90, and the criterion validity was between .892 to .917.

Thus, all the measurement scales have highly consistency.

Research Procedure
Implementation of Grouping: We randomly picked one class to give TSI; the other one was given the cognitive style scale. Cognitive style heterogeneous grouping of the class was based on the subject’s cognitive style score (Hidden Figure Test) [10]; a subject with a higher score means his/her cognitive style is more field independent whereas a subject with a lower score denotes his/her cognitive style is more field dependent. After arranging cognitive style scores in descending order, we divided the subjects into two sub-groups: the top 50% was field independent group and the bottom 50% was field dependent group. After arranging entrance examination scores in descending order in both field independent and field dependent groups, the top 50% of the entrance examination scores is field independent with high entrance examination scores sub-group and field dependent with high entrance examination scores sub-group, respectively. In contrast, the bottom 50% of the entrance examination scores was field independent with low entrance examination scores sub-group and field dependent with low entrance examination scores sub-group, respectively. We then extracted one person from each above four groups to form a heterogeneous cooperative learning sub-
group (four persons per sub-group), thus grouping all participants to form experimental group A.

According to the score on TSI, developed by Sternberg [19], we undertook the thinking style heterogeneous grouping and then classified high entrance examination scores and low entrance examination scores students into global type and local type. Combining with the entrance examination scores, there were four sub-types of students: global and high entrance examination scores (25%), global and low entrance examination scores (25%), local and high entrance examination scores (25%), local and low entrance examination scores (25%), respectively. Next, we extracted one person from each above four groups to form a heterogeneous cooperative learning sub-group (four persons per sub-group), thus grouping all participants to form experimental group B.

Implementation of Experimental Teaching: After the administration of these tests, all students in both groups participated four hours a week of blended learning for six weeks. In order to ensure the internal and external experimental validities, both groups received blended heterogeneous cooperative learning using the same teaching material and content by the same instructor.

Implementation of Post-test: After the experimental teaching, all subjects received post-tests; the measurement scales used included: 1. programming design learning achievement scale, 2. programming design learning attitude scale. Post-tests were used to measure the programming design learning achievement and attitude.

Data Processing: We conducted statistical analysis on the data obtained from the post-test measurements to investigate programming design learning performances differences between the heterogeneous cooperative learning groups. For statistical analysis, SPSS 12.0 package was used. The significance level for the statistical results in the study was .05, and all the results were tested two ways. Hotelling's $T^2$ was run to compare the post tests scores,. ANOV A would be used if the Hotelling's $T^2$ value reaches the significance level.

4. DATA ANALYSIS

Data obtained after the experiment were used to statistically test hypotheses proposed by this research.

Basic Data Analysis of Samples
After removing the invalid sample who failed to participate all the way, experimental group A included 44 valid samples(11 heterogeneous cooperative learning subgroups) while experimental group B included 44 valid samples(11 heterogeneous cooperative learning subgroups), a total of 88 valid samples. Frequency distribution (N) and percentage (%) statistical methods were used to analyze valid samples’ data. Research results are as follows:

Gender: 59 participants were male, accounting for 67% of all subjects; 29 participants were female, accounting for 33%.

Enrollment background: 42 students’ belonged to the industrial track of vocational high school, which accounted for 47.7% of the all subjects. There were 29 students, accounted for 33.0% of the all subjects, whose backgrounds were business or management major, which are summarized into the business track of vocational high school; 17 students, accounted for 19.3% of the subjects, were from the background of general high school, which is classified as high school track.

Gender Analysis
In this study, Levene's test was used to test homogeneity on the programming design course learning achievement; Levene's test reached a statistically significant difference ($F = 5.880, p = 0.017$), accordingly, the variances of different genders were not homogeneous. Therefore, the degree of freedom of t-test required correction. On the contrary, Levene's test of homogeneity of variance for programming design course learning attitude did not reach statistical significance ($F = 0.286, p = 0.584$).

The result of t-test analysis shown that different genders did not have any significant differences on programming design course learning achievement ($t = 789, p = 432$) nor programming design learning attitude ($t = 981, p = 332$), as shown in Table 1.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Male Mean</th>
<th>Male SD</th>
<th>Female Mean</th>
<th>Female SD</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude</td>
<td>3.405</td>
<td>.437</td>
<td>3.327</td>
<td>.391</td>
<td>86</td>
<td>- .981</td>
<td>.332</td>
</tr>
</tbody>
</table>

*Degree of freedom after correction

Background Analysis
The Levene’s test was used to test the homogeneity, on programming design course learning achievement ($F = 1.855, p = 163$) and programming design course learning attitude ($F = 262, p = .770$) did not have any significant difference, which mean that there were homogeneous among different backgrounds.

In the ANOVA analysis, results indicated that students with different background did not have significant differences on both programming design course learning achievement ($F = 1.328, p = .271$) and programming design course learning attitude ($F = .570, p = .568$), as shown in Table 2.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Between-group SS</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achievement</td>
<td>151.862</td>
<td>2</td>
<td>75.931</td>
<td>1.328</td>
<td>.213</td>
<td>.013</td>
</tr>
<tr>
<td>Within-group</td>
<td>481.036</td>
<td>85</td>
<td>57.189</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>502.898</td>
<td>87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>.204</td>
<td>2</td>
<td>.102</td>
<td>.570</td>
<td>.508</td>
<td>.030</td>
</tr>
<tr>
<td>Within-group</td>
<td>15.241</td>
<td>85</td>
<td>179</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>15.446</td>
<td>87</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Programmed Design Learning Performance Analysis between group A and B
This study used Hotelling's $T^2$ to test learning attitude and achievement differences related to the programming design course between two heterogeneous cooperative learning groups.

Both programming design achievement post-test scores (Levene $F = 1.608, P = .208$) and programming design attitude post-test scores (Levene $F = .937$) did not reach a statistically significant level in Levene's homogeneity test and in the overall homogeneity test (Boxes $M = 1.989, p = .585$), which matched the assumption of homogeneity of variance.

In Table 3, the two heterogeneous cooperative learning group students had significant differences on post-test scores of the programming design learning performance (Hotelling's $T^2 = .422, F = 17.917, p = .000$).

Further more, ANOVA analysis indicated two heterogeneous cooperative learning group students had significant differences on the post-test scores of both programming design learning achievement ($F = 22.982, P = .000$) and attitude ($F = 12.835, P = .023$).
The mean and standard deviation of programming design learning achievement and attitude were shown in Table 4.

Table 4: Summary of programming design learning attitude and achievement post-test scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Samples</th>
<th>Achievement post-test scores</th>
<th>Attitude post-test scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>A</td>
<td>44 Students (11 Groups)</td>
<td>16.430</td>
<td>7.209</td>
</tr>
<tr>
<td>B</td>
<td>44 Students (11 Groups)</td>
<td>9.500</td>
<td>6.326</td>
</tr>
</tbody>
</table>

After comparing each group’s average, students in the thinking style and entrance examination scores group had higher post-test scores on programming design achievement and attitude than students in the cognitive style and entrance examination scores group.

5. CONCLUSION AND SUGGESTIONS

Conclusion
This study attempted to investigate the impact of programming design courses heterogeneous cooperative learning on blended learning performance among university of technology students. This study also examined the differences of student enrollment backgrounds and genders. Furthermore, to discuss the differences of “thinking styles with entrance examination scores” and “cognitive learning styles with entrance examination scores” on programming design learning performance. Findings indicated that backgrounds and genders had no differences on the programming design performance. However, the participants in the “thinking style with entrance examination scores” group had better programming design learning performance than the “cognitive style with entrance examination scores” group.

Suggestions
In the past two decades, numerous studies supported cooperative learning as a strong enhancer of learning performances and that cooperative learning is applicable to all academic years across various disciplines [05]. Slavin [20] stated that cooperative learning can enhance learning performances, improve interpersonal relationships among peers, and enhance students’ thinking, problem solving, integration, and application skills. Findings from cooperative learning relevant literatures indicate the heterogeneous cooperative learning grouping has the best learning performances. Accordingly, this paper suggests the implementations of cooperative learning should lead to adoption of heterogeneous cooperative grouping. However, there are many references regarding heterogeneous cooperative grouping, therefore, in this study, participants of the “thinking style and entrance examination scores” heterogeneous cooperative learning grouping have significant better learning performances than students of the “cognitive style and entrance examination scores” heterogeneous cooperative learning grouping. As a result, this study suggests that teachers use “thinking style and entrance examination scores” as the reference for heterogeneous cooperative learning grouping when using heterogeneous cooperative learning approach to teach, so as to significantly enhance learning performances.

6. ACKNOWLEDGEMENT

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7. REFERENCE
