Learning Effects of Blended Learning at Different Ratios With S-P Chart

Chien-Pen Chuang
Professor, Department of Industrial Education, National Taiwan Normal University
NTNUIE
Taipei, Taiwan
chuang@ntnu.edu.tw

Bin-Yong Zheng
Graduate, Department of Industrial Education, National Taiwan Normal University
NTNUIE
Taipei, Taiwan
zen4641@hotmail.com

Hui-Chuan Chien
Graduate, Department of Industrial Education, National Taiwan Normal University
NTNUIE
Taipei, Taiwan
ian_sun23@hotmail.com
Yi-Jeng Huang

Associate Research, Institute of Occupational Safety and Health, Council of Labor Affairs
Taipei, Taiwan
elitecko@gmail.com
Nien-Tzu Hsieh
Principal, Taipei Municipal ZhongLun High School
Taipei, Taiwan
nientzu5169@yahoo.com.tw

Abstract *:*

Thanks to computer technology, digital learning has evolved to the stage of mobile learning. However, in school courses, it is still necessary to teach face to face for humanistic teaching. As of yet, digital learning still plays a supplementary teaching role, but research on what ratio it should be in teaching activity has been lacking. This study attempts to discuss the best use percentage of traditional face-to-face teaching and digital learning by selecting two classes of the information department of a vocational high school, for a semester of experimental teaching. In order to discuss effects of different ratios of blended learning strategies and learning satisfaction, independent variables are defined to be 3:1, 2:1, and 1:1 for traditional class learning and digital learning in blended learning; and dependent variables are defined to be electronics learning effects and learning satisfaction. A nonequivalent pretest-posttest quasi-experiment approach was conducted. On the experimental group, a blended learning strategy of different ratios were adopted, including 3:1、2:1 and 1:1,

each ratio was adopted for a 6-week experiment. On the control group, a merely traditional face-to-face teaching approach was performed. At the same time, a S-P chart approach was used to carry out a statistical analysis to search for the best blended ratio. Results show that, compared with digital learning, traditional face to face teaching has the best effects at 2:1.

Keywords-component; *Blended Learning; Digital Learning; S-P Chart*

I. Research Motivation

Since computer-aided teaching emerged in the 1980s, by the development computer technology and the Internet, digital learning has become a new paradigm for teaching activity. Nevertheless, learners lack the dynamic for autonomous learning, the skill for time management, and the quality for interpersonal communication. Hence, digital learning remains a supplementary learning for cognition construction and fails to completely substitute physical classroom courses[1]. Besides, Relevant research believes that conventional face-to-face teaching is effective to cognition construction and that it makes immediate feedback between teacher and student possible to enhance the learning result[2]. For this reason, in 2000, some proposed a blended learning which combines traditional face-to-face learning with digital learning[3][4], which benefits promoting teaching results by combining advantages of both [5].

The learning field of blended learning includes “traditional physical classroom” and “digital learning”. Its teaching philosophy, subject content, and teaching media interacts with student’s maturity and learning hours. Though some studies discuss a blending of synchronous teaching and asynchronous teaching [6] [7] [8], a blending of cooperative learning and typical learning [8], a blending of physical courses and digital courses [9] [10] [11], even a blending of digital teaching media [12] [13] [14]. However, they place their focus mostly on learner’s learning progress [15] [16] [17] [18] [19], or on construction of digital platform [20] [21] [22]. Alternatively, some discus a blending of materials and delivery [5] [23] [24] . But no researchers turn their attention to a blended ratio of physical face-to-face teaching and digital teaching. This study attempts to discuss the optimal blended ratio to enhance learning results. And its experimental teaching aimed at students of the information department learning electronics at a vocational high school.

II. Literacy Review

I. BLENDED LEARNING RELEVANT THEORIES

Blended learning has been applied to the education field for years. In Taiwan, it was earliest applied by combining TV broadcasting with classroom face-to-face instruction by Open University and Open College [6]. With the convenience of the Internet, Relevant researches further indicated that blended learning is a natural evolution of digital learning [5] [25] [26]. The scholar defined blended learning to be an optimal learning goal [27]. By combining two or more different learning media, learning strategy and learning situation, this approach stimulates students to learn by ways which are most suitable to them.

II. S-P CHART ANALYSIS

S-P table was created by Japanese researcher Takahiro Sato in the 1970’s. It was designed to analyze attention coefficients of students’ answer and response patterns with questions (including students’ and questions’ attention coefficients), as well as the overall test’s difference coefficient and homogeneity coefficient.

These coefficients are used to assist teachers to diagnose students' performance and test results and serve as a reference for improving teaching, formulating test questions and giving guidance to students [28]. S-P table concerns item response patterns when students are taking a test, to serve as a test analysis approach for diagnose or determine if the response pattern is normal. Such approach is best for formative evaluation of classes with fewer students [29] [30]. With students' attention coefficient and score percentage, all students' learning statuses can be divided into six types. Besides, with questions' attention coefficient and percentage of students who gave right answers, all questions' qualities can be split into 4 types, shown in Figs. 1 & 2 [31] [32] .

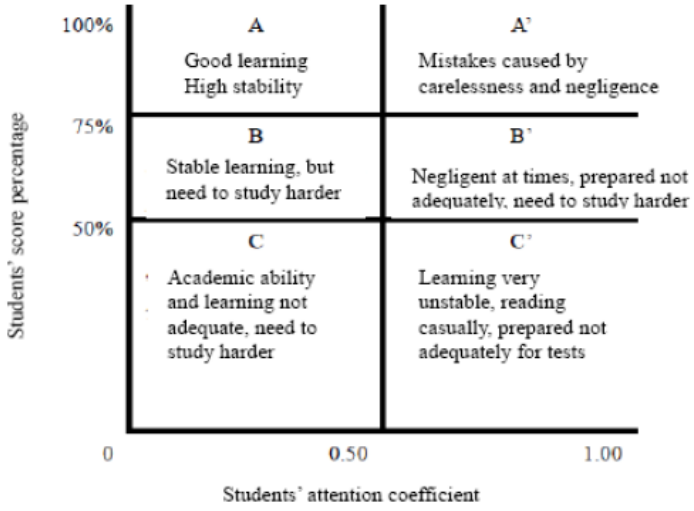

Figure 1. Students' attention coefficient and score percentage

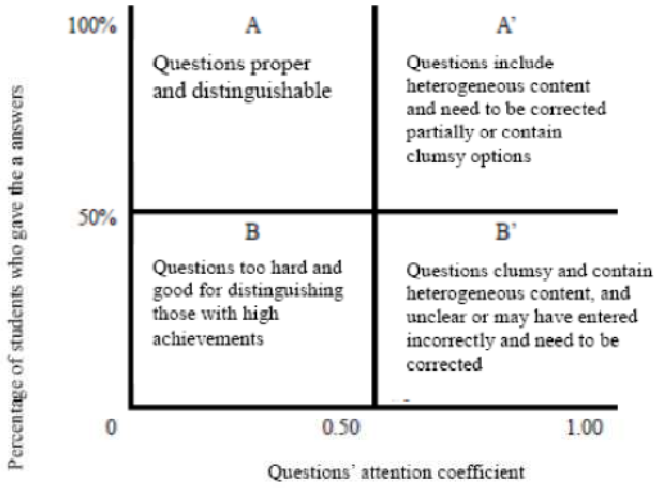

Figure 2. Questions' attention coefficient and percentage of students who gave the right answers

III. Research Method and Design

I. RESEARCH FRAMEWORK

In order to discuss effects of different ratios of blended learning strategies and learning satisfaction, independent variables are defined to be 3:1, 2:1, and 1:1 for traditional class learning and digital learning in blended learning; and dependent variables are defined to be electronics learning effects and learning satisfaction, as shown in Fig. 3.

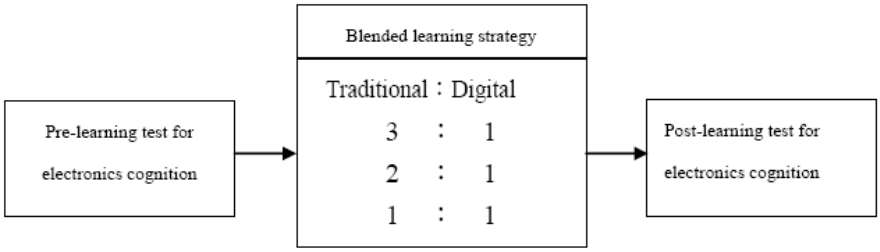

Figure 3. Research Framework

II. METHODOLOGY

This research adopted a nonequivalent pretest-posttest quasi-experiment approach. On the experimental group, a blended learning strategy of different ratios were adopted, including 3:1、2:1 and 1:1, of which each ratio was adopted for a 4-week experiment. On the control group, a merely traditional face-to-face teaching approach was performed. Each type conducted a pretest at the beginning to serve as a basis point of determination for comparison.

TABLE I. EXPERIMENT DESIGN

	Phase I			Phase II			Phase III		
Experimental group	O1	X	O2	O3	X	O4	O5	X	O6
Control group	O1		O2	O3		O4	O5		O6

O1: Electronics cognition pre-learning test I; O3: Electronics cognition pre-learning test II; O5: Electronics cognition pre-learning test III;
O2: Electronics cognition post-learning test I; O4: Electronics cognition post-learning test II; O6: Electronics cognition post-learning test III;
X1: 3:1 blended learning strategy; X2: 2:1 blended learning strategy; X3: 1:1 blended learning strategy

III. EXPERIMENT DESIGN

With different blended ratios of class learning and digital learning, on the 3:1 phase class learning session is 3, digital learning session 1. As a result, face-to-face instruction will be more. At 1:1, both will spend the same time. This study is purported to test the same learner's learning response through different phases and each phase did not use different samples for experiment. This study divides electronics content into 3 phases for teaching, which are described below:

A. Experiment I

Experiment lasted 6 weeks, blended ratio 3:1. Therefore, traditional classroom learning 15 sessions, digital learning 5 sessions. Besides, the Experiment I course included "Introduction to Fundamental Waves", "Intrinsic Semiconductor, P-type & N-type Semiconductors", "Diode Bias", "Diode Characteristic Curves", "Diode Equivalent Circuits", "Zener Diodes", "Light-Emitting Diode (LED)", "Rectifying Circuits", etc.

B. Experiment II

Experiment lasted 6 weeks, blended ratio 2:1. Therefore, traditional classroom learning 16 sessions, digital learning 8 sessions. Besides, the Experiment II course included "Filter Circuits", "Double Voltage Circuits", "Carrier Circuits", "Clamping Circuits", "Bipolar Transistors", "Transistor Amplification", "Transistor Switching Function", etc.

C. Experiment III

Experiment also lasted 6 weeks, blended ratio 1:1. Therefore, traditional classroom learning 12 sessions, digital learning 12 sessions. Besides, the Experiment III course included “DC-operating Point”, “Fixed Bias Circuits”, “Feedback Bias Circuits”, “Divider Bias Circuits”, “Transistor Amplifier Operating Principle”,

“Transistor AC Equivalent Circuits”, “Common Emitter Amplifier Circuits”, “Common Collector Amplifier Circuits”, “Common Base Amplifier Circuits”, etc..

IV. Data Analysis

I. ANALYSIS OF LEARNING EFFECTS AT DIFFERENT BLENDED RATIOS

This study discusses difference between blended learning and conventional learning under different ratios by comparison and analysis of learning effects with A+A' type . Table 2 shows that after the pretest of the Experimental Group, A+A' type accounted for 37.14%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 57.14%, an increase of 20%. And after the Control Group’s pre-test, A+A' type accounted for 19.35%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 19.35%, an increase of 0%. From the foregoing, comparing the Experimental Group and the Control in terms of learning effects and performance on electronics learning at the vocational high school, the former’s overall progress was higher than the latter’s. In other words, the Control Group’s enhancement of effects in traditional classroom learning did not outperform the Experimental Group which was formed by blended learning strategy. As a result, this study found blended learning strategy better than the traditional classroom learning strategy at 1:1..

TABLE II. A BRIEF COMPARISON OF BLENDED LEARNING AND TRADITIONAL LEARNING AT 3:1 IN TERMS OF EFFECTS

			A	A'	B	B'	C	C'	Total
Experimental (n = 35)	Pre	%	34.29%	2.86%	57.14%	2.86%	0.00%	2.86%	100%
	Post	%	45.71%	11.43%	31.43%	8.57%	2.86%	0.00%	100%
		Δ0	11.43%	8.57%	-25.71%	5.71%	2.86%	-2.86%	100%
Control (n =31)	Pre	%	12.90%	6.45%	22.58%	9.68%	35.48%	12.90%	100%
	Post	%	25.81%	12.90%	19.35%	25.81%	3.23%	12.90%	100%
		Δ0	12.90%	6.45%	-3.23%	16.13%	-32.26%	0.00%	100%

A: Excellent learning, high stability; A': good learning, but negligent; B: stable learning and medium or higher level; B': unstable learning; C: inadequate learning; C': abnormal learning

In addition, Table 3 suggests that, after the Experiment Group’s pre-test, A+A' type accounted for 8.57%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 62.86%, an increase of 54.29%. And after the Control Group’s pre-test, A+A' type accounted for 0%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 31.43%, an increase of 0%. From the foregoing, comparing the Experimental Group and the Control in terms of learning effects and performance on electronics learning at the vocational high school, the former’s overall progress was higher than the latter’s. In other words, the Control Group’s enhancement of effects in traditional classroom learning did not outperform the Experimental Group which was formed by blended learning strategy. As a result, this study found blended learning strategy better than the traditional classroom learning strategy at 1:1.

TABLE III. A BRIEF COMPARISON OF BLENDED LEARNING AND TRADITIONAL LEARNING AT 2:1 IN TERMS OF EFFECTS

			A	A'	B	B'	C	C'	Total
Experimental (n = 35)	Pre	%	5.71%	2.86%	20.00%	11.43%	42.86%	17.14%	100%
	Post	%	40.00%	22.86%	25.71%	8.57%	0.00%	2.86%	100%
		Δ0	34.29%	20.00%	5.71%	-2.86%	-42.86%	-14.29%	100%
Control (n =31)	Pre	%	0.00%	0.00%	11.43%	5.71%	48.57%	22.86%	100%
	Post	%	25.71%	5.71%	20.00%	17.14%	5.71%	14.29%	100%
		Δ0	25.71%	5.71%	8.57%	11.43%	-42.86%	-8.57%	100%

A: Excellent learning, high stability; A': good learning, but negligent; B: stable learning and medium or higher level; B': unstable learning; C: inadequate learning; C': abnormal learning

Table 4 suggests that, after the Experiment Group's pre-test, A+A' type accounted for 0%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 20%, an increase of 20%. And after the Control Group's pre-test, A+A' type accounted for 0%. After 4 weeks of teaching experiment and a post-test, A+A' type accounted for 20%, an increase of 0%. From the foregoing, comparing the Experimental Group and the Control in terms of learning effects and performance on electronics learning at the vocational high school, the former's overall progress was equivalent to the latter's. However, if Type B students were added, after the Experimental Group's pre-test, A+A'+B accounted for 2.86%, and after a post-test, 60%, an increase of 57.14%. And after the Control Group's pre-test, A+A'+B accounted for 2.86% overall, and after a post-test, 51.43%, an increase of 42.86%. This suggests that the Experimental Group reached a medium or higher level in terms of progress on electronics learning effects at the vocational high school, and was also higher than the Control Group. As a result, this study found blended learning strategy better than the traditional classroom learning strategy at 1:1.

TABLE IV. A BRIEF COMPARISON OF BLENDED LEARNING AND TRADITIONAL LEARNING AT 1:1 IN TERMS OF EFFECTS

			A	A'	B	B'	C	C'	Total
Experimental (n = 35)	Pre	%	0.00%	0.00%	2.86%	2.86%	65.71%	28.57%	100%
	Post	%	14.29%	5.71%	40.00%	11.43%	20.00%	8.57%	100%
		Δ0	14.29%	5.71%	37.14%	8.57%	-45.71%	-20.00%	100%
Control (n =31)	Pre	%	0.00%	0.00%	8.57%	17.14%	22.86%	40.00%	100%
	Post	%	17.14%	2.86%	31.43%	5.71%	8.57%	22.86%	100%
		Δ0	17.14%	2.86%	22.86%	-11.43%	-14.29%	-17.14%	100%

A: Good learning, high stability; A': good learning, but negligent; B: stable learning and medium or higher level; B': unstable learning; C: inadequate learning; C': abnormal learning

II. A COMPARISON OF EFFECTS OF BLENDED LEARNING MODELS AT DIFFERENT RATIOS

According Table 5, with A+A' as a basis point for comparison, 2:1 ratio was higher than 3:1 and 1:1 in terms of progress range, and the progress range was as high as 34.29%. On another hand, with A+A'+B as a basis point for comparison, 2:1 ratio was higher than 3:1, and 1;1 was also higher than 3:1. This suggests that traditional classroom learning and digital learning sessions are optimal at 2:1. In other words, a total of 24 sessions can be split to 16 for traditional classroom learning and 8 for digital learning. Furthermore, traditional classroom learning should avoid an excess in order to prevent learning fatigue or a gradual decrease of learning

motivation.

TABLE V. A BRIEF COMPARISON OF BLENDED LEARNING EFFECTS AT DIFFERENT RATIOS

Learning type	Ratio	Pre-test	Post-test	Progress
A+A'	3:1	37.14%	57.14%	20%
	2:1	8.57%	62.86%	54.29%
	1:1	0%	20%	20%
A+A'+B	3:1	94.29%	88.57%	-5.71%
	2:1	28.57%	88.57%	60%
	1:1	2.86%	60%	57.14%

A: Good learning, high stability; A': good learning, but negligent; B: stable learning and medium or higher level

V. Abbreviations and Acronyms

I. CONCLUSION

A. Blended learning strategy better than traditional classroom learning

This study found that different blended learning strategies, including traditional classroom and digital learning at 3:1, 2:1, and 1:1, were all better than traditional learning in terms of learning effects. This shows that, in addition to enhancing learning results, blended learning strategy also allows learners a considerable degree of self-regular learning. Learners may explore by themselves over their perplexities to make an in-depth learning.

B. Classroom learning and digital learning at 2:1

Classroom learning and digital learning at 2:1 – optimal blended ratio learning strategy. Besides, this study found that, when traditional classroom learning and digital learning were at different blended ratios, 2:1 was best for learning effects, followed by 1:1 and 3:1. This shows that the best blended learning should be traditional face-to-face learning, complemented by digital learning.

II. FUTURE STUDY

Future research may evaluate effects of different blended learning ratios over non-intelligence related factors such as learning style, prior knowledge, etc. by different learners. This will allow us to understand what effects - a mediator or a moderator - these factors - play at different blended learning ratios.

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