

# Effects of Blended Class on "History of Computers" with Peer Assessment for an Assignment to Introduce a Historical Character

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Abstract: In the class of learning the "History of Computers", slides were distributed to students as written materials, and lectures were given according to the slides. At the end of the lesson, students were requested to describe the flow of history and a mini-examination then was conducted. As an assignment, students investigated a historical character in computer history and made a presentation slides to introduce it in the form of a report. E-learning that allows lecture-slide learning was made available so that students were able to perform preparation and review in addition to the lesson. Students were requested to browse and mutually evaluate their assignment in a PowerPoint. Additionally, students who scored highly in the evaluation were requested to give a presentation for the characters they investigated. At that time, the other students were requested to describe points to improve the reports whose presentation were made. In these manner, blended learning was performed by introducing numerous interactions among students. At the beginning and end of this lesson, the degree of term recognition and consciousness learned during the lesson were checked. It was identified that the students' amount of knowledge was increased and that awareness was improved. This paper reports these findings.

**Key words:** history of computers, recognition degree of terms, consciousness related to ability, blended learning, peer assessment

# **1. Introduction**

At present, blended learning has been promoted primarily in higher education institutions (Bonk et al., 2006; Miyaji, 2009a; Miyaji, 2009b; Miyaji, 2011; Mochizuki et al., 2003; Thorne, 2003). It is possible to support many and various student learning styles and to deepen understanding by using more than one media (Adachi K., 2007; Bersin, 2004). As one specific measure for securing and improving the quality of higher education in the new era, the Central Education Council recommended that the following approaches would be investigated after information and communication technology is introduced aggressively in line with the objectives of educational research, education method is improved and teaching design is made adequately (Ministry of Education, Culture, Sports, Science and Technology, 2008). They recommend remote education using e-learning, promotion of prior learning and post learning using a learning management system, and introduction of blended learning.

For the realization of those objectives, the author has been conducting blended learning for introduction to computer science. It has been reported that lessons in which media such as lecture notes, e-learning, and mini-examinations are fused together are effective (Miyaji et al., 2005). Reportedly, introduction of a

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questionnaire about the degree of understanding, which increases interactions with a teacher, was able to boost effectiveness (Miyaji et al., 2007).

Takeshita et al. (2008) showed that different effects of synchronous type e-learning depend on the groups of learners who are classified according to learning status and that learners with an increased number of interactions tend to achieve higher scores. Toda et al. (2006) reported that the satisfaction level and motivation are increased by setting group sessions and increasing interaction in the training of teachers where learners themselves play a leading role in mutual discussion.

This paper deals with the lesson of "History of computers" performed by blended learning in which several media including e-learning are combined to increase interactions. E-learning was made available, reports presented were mutually evaluated, and students were requested to correct it based on the evaluation and perform mutual evaluation again. Furthermore, student representatives were requested to give a presentation of the report. Other students evaluated them. The lesson was modified to increase interactions as described above. Effective lessons were deployed to identify increases in knowledge amount and the degree of consciousness improvement. Although the subjects that were explained above were contents of science, "History of computers" is a subject of liberal arts. A purpose of this paper is to clarify the following: A blended lesson is effective for the subject of liberal arts; Giving presentation about a report brings any kinds of effect.

#### 2. Teaching Design and Lesson Contents

As blended learning, a 90 min lesson was performed seven times for "History of computers", an optional course for the Department of Information Science, University A. To improve this lesson, the media to be used were added and practiced. Table 1 shows the teaching design and lecture plan. A final examination was held after the lesson for motivating learning and for checking the level of understanding. In all, 49 students participated.

	Lesson									e-learning					
week	Lesson contents	No. of slides used in the lecture	Materials distributed	Mini-examination	Explanation of answers for mini examination	Questions of course of history	Explanatory sheet for lecture plan and method	Survey of recognition degree of terms	Consciousness research	Presentation	Report of historical character	Evaluation sheet	Learning using lecture slides	Access to answers for mini examination	
1	History of calculation and calculating machine	16	Chapter 1	Mini- exam 1		Question 1	Distribution	Before	Before			Consciousness (before)			
2	History of computer	17	Chapter 2	Mini- exam 2	Mini- exam 1	Question 2							Chapter 1	Mini- exam 1	
3	History of microprocessors	21	Chapter 2	Mini- exam 3	Mini- exam 2	Question 3					Submission	Self-evaluatio n	Chapter 2	Mini- exam 2	
4	History of personal computers	20	Chapter 4	Mini- exam 4	Mini- exam 3	Question 4							Chapter 3	Mini- exam 3	
5	History of software	24	Chapter 5	Mini- exam 5	Mini- exam 4	Question 5						Mutual evaluation	Chapter 4	Mini- exam 4	
6	Presentation of historical characters				Mini- exam 5					Peer assessment		Evaluation by others	Chapter 5	Mini- exam 5	
7	History of networks	23	Chapter 6		Mini- exam 6	Question 6		After	After		Re-submission	Mutual evaluation			
8	Final examination											Consciousness (after)	Chapter 6	Mini- exam 6	

 Table 1
 Teaching Design and Lecture Plan of History of Computers

#### 2.1 Objective and Target of Lesson

The purpose of this lesson is to review the path by which human beings have progressed to escape from cumbersome calculations and to ascertain the greatness of modern computers. If the steps of development of computer-related technology are known, we can learn the orientation of information related technologies. We intend to acquire data for creation of new information-related technology by looking into the past. In addition, we will foster thinking ability and problem-solving ability through the activities provided in this lecture.

As the objective, students will understand the path that modern computers have taken so far and reconfirm information related technologies used at present, which students have already learned. If technologies developed in the past are positioned from a historical viewpoint, then each of the technologies might be evaluated.

#### 2.2 Teaching Design

The teaching design shown in Table 1 is explained. In the first week of the lesson, an explanatory sheet is distributed to explain the lecture plan. The degree of term recognition and consciousness are surveyed in advance. Contents of the lecture are distributed with each lesson as the data and the lecture are given using lecture slides. Following this, a mini-exam was carried out and then a flow of history was described. After the lesson, students can browse the lecture slides using e-learning.

Students are requested to investigate a historical character related to computers and to submit a report summarizing their investigation in the form of PowerPoint slides by the third week. Using the e-learning function, students are requested to browse them after the lesson before the fifth week, to perform mutual evaluation and to present an evaluation sheet inputting evaluation results in the form of an Excel file. The teacher gathered and sorted these evaluations together as evaluation by others for each student. Then the teacher registers them to enable downloading. Referring to these evaluations, students are requested to correct the reports introducing historical characters and to resubmit them by the seventh week. Five representatives of the students will give a presentation at the sixth week. At the seventh week, surveys assessing the degrees of term recognition and consciousness are conducted.

#### 2.3 Deployment of Lesson

For deployment of the lesson, answers for previous mini examinations are explained and comments on student's questions and impressions of the lecture are given. Next, slide materials with blanks into which important matters of the lecture slide on that day should be filled are distributed. The lecture lasts for about 65 min while lecture slides are projected on the screen. At the end of the lecture, historical characters related to lecture contents are introduced as an episode. At the end of the lesson, a mini-examination, including one to four questions that are presumed to be points of the lecture, is given for about 10 min. Students are permitted to refer to textbooks and materials to solve these questions. The last question of the mini-examination is intended to check the level of understanding and to elicit students' impressions in about 10 min. Finally, students are requested to describe the flow of the history lectured on that day including two to four designated keywords within 200 characters in a manuscript format (20 characters x 11 lines) in about 10 min.

#### 2.4 Contents of Assignment

As the assignment of this lesson, students were requested to draft a report to introduce a historical character. As the format of the report, students downloaded a PowerPoint file, filled in their contents after finding out things about the character, and then submitted it. Contents consist of the following eight items:

(1) Name of person in whom a student is interested

- (2) History of the person from birth to death
- (3) Matters related to that person in terms of computer history
- (4) Reasons why a student became interested in that person

- (5) Achievements of that person recognized in computer history
- (6) Influences of achievements of that person in computer history on other matters
- (7) Items which deepened understanding in computer history
- (8) References cited

Reports thus submitted were stored in Web format and registered in the server. As one function of e-learning, all students become accessible to browse reports. Using e-learning functions, students downloaded an Excel file for an evaluation sheet and made evaluations. After mutual evaluations, students uploaded the sheet. Their evaluations were sorted out individually and were registered as the "Evaluation summary" file. This file is accessible by e-learning.

In addition, during the sixth week, five students who received high evaluations were requested to give a presentation to introduce the person whom they investigated uniquely. At that time, they evaluated the same items as those assessed in peer evaluation. They were asked "To improve the report which the student presented, how would you correct it?" for each item. They replied in the right column next to each question item.

By the seventh week, students were requested to correct the report and resubmit it. They can browse it after the teacher registered it. Then they performed mutual evaluations again. Contents of the lecture were deepened or expanded by introducing report modification/correction activity as described above. Consequently, much mutual interaction took place among students.

#### 3. Analysis Results and Discussion

For terms related to the lesson, the degree of recognition was surveyed before and after the lesson to ascertain changes in the amount of knowledge. Students entered the degree of consciousness related to the capability in the evaluation sheet before and after the lesson to ascertain changes in consciousness. After the lesson, students also entered activities presumed to be helpful for improving consciousness to ascertain activities that are helpful for consciousness improvement.

In the following description, a significant difference is considered when it is recognized by significance level of 5% as results of significant difference test. Symbols m, SD, t and p respectively denote the mean, standard deviation, t-value, and significance probability.

#### 3.1 Changes in Recognition Level of Terms Related to the Lesson

For 50 terms related to contents of the current lesson shown in Table 2, the survey of recognition degree (Miyaji et al., 2007) was performed twice before (first week) and after (7th week) the lecture. 50 terms regarded as important were selected from terms that appeared in the lecture. However, a "proxy server" was added for checking purposes.

The degrees of recognition of terms are classified into three: 1. I do not know; 2. I do not know details, but I have heard it; and 3. I know. Averages ( $m_{pre}$ ,  $m_{post}$ ) of the recognition degree of terms before and after the lecture were (1.9, 2.5). The number of students who responded twice before and after the lecture was 34.

For the recognition degree of all 50 terms before and after the lecture, a Wilcoxon rank-sum test was performed. Results are shown in the lowermost level of Table 2. A significant difference was found, as shown in the bottom line. Results show that the recognition level of terms had increased after the lecture, meaning that the amount of knowledge increased overall.

For the degree of recognition of each term before and after the lecture, a Wilcoxon rank-sum test was performed. Results show that a significant difference was recognized for 41 terms among 50 terms between before and after the lecture. It was noticed from this that the amount of knowledge increased for these terms.

Consequently, a significant difference was recognized for almost all terms.

Terms for which no significant difference was recognized were the six terms of network, database, personal computer, proxy server, television game, and USB. Of those, [proxy server] was not a term explained in the lesson. This term was embedded intentionally to ascertain whether the respondent replied without any actual reflection on the course. Therefore, the recognition degree of this term should not change. The result showed no significant difference. The remaining five terms were well known before the lecture. The recognition level was high before the lecture. The values did not increase greatly, showing nearly equal values before and after the lecture.

Students accessed the reports and performed peer evaluations. All evaluations thus made were reviewed. The reports were corrected according to browse peer reports and to peer assessment. Then students were requested to submit the report again. In addition, five students who received high evaluations in peer assessment were requested to give a presentation, and performed question and answer sessions to increase their interactions. Results show that it was recognized to increase knowledge for almost all terms.

#### 3.2 Changes in Rating Scale Values of Attitude Related to Capability

For the 30 items of consciousness related to capability shown in Table 3, a prior survey was made initially in the first lesson. A post survey was made at the end of the seventh lecture (Miyaji et al., 2009). The rating scale includes the following nine levels: 1. Has none, 3. Has slightly, 5. Has a little, 7. Has considerably, 9. Has greatly. The number of students who responded twice before and after the lecture were 49.

For all 30 items, the average rating scale value before and after the lecture was (3.8, 4.5). For all 30 items, significant difference was noticed with results of the paired t-test of prior and post rating scale value. Results show that consciousness related to the capability was improved overall.

Rating scale values before and after the lecture for every item of consciousness related to the capability were subjected to a t-test. Results of the test are shown in Table 3. Significant improvement was recognized for the following 17 items: (7) Deepening of understanding of learned knowledge, (27) Capability of composing knowledge and creating knowledge, (13) Capability of expressing own thought other than in sentences, (12) Capability to express one's own thought by sentences, (15) Presentation capability, (17) Communication capability, (18) Capability to self-evaluate properly what figured out by oneself, (21) Capability to pursue things thoroughly, (9) Information collection capability, (11) Information analysis capability, (8) Capability to study independently, (28) Capability to think independently, (22) Capability to perform, and (23) Capability to co-operate. Furthermore, as for items related to computers, it is recognized that significant improvement was made for (2) Understanding of computers, (3) Computer operating skill, and (4) Computer utilization method and expansion of scene. In addition, a significant trend was recognized for items (14), (19), (20), (24), and (29). From these findings, in an activity where a student was requested to write a report introducing a historical person and to evaluate it, many items result in higher consciousness related to the capability because many interactions are given.

One objective of the present lecture is "To foster thinking ability and problem-solving ability through various activities involved in the present lecture". A significant difference was recognized for the evaluation item "(28) Thinking ability", which corresponds to this object. It might be said that "Thinking ability" was improved.

Another objective of the lecture is to improve problem-solving ability. 17 items (more than half) in Table 3 will be improved. Although evaluation item "(26) Problem-solving capability" itself was not improved, much consciousness supporting the problem-solving ability was improved. Therefore, it might be said that such consciousness related to the problem-solving ability has been improved.

Table 2         Results of Wilcoxon Rank-Sum Test of Recognition Degree of Terms									
N.	Trans	Before			ter	Wilcoxon			
NO.	Terms	m	SD	m	SD	z	р		
5	Wind up calculator	1.4	0.5	2.4	0.6	4.9	***		
15	Time-sharing system	1.4	0.6	2.3	0.6	4.7	***		
1	Mechanization of four arithmetic operations	1.8	0.7	2.5	0.5	4.7	***		
14	Family thought	1.2	0.5	2.1	0.6	4.7	***		
4	Development of electronic technology	1.6	0.6	2.5	0.5	4.6	***		
7	Analytical engine	1.3	0.5	2.2	0.6	4.6	***		
3	Automation of calculation procedures	1.6	0.6	2.3	0.6	4.5	***		
6	Statistic machine	1.3	0.6	2.3	0.6	4.5	***		
40	ALGOL	1.4	0.5	2.2	0.6	4.4	***		
39	FORTRAN	1.7	0.7	2.5	0.6	4.4	***		
46	ARPANET	1.7	0.8	2.7	0.5	4.4	***		
26	Moore's Law	1.1	0.4	1.8	0.6	4.4	***		
42	Pascal	1.5	0.5	2.2	0.6	4.3	***		
21	8-bit CPUi8008	1.6	0.5	2.3	0.6	4.1	***		
22	16-bit CPUi8086	1.6	0.5	2.3	0.6	4.1	***		
12	Program built-in type	1.7	0.7	2.4	0.7	4.1	***		
23	32-bit CPU 80386DX	1.6	0.5	2.3	0.6	4.1	***		
16	On-line real-time system	1.5	0.6	2.4	0.7	4.1	***		
17	Decentralized processing system	1.8	0.7	2.5	0.6	4.0	***		
36	Cybernetics	1.3	0.5	2.0	0.6	3.9	***		
41	COBOL	1.7	0.6	2.4	0.6	3.9	***		
18	Down-sizing	1.8	0.8	2.3	0.6	3.8	***		
25	MIPS	1.8	0.7	2.5	0.6	3.7	***		
32	Handy personal computer	1.7	0.7	2.4	0.7	3.7	***		
20	4-bit CPUi4004	1.8	0.7	2.4	0.6	3.6	***		
43	Operating system	2.3	0.6	2.7	0.5	3.5	***		
8	Vacuum tube	2.1	0.8	2.6	0.6	3.4	***		
2	Encoding of information	2.1	0.7	2.6	0.5	3.3	***		
30	Mechatronics	1.6	0.6	2.1	0.7	3.3	***		
24	Operation clock	1.9	0.8	2.4	0.7	3.2	***		
11	ENIAC	1.5	0.8	2.0	0.6	3.2	**		
34	Dedicated Japanese word processor	1.9	0.8	2.6	0.6	3.1	**		
10	IC	2.3	0.7	2.7	0.6	3.1	**		
38	BASIC language	2.1	0.6	2.5	0.6	3.0	**		
31	OA	1.7	0.7	2.1	0.7	2.8	**		
9	Transistor	2.2	0.6	2.6	0.6	2.7	**		
13	Binary notation	2.6	0.7	2.8	0.5	2.5	*		
19	Microprocessor	2.1	0.7	2.4	0.7	2.5	*		
35	Software for Japanese word processor	2.2	0.8	2.7	0.6	2.4	*		
47	Internet	2.7	0.5	2.9	0.3	2.1	*		
48	WWW	2.6	0.7	2.8	0.4	2.1	*		
49	Browser	2.6	0.7	2.8	0.4	1.9	+		
37	Programming language	2.6	0.6	2.8	0.4	1.9	+		
33	Spreadsheet software	2.6	0.6	2.8	0.4	1.7	+		
45	Network	2.7	0.6	2.9	0.4	1.6			
44	Database	2.6	0.6	2.8	0.4	1.5			
28	Personal computer	2.8	0.4	2.9	0.3	0.7			
50	Proxy server	2.0	0.8	2.1	0.5	0.4			
29	Television game	2.8	0.5	2.8	0.4	0.4			
27	USB	2.8	0.5	2.8	0.4	0.3			
Average			0.3	2.5	0.4	5.0	***		

# Effects of Blended Class on "History of Computers" with Peer Assessment for an Assignment to Introduce a Historical Character

Average \*\*\* p < .001, \*\* p < .01, \*p < .05,+p < .1

Effects of Blended Class on "Hi	story of Computers"	with Peer Asse	ssment for an A	Assignment to
	Introduce a Historica	al Character		

Tuble of Tests of Significant Difference of Consciousness related to Capability										
Consciousness related to conshility	Befor	re	After		t-test					
Consciousness related to capability	m	SD	m	SD	t	р				
(7) Deepening of understanding of learned knowledge	3.6	1.3	4.6	1.4	3.3	***				
(13) Capability of expressing own thought other than in sentences	3.1	1.5	4.0	1.2	2.7	**				
(15) Presentation capability	3.0	1.6	4.0	1.5	2.5	*				
(4) Computer utilization method and expansion of scene	3.8	1.7	4.8	1.5	2.4	*				
(27) Capability of composing knowledge and creating knowledge	3.7	1.5	4.5	1.5	2.4	*				
(17) Communication capability	3.7	1.3	4.6	1.6	2.3	*				
(28) Capability to think independently	3.8	1.6	4.7	1.7	2.3	*				
(2) Understanding of computers	3.9	1.3	4.6	1.3	2.2	*				
(3) Computer operating skill	4.0	1.3	4.8	1.5	2.2	*				
(9) Information collection capability and investigation capability	4.0	1.4	4.8	1.7	2.2	*				
(8) Capability to study and learn indepently	3.7	1.3	4.5	1.5	2.2	*				
(22) Capability to perform practice and execute	3.8	1.5	4.5	1.3	2.1	*				
(18) Capability to self-evaluate properly what is figured out by oneself	3.7	1.6	4.4	1.5	2.1	*				
(23) Capability to co-operate and to learn concertedly	3.7	1.5	4.5	1.7	2.0	*				
(12) Capability to express one's own thought by sentences	3.5	1.7	4.3	1.5	2.0	*				
(21) Capability to pursue things thoroughly and spirit of inquire	3.7	1.5	4.3	1.3	2.0	*				
(11) Information analysis capability	3.8	1.5	4.5	1.4	2.0	*				
(29) Creativity and capability to create	3.5	1.6	4.3	1.5	1.9	+				
(14) Capability to talk to and explain to others comprehensively	3.2	1.7	3.9	1.5	1.8	+				
(24) Sense of fulfillment and satisfaction	3.9	1.6	4.6	1.6	1.8	+				
(19) Capability to evaluate properly what has been figured out by others	3.7	1.5	4.4	1.5	1.7	+				
(20) Capability to correct and improve what has been figured out by oneself	3.8	1.5	4.3	1.4	1.7	+				
(10) Capability to sort out and sum up information and data	4.0	1.4	4.6	1.8	1.6					
(25) Sense of accomplishment and sense of achievement	4.1	1.7	4.6	1.6	1.3					
(5) Capability to set a theme and problem finding capability	3.6	1.3	4.1	1.3	1.3					
(6) Capability to plan and to project things	3.7	1.5	4.2	1.5	1.3					
(16) Capability to listen to others and to raise questions to others	3.8	1.6	4.3	1.8	1.2					
(1) Interest and concern with computers	5.3	1.5	5.7	1.7	1.2					
(30) Interest and concern with this field	4.6	1.4	5.0	1.8	1.2					
(26) Problem-solving capability	4.1	1.4	4.4	1.7	0.9					
Average	3.8	1.1	4.5	1.1	2.6	**				

Tabla 3	Tosts of Significant	Difference of	Consciousness	Dolotod to	Conchility
Table 5	Tests of Significant	Difference of	Consciousness	Related to	Capability

\*\*\*p < .001, \*\* p < .01, \* p < .05, + p < .1

#### 3.3 Activities that are Helpful for Improvement of Capabilities

When students replied the rating value about attitude of 30 items at the post survey, they were required to enter the activities which were useful for improvement of each attitude among 37 activities at the right of the column where the degree of attitude was entered. The number of activities enumerated was 1,614. 36 students responded. Therefore, the average number of activities enumerated per person was 44.8.

The cross table was created with activity as a column, with the consciousness as a row. Activities that were enumerated by many students were "1. to listen to the lecture (450), 19. to complete the report (168), 17. to

prepare the report (162), 13. to review the lesson (111), and 32. to study for the final examination (81)". The numbers in parentheses show the number of enumerated activities. These results show that requesting the students to survey the historical person and to prepare a report for introduction of the person are greatly helpful for improving the degree of terms recognition and consciousness.

## 3.4 Cluster Analysis for Awareness Related to Ability and Activities Useful for Improving It

The activities useful for improving the attitude related to abilities were totaled by making a  $30 \times 37$  cross table. In the following, the numbers with a parenthesis express the number of attitude, and Arabic figures express the number of activity.

As many cells in the table had less frequency than five and the number of activities per cell was 1.4 on average, we cannot conduct  $\chi^2$  test if nothing is done. Then it was considered to take some cells in similar attitude and similar activities respectively. First, the cluster analysis was conducted about the cross table using Ward's method with the activity as a variable, with the attitude as a case. As a result, the attitude was classified into next four groups I to IV. The group I consists of the attitude (1), (2), (4), (7) and (30). These numbers are the attitude shown in Table 3. As the number of activities enumerated for these attitudes is much over average number, it was referred to as "attitude related to the computer". In the same way, the group II consists of the attitude (3), (18), (19), (20), (24) and (25). Because all these are enumerated by similar extent to average number, it was referred to as "attitude related to evaluation, correction and satisfaction". The group III consists of the attitude (16), (17) and (23). Since activities enumerated for these attitudes are similar extent to average number, it was referred to as "attitude related to ability to listen, talk and collaborate". The group IV consists of the attitude (5), (6), (8), (9), (10)-(15), (21), (22), and (26)-(29). Since the number of activities enumerated for any attitude is around the average number, it was referred to as "attitude related to as "attitude related to learning, clarifying and investigating".

Secondly, the cluster analysis was conducted about the cross table using Ward's method with attitude as a variable, with the activity as a case. As a result, the activities were classified into next four groups 1 to 4. The group 1 only consists of activity "1. to hear a lecture". It was referred to as "activities to hear a lesson". The number enumerated about this activity is 450. The group 2 consists of only activity "17. to write the report for which a person is examined and introduced". From this it was referred to as "activities to write a report". The number enumerated about this activity is 162. The group 3 consists of the following five activities: 5, 8, 10, 16 and 19. Since activities of "5. to answer to a quiz", "10. to learn using documents distributed", "16. to arrange intelligibly what was investigated", and "19. to complete a report" were enumerated about these activities is 285. The group 4 consists of the rest thirty activities: 2-4, 6, 7, 9, 11-15, 18, 20-37. Since activities of "2. to ask a friend about lecture contents", "4. to learn with lecture slide", "13. to review", "21. to read peer reports", "25. to correct a report", and "32. to study for final exam" were enumerated much, it was referred to as "activities to learn by review, exam, lecture slides, reports, etc." The number enumerated about these activities to learn by review, exam, lecture slides, reports, etc." The number enumerated about these activities is 717.

#### 3.5 Activity Useful for Improving the Attitude Related to Ability

The frequency in cells is added up for every cluster about attitude and an activity. Results are shown in left of Table 4. Each expected frequency of cell in Table 4 was more than 15 and no cell has less frequency than five. Therefore, this table was considered to be analyzed as  $4\times4$  contingency table. The  $\chi^2$  test was conducted for this table. As a result, the frequency deflection was recognized ( $\chi^2$  (9) = 80.3, p < .001). Therefore, a result of residual analysis is shown in the lower left of Table 4. Significant deflection with positive residual is shown by a \* mark in

the cell of the lower right of Table 4. Activities useful for improving the attitude are explained by significant cells with greater frequency in the following.

The activity group, "1. Activities to hear a lesson", is significantly useful for improving the attitude group, "I. Attitude related to the computer". The activity groups, "2. Activities to write a report" and "3. Activities to complete a report and learn by documents", are significantly useful for improving the attitude group, "IV. Attitude related to learning, clarifying and investigating". The activity group, "4. Activities to learn by review, exam, lecture slides, reports, etc.", is significantly useful for improving the attitude groups, "II. Attitude related to evaluation, correction and satisfaction" and "III. Attitude related to ability to listen, talk and collaborate."

The finding that all of 37 activities were helpful in improving any attitude of the 30 items was obtained from the cross-tabulation of attitudes and activities. It is suggested that a series of activities, such as taking a class, examining about a person on history of computer, writing a report about it, carrying out peer evaluation, answering to a quiz and studying for final exam, fostered thinking ability and problem-solving ability in this lecture.

Clusters of activities and attitude	Observ	ved frequ	uency		Expected frequency				
	1. Activities to listen a lesson	2. Activities to write a report	3. Activities to complete a report and learn by documents	<ol> <li>Activities to learn by review, exam, lecture, slides, reports, etc.</li> </ol>	Total	1. Activities to listen a lesson	2. Activities to write a report	3. Activities to complete a report and learn by documents	<ol> <li>Activities to learn by review, exam, lecture, slides, reports, etc.</li> </ol>
I. Attitude related to the computer	124	19	46	112	301	83.9	30.2	53.2	133.7
II. Attitude related to evaluation, correction and satisfaction	75	22	51	163	311	86.7	31.2	54.9	138.2
III. Attitude related to ability to listen, talk and collaborate	42	5	12	90	149	41.5	15.0	26.3	66.2
IV. Attitude related to learning, clarifying and investigating	209	116	176	352	853	237.8	85.6	150.6	378.9
Total	450	162	285	717	1614	450.0	162.0	285.0	717.0
	Adjusted residual					Significance probability			
I. Attitude related to the computer	5.7	-2.4	-1.2	-2.8		***			
II. Attitude related to evaluation, correction and satisfaction	-1.6	-1.9	-0.6	3.2					**
III. Attitude related to ability to listen, talk and collaborate	0.1	-2.8	-3.2	4.1					***
IV. Attitude related to learning, clarifying and investigating	-3.2	5.0	3.3	-2.7	]		***	***	

Table 4  $\chi^2$  Test and Residual Analysis About the Cluster of Attitude and Activity

\*\*\* p < .001, \*\* p < .01

# 4. Conclusions

For the lesson of "History of computers", lecture slides were distributed. Then a lecture was given using these slides, a mini-examination was held at the end, and students were requested to describe the flow of the history of computers. As the theme of this lesson, students were requested to study a historical character and to submit a report describing this person in the form. Then a student browses and rates it mutually. The e-learning

system was designed so that a student was able to study using lecture slides. Students were able to prepare and review repeatedly the slide materials outside classroom. Additionally, five students who scored highly in peer evaluations were requested to give a presentation of the person they studied.

Practices of such blended learning revealed the following items:

(1) A survey of recognition degree of terms identified that the amount of knowledge increased as a whole. An increase in the amount of knowledge was recognized for almost all terms.

(2) A survey of consciousness related to the capability revealed that consciousness was improved overall. Consciousness of 17 items in 30 items was raised.

(3) As for activities helpful for improvement of the capability, activities related to "listening to the lecture" and "preparing the report" are particularly helpful for improvement of consciousness related to the capability.

(4) The activity group, "Activity to hear a lesson", is useful for improving the attitude group "Attitude related to the computer". The activity groups, "Activities to write a report" and "Activities to complete a report and learn by documents", is useful for improving the attitude group, "Attitude related to learning, clarifying and investigating". The activity group, "Activities to learn by review, exam, lecture slides, reports, etc.", is useful for improving the attitude groups, "Attitude related to ability to listen, talk and collaborate".

We intend, in the future, to use media with our ingenuity and to study the role of each medium for improvement of the effects so that everyone can understand the history of computers through lessons, introduction to historical character, mutual evaluation, and correction and improvement of the report and can be able to explain the history of computers to other persons.

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