

Characteristic of Three Kinds of Blended Classes Categorized Using Awareness and Activities

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Abstract For last 10 years or so, we have been practicing class session through incorporation of “blended learning”. Such class sessions are generally divided into 3 types which are lecture, exercise and experiment. We have been examining utilized media, change in awareness related to ability, useful activities, etc. for such classes. We will be taking up 10 subjects among such classes and will compare the utilized media in the class by comparing the class development. For 30 items that have common awareness, we will conduct significance test and will compare the difference between the subjects. By using the average rating score of pre/post survey of such awareness, its elongation, and the number of activities, we will conduct principle component analysis, and will conduct cluster analysis by using principle component score, and will examine the cause of difference by categorizing the subject. Correlation analysis is conducted using principal component scores to find relation between three kinds of principal component scores. The results of these analysis indicate the following findings. Awareness improves in the order of group “experiment type class”, “exercise type class”, and “lecture type class.” Awareness of “experimental type class” gave indication of greater elongation than that of “exercise type class” and “lecture type class”. Awareness of subjects improves mostly in order of Group “experimental type class”, “exercise type class”, and “lecture type class”. As the experience oriented activity time gets longer, the improvement in awareness is increased.

Keywords: *blended class, class type, class development, utilized media, change of awareness, principal component analysis, cluster analysis*

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1. Introduction

At present, by placing higher education institution at the center, “blended learning” is being implemented for the sake of making classes more effective, efficient and attractive [1,3]. It has been reported that implementation method of “Blended Learning” is incorporated for the training sessions in the corporate world [2]. The author is moving forward with university education that will nurture problem solving ability with incorporation of making things by hand and rating activities [5]. As the support for the lecture, a proposal has been made to increase study opportunities for various students, and to be able to correspond to individual students so that they can prepare/review at “anytime and anywhere” [3].

As a part of such proposal, the author conducted a “blended class” that combined to take a lecture, to use lecture sorting notes distributed, to have mini tests, and to learn by e-learning (learning based on lecture slides and exercise problems, mutual learning and rating of materials drawn up by students) [7]. After conducting a survey analysis on lecture method, change in awareness, term recognition, useful activities etc., the author made a report which concluded such activities to be effective [8,10,12,13,17].

On the basis of these outcomes, by targeting elementary school, middle school, high school, university, professional school, corporations, etc., a book on “blended learning” called “From e-learning to blended learning” was edited and published through gathering the procedure of efficient, effective, and attractive blended class, and the effect of practice in such class [7]. We compared utilized media and change of awareness related to ability among 10 blended classes [25]. It reported that with respect to all of the subjects including general awareness and awareness related to subjects, significant improvement is shown on average rating score for all of awareness items.

In this paper, by using information related to awareness, 10 subjects that were set up as a class design and were put into practice will be categorized into 3 class type groups. We will identify the characteristic of class type group of categorized subjects by using the awareness elongation, utilized media and required time for such media.

2. Research Purpose

In order to find out the kind of difference concerning the effect of utilized media and its implementation method that exist among the subject of blended class implemented at information related department in University A, we will compare class method, utilized media, the result of

awareness survey conducted before/afterwards, and activities that are useful for awareness improvement that was surveyed afterwards. We will identify the kind of difference that exists between the learning effect of each type when categorizing subjects into lecture type class, exercise type class, and experiment type class.

3. Class Type

The class will be generally divided into lecture type class, exercise type class, and experiment type class. The lecture type class is held in a class room setting where an instructor faces the students, and since such class is often held by partially combining exercise, etc., it is regarded as a lesson form with emphasis on assembly style learning.

The exercise type class is a type of class which enables students to gain deeper understanding on their learned materials by first making them solve problems/topics and afterwards provide them with answers and commentary for such materials. It is a lesson form that combines individual learning as main and assembly style learning as secondary.

The goal of information science related experiment type class is to verify the theory and basic principle of information science, to promote permanent understanding of knowledge, to master basic operational skill of experiment, and to nurture strict and steady work attitude. It is a lesson form that experientially enables students to learn basic programming, algorithm, and computer operation skill through actually operating the computer. This is a lesson form with emphasis on individual learning with eventual submission of report.

4. Comparison Method

When making general division of surveyed question items, they are divided into general awareness and awareness related to subject. As the example of rating items of awareness survey that was conducted, rating items of Subject G are shown on Table 1. At the beginning and end of the class for each subject, we have asked students to respond to the rating item of Table 1. Through significant test, we will compare just what kind of difference exists between the changes in general awareness that students have responded. We will also compare to see if there is difference between the numbers of activities that are useful in improving awareness through significant test.

By using 4 types of data that are related to awareness, we will obtain the principal component score and will compare 10 subjects by using the score. We will separate utilized media into 5 levels based on its frequent use. We will conduct principal component analysis by using its levels. Next, we will conduct the principal component analysis by using awareness

In addition, we will conduct the principal component analysis by using the activity time of 8 types of media for each subject. Three kinds of principal component scores will be obtained. Finally, we will make a comparison of 10 subjects by using three types of the principal component scores.

By obtaining the correlation coefficient of the principal component scores of these 3 types, we will compare the characteristics of the class type group.

Table 1. Example of rating items of awareness survey for Subject G

Kind	Awareness toward abilities
General awareness	(1) Interest in and curiosity about computers
	(2) Understanding of computers
	(3) Computer operation skills
	(4) Computer usage methods and broadening of situations
	(5) Ability to set challenges, ability to discover problems
	(6) Ability to plan, to do things in a planned manner
	(7) Cultivation of understanding of knowledge learned
	(8) Ability to study by oneself, ability to learn
	(9) Ability to gather information, ability to conduct research
	(10) Ability to sort through related information or data
	(11) Ability to analyse information
	(12) Ability to express thoughts in writing
	(13) Ability to express thoughts through media other than writing
	(14) Ability to talk to and explain to others comprehensively
	(15) Ability to make presentations
	(16) Ability to listen to others and to ask questions to others
	(17) Communication ability
	(18) Ability to appropriately self-evaluate one's thoughts
	(19) Ability to appropriately evaluate other people's thoughts
	(20) Ability to correct and improve on one's own thoughts
	(21) Ability to pursue matters deeply, ability to explore matters
	(22) Ability to execute, ability to practice, ability to put into action
	(23) Ability to cooperate and to learn concertedly
	(24) Sense of accomplishment, sense of satisfaction
	(25) Sense of fulfilment, sense of achievement
	(26) Ability to solve problems
	(27) Ability to construct and create knowledge
	(28) Ability to think, consider and come up with ideas by oneself
	(29) Creativity/ability to create
	(30) Interest in and curiosity about this field
Awareness related to subject	(31) Interest in e-learning
	(32) Knowledge regarding e-learning
	(33) Knowledge regarding the kind of e-learning
	(34) Knowledge regarding the system of e-learning
	(35) Knowledge regarding the structure of e-learning
	(36) Knowledge regarding how to utilize e-learning
	(37) Interest in the blended class
	(38) Knowledge regarding the blended class
	(39) Knowledge regarding the design of the blended class
	(40) Knowledge regarding the class plan of the blended class
	(41) Knowledge about the class development of the blended class
	(42) Knowledge regarding how to utilize media
	(43) Knowledge regarding how to make distribution document
	(44) Knowledge regarding how to write the report of the problem

5. Utilized Media of Subjects

We will make a comparison on media that was utilized for 10 subjects of information related course at University

A. Lecture type classes are 5 subjects of A to E subjects, exercise type classes are 3 subjects of F to H subjects, and experiment type class are 2 subjects consisting of subject I and J.

Table 2. Media used in each subject

Kind	Class Type Media name	Lecture					Exercise		Experiment		
		A	B	C	D	G	F	H	E	I	J
Lecture	Answer slide of small test	4	4	4	4	0	0	0	0	0	0
	Answer slide of exercises	0	0	0	0	0	4	3	0	0	0
	Lecture by the slide	4	4	4	4	4	4	4	4	4	4
	Document which commented on class content	0	0	4	0	0	4	0	0	3	3
	Textbook	4	4	0	4	4	0	4	4	0	0
	Experiment book	0	0	0	0	0	0	0	0	2	2
	An exercise program and problems	0	0	0	0	4	0	0	0	0	0
	Peer evaluations of the work	0	0	0	0	0	0	0	0	3	3
	Document which explains on the challenge to address voluntarily	0	0	0	0	2	0	0	0	0	0
	Peer evaluations on the voluntary challenge program	0	0	0	0	2	0	0	0	0	0
	Form for term recognition survey	2	2	2	2	2	2	2	2	2	2
	Form for attitude survey	2	2	2	2	2	2	2	2	2	2
	Form for exercises	4	4	0	0	0	4	4	0	0	0
	Form to describe a flow of the history	0	0	4	0	0	0	0	0	0	0
	Small test	4	4	4	4	0	0	0	0	0	0
	Notebook to arrange lecture contents	3	3	0	3	0	0	0	0	0	0
	Document which explains a lecture plan and a method	1	1	1	1	1	1	1	1	1	1
	Document which explains challenges to comment on a term	1	1	0	0	0	0	0	0	0	0
	Document which explains to introduce the historical person	0	0	1	0	0	0	0	0	0	0
	Document which explains the design method of the class of information studies	0	0	0	1	0	0	0	1	0	0
	Form to design the class of information studies	0	0	0	4	0	0	0	3	0	0
	Form to answer calculation problems	0	0	0	0	0	4	0	0	0	0
	Question vote	0	0	0	0	0	4	0	0	0	0
Clicker	0	0	0	0	0	4	0	0	0	0	
Image scanner	0	0	0	0	0	0	0	0	0	4	
PC	1	0	0	0	4	0	4	3	4	4	
Elearning	Learning by the slide	4	4	4	4	4	4	4	4	4	4
	Learning by the exercise	4	4	4	4	0	4	4	4	0	0
	Browsing of answer slide of small test	4	4	4	4	0	0	0	0	0	0
	Browsing of report which comments on a term	2	2	0	0	0	0	0	0	0	0
	Browsing of the report	0	0	0	3	0	0	0	3	0	0
	Browsing of report which introduces the historical person	0	0	2	0	0	0	0	0	0	0
	Evaluation sheet	3	3	3	3	3	3	3	3	3	3
	Example program	0	0	0	0	3	0	0	0	0	0
	Frame of report which comments on a term	1	1	0	0	0	0	0	0	0	0
	Frame of report	1	1	0	1	1	1	1	1	1	1
	Frame of report which introduces the historical person	0	0	1	0	0	0	0	0	0	0
	Frame for the design method of the class of information studies	0	0	0	1	0	0	0	1	0	0
	Notebook to arrange lecture contents	3	3	0	3	0	0	0	0	0	0
	Question email	4	4	4	4	4	4	4	4	4	4
	Bulletin board	4	4	4	4	4	4	4	4	4	4
Principal component scores that are provided using frequency of the media	1.25	1.31	0.54	1.25	-0.81	-0.58	-0.38	-0.28	-1.11	-1.20	

4: "used almost every week", 3: "used 4 to 5 times", 2: "used twice", 1: "used once", and 0: "no use"

We have categorized the frequency of media utilized during class or outside of class into 5 levels and show it on Table 2. The 5 levels 4, 3, 2, 1 and 0 on Table 2 show

that each of them is "almost used every week", "used 4 to 5 times that amounts to roughly 1/3", "used twice", "used once", and "no use" respectively.

6. Typical Class Development of Each Class Type

Class methods, change of term recognition and change of the attitude have been already reported for eight of ten subjects analyzed. Contents of subject A, C, E, F, G, H, I, and J are reported in papers ([4,6]), ([13,17]), ([11,14,15]), ([16,19]), ([20,21,23]), ([18,22,24]), [5], and [12] respectively. In the following, a class development example of one subject is explained in each class type.

6.1. Development Example of Class A in the Lecture Type

The class subject that was the target of our research was an Introduction to Computer in the first semester of the first year in the Department of Information Science at a university. The class was conducted 15 times with each class being 90 minutes long. A midterm and a final examination were conducted in the 7th and 15th week in order to motivate learning and confirm the understanding.

The outside the classroom blended class will be explained in the following [4,6]. 89 students participated. We distributed a structured notebook which consists of about 100 questions within 26 pages. Students were recommended to use it for preparation and review. Students were given a lecture by projecting slides onto a screen in the classroom for about 80 minutes. A small test which consists of 2 to 5 questions was conducted while allowing the students to see a textbook for about 10 minutes at the end of the class. The questions asked about points from the lecture.

Students were required to bring the structured notebook each time they come to class. They write answers in it to establish the class's contents. A teacher went around the desks while the students were writing and responded to their questions. In some cases a method of thinking for how to solve problems were explained on the blackboard.

E-learning has functions of learning via lecture slides and exercises. This can be used for preparation and review before and after a class. As Introduction to Computer is a special subject and involves a lot of technical terms, there are a lot of students who find it difficult to understand the contents in only one lecture. At the students' convenience, lecture slides can be repeatedly seen as many times as necessary to improve their understanding. Individual learning is conducted by using such e-learning methods. Students were required to solve problems using e-learning mainly in the classes one week prior to having examinations in order to encourage learning through problem solving. It is our goal that all the students acquire subject content by such means.

A student was required to make learning material for explaining technical terms in a few pages which is a part of subject contents in order to utilize the knowledge learned concerning the subject contents at the end of the course. Document including an example of the learning material was distributed and how to make it was explained. The report sheets were registered after submission. Students saw and rated them mutually. Then, they corrected and improved the learning material by referring to the evaluations and teacher's advice. We hope that the activities further deepen the understanding and broaden the lecture contents. These activities encouraged interaction among the students.

After completing the e-learning, students were required to input their learning situation, evaluation value of the learning contents, and degrees of abilities and attitude into an evaluation sheet, and submit the file. We told the students to include all submission materials in their personal records to create motivation for learning.

6.2. Development Example of Class H in the Exercise Type Class

Content of subject H is Operations Research (OR) and exercise type class. OR is a mathematical model for decision-making. Many mathematical models are proposed. The goal of this class is to explain these techniques, to actually practice these techniques after the lecture, to cultivate understanding and to be useful in problem solving in society [22,24]. In addition, through various activities in these lectures, the ability to think and solve problems is cultivated.

The aims of this class are to understand the selected mathematical models in OR and the algorithms of these techniques so that students can solve the problems according to these algorithms.

In the first week, class plan explanations were distributed and class planning was explained. After that, an initial survey of term recognition and awareness was conducted. Based on the textbook, the goals, problem definition and solution method for the example were explained for Chapter 4 Transportation. Next, practice sheets were distributed and students were asked to solve the practice problems referring to the explanation of the solution method for the example. At that time, students were given advice to browse the e-learning lecture slides and refer to them. During practice, the teacher went around the classroom and accepted a question. Students were observed helping each other. Those who came up with the answers were asked to submit their practice sheets. Those who did not come up with the answers were asked to bring their completed practice sheets to the teacher's office before the next class.

The next week, the answers to the practice problems were given. After that, sheets were handed back to those who had made mistakes in the answers or the calculations. Next, challenge sheets were distributed and students were asked to solve the problems. At that time, the students were advised to browse the e-learning lecture slides and refer to them. Those who came up with the answers were asked to submit their challenge sheets. Those who did not come up with the answers during class were asked to bring their completed challenge sheets to the professor's office by the next class.

In the 3rd week, the goals, problem definition and solution method for the example were explained for Chapter 5 Allocation. Next, the students were asked to solve practice problems in the same way as for Chapter 4 and submit them. In the 4th week, the students were asked to solve challenge problems in the same way as for Chapter 4 and submit them. In this way, the class got through one chapter every 2 weeks.

The submission of practice and challenge problems was repeated until the answer was correct. If a problem sheet was to be given back, mistakes on the sheet were marked with a colored pencil. There were some students who took a long time to get the right answers even though they were

able to browse e-learning documents after the answers were explained in class. In the end, 7 practice and challenge problems were completed in 15 weeks. Post surveys of term recognition and awareness were taken in the 15th week.

Students were asked to fill in the goals, problem definition and discussion for each chapter after downloading framework files and were asked to submit these two reports in the 8th and the 14th weeks.

6.3. Development Example of Class J in the Experiment Type Class

The target subject is called an information science experiment, consisting of three hours per week as one of the compulsory subjects in the second semester at the department of information science in a university. The content which the author was in charge of was "creating digital storytelling" [12]. Students are separated into three groups. Each group creates the storytelling for four weeks. Each class session was 180 minutes long, and the class proceeded according to the plan. The themes of each group are different as follows; three theme are "self-understanding", "a children's story", and "a future course". Each group carried out the class by four weeks. The first, second and third groups created each theme of storytelling from 1 to 4, from 5 to 8, and from 9 to 12 weeks respectively. The class was conducted by a teacher and a teaching assistant. After explaining the activity contents of the day at the beginning of each class, the teachers walked around the classroom and responded to questions as needed. The number of students attending a lesson was 63 persons in total. These of three groups are 21, 22 and 20 persons respectively.

One of the purposes of this class is to heighten students' literacy in computer and self-expression through creative activities. The literacy in computer means that the PC can be smoothly operated using functions of Word, Excel, PowerPoint and so on.

Self-understanding and self-analysis are important when searching for jobs. Another purpose is to deepen self-understanding and a meaning to work through creating a storytelling on the assigned theme.

The teacher gathered together three groups for a class some days ago. Then he distributed an experiment description document (A4 paper, 31 pages) to the students and explained the outline of class method. Based on the experiment description document, the teacher explained the experiment's purpose, contents, plan, slide creation method, experimental method, and related details. He distributed one A4 sheet to the students. Six pictures and the narrative stories could be entered using both sides of the sheet. Students were assigned to write a story on the right-hand page and to draw a related picture within the square frame on the left-hand page before the first session. The illustration and character for an animation are drawn outside of the square frame. The students were instructed to paint handwritten picture with colored pencils.

The students were instructed to download the story slide of the "My course in the future" as an example for their assignment.

The teacher explained how to animate slides in the first session. They subsequently scanned the images of their sheet with an image scanner. Then they imported the images to Paint software, which were installed as part of

Windows XP Microsoft suite of files. The students cut the images on Paint software and pasted them on slides with PowerPoint. The teacher instructed a student who completes the work and has room at time so as to attach an animation using a function of PowerPoint.

At the beginning of the second session, the teacher explained how to write reports. They were required to enter the final image works into PowerPoint to create their slides. They attached an animation to illustrations and characters for deeper understanding for their stories. Students then recorded their storytelling narrations using a microphone while viewing their slide show after their works were completed. At the end of the second session, the students required to submit the file of the storytelling slide. Students themselves rated their works on an evaluation sheet after completing the works.

At the start of the third session, the teacher printed and distributed a peer evaluation sheet and a handout in which all works by the students were printed. The slide shows of all members in the class were sequentially projected on the screen and viewed. Then they were required to evaluate them for one minute. After the students evaluated each story, the evaluations were entered into the peer evaluation sheet. After viewing all the story slide shows, the students entered the rating value and comment to spreadsheet in Excel, and the files were submitted using the Internet. The teacher gathered and summarized the evaluations in each student's file, then gave each student access to an e-learning portal so that they could download the peer evaluations. The teacher also pointed out the points that should be revised in the printed work and distributed instructor feedback to each student. The students were then required to modify their digital stories and slides by referring to the peer evaluations and the instructor feedback provided. Students performed the second self-assessments after modification in the third session. After the correction, they submitted the file of the story slide.

The modified story slides were viewed again in the same manner as during the third session, and then evaluated once again in the fourth session. The second peer evaluation was entered into an assessment spreadsheet, and the files were also submitted.

The teacher gathered and summarized the evaluations in each student's file, then gave each student access to an e-learning portal in the same manner as in the third session. Students then pasted the second peer assessment for themselves on an assessment spreadsheet. By comparing the first and second evaluations, students could learn from and interpret the appropriateness of the corrected elements. Students performed the third self-assessments after the final evaluation in the fourth session.

The report was divided it into three times. Students were asked to submit reports on previous day of the third, fourth and fifth session. The submitted report was pointed out a correction point and returned on the next day.

7. Analysis Result and Observation

7.1. t Test for Rating Score of Ability and Awareness

To find out about modification in awareness, ability related awareness survey was conducted through the

holding of information related class session. Concerning the ability and awareness that showed signs of improvement due to class session, 2 surveys were taken, once before and once after the class attendance. The rating score for such survey was divided into the following 9 levels: (1. Non-existence, 3. Very small existence, 5. Small existence, 7. Large existence, and 9. Very large existence). The result will be explained by analyzing such survey data of 10 subjects through significant test.

The number of students who submitted both before/after survey of 10 subjects is between 18 and 79 people as shown on Table 3. With respect to the general awareness of 30 items, we have conducted a “t test” that corresponded to difference between rating score before

and after survey in rating item shown on Table 1 of each subject’s ability and awareness survey. “t-test” results for individual subject are shown on Table 3. The row of Table 3 consists of class type, subject name, number of rating items, number of respondents, number of items that had significant difference, number of items that had tendency for significant difference, ratio (%) of items recognized for significant difference, ratio (%) of items with tendency for significant difference, average of difference in rating score. The classification of the subject in Table 3 is based on the result in Section 7.3. The column consists of 5 subjects A to D and G of lecture type, 2 subjects F and H of exercise type, and 3 subjects E, I and J of experiment type.

Table 3. Comparison of the results of significant difference test for awareness related to ability

Class type			Lecture					Exercise		Experiment			
Kind	Statistic	Subject name	A	B	C	D	G	F	H	E	I	J	
		Grade	1	2	2	3	2	2	3	3	3	3	
		No. of respondents	79	43	39	18	27	31	22	25	87	30	
General awareness	No. of items that awareness improved	Significant difference	25	3	15	9	5	27	5	28	30	30	
		Tendency for significant difference	2	3	6	4	4	2	4	1	0	0	
	Ratio of number (%)	Significant difference	83.3	10.0	50.0	30.0	16.7	90.0	16.7	93.3	100.0	100.0	
		Tendency for significant difference	6.7	10.0	20.0	13.3	13.3	6.7	13.3	3.3	0.0	0.0	
		Total	90.0	20.0	70.0	43.3	30.0	96.7	30.0	96.7	100.0	100.0	
	Mean	Pre-awareness	4.07	4.80	3.80	4.72	4.51	4.72	4.84	3.93	4.06	4.00	
		Post-awareness	4.84	4.91	4.47	5.31	4.89	5.43	5.18	5.29	5.80	5.63	
		Elongation	0.77	0.11	0.67	0.59	0.38	0.70	0.35	1.36	1.74	1.62	
		Standard deviation	2.07	1.78	2.18	1.62	2.19	1.30	1.52	1.72	1.36	1.40	
		Singnificance probability	***	*	***	***	***	***	***	***	***	***	***
		Maximum elongation	1.63	0.86	1.09	1.83	1.20	1.25	2.00	2.16	2.34	2.19	
		Minimum elongation	-0.43	-0.35	0.35	-0.06	-1.09	0.46	-0.50	0.20	1.24	1.18	
	Awareness related to subject	No. of items that awareness improved	Significant difference	4	4	-	12	14	3	4	-	-	-
			Tendency for significant difference	0	0	-	0	4	0	0	-	-	-
Ratio of number (%)		Significant difference	80.0	80.0	-	85.7	56.0	75.0	80.0	-	-	-	
		Tendency for significant difference	0.0	0.0	-	0.0	16.0	0.0	0.0	-	-	-	
		Total	80.0	80.0	-	85.7	72.0	75.0	80.0	-	-	-	
Mean		Pre-awareness	3.06	3.97	-	4.16	3.90	4.27	3.37	-	-	-	
		Post-awareness	4.89	4.83	-	5.41	4.91	5.43	5.04	-	-	-	
		Elongation	1.83	0.87	-	1.25	1.01	1.16	1.70	-	-	-	
		Standard deviation	2.28	2.21	-	1.67	2.43	1.34	2.08	-	-	-	
		Singnificance probability	***	***	-	***	***	***	***	-	-	-	
		Maximum elongation	2.48	1.26	-	1.94	2.65	1.54	2.00	-	-	-	
		Minimum elongation	0.24	-0.33	-	0.50	-0.66	0.29	0.91	-	-	-	
No. of activities per a student		Mean	1.71	1.11	1.38	1.42	1.52	2.21	2.34	1.78	2.44	2.23	
		Standard deviation	0.25	0.15	0.11	0.27	0.17	0.55	0.39	0.27	0.36	0.27	
Principal compornent score			-0.29	-1.41	-0.57	-0.52	-0.88	0.16	-0.30	0.67	1.71	1.44	

*** p<.001, * p<.05.

In Table 3, the average ratio of the number of rating items recognized for significant difference were approximately 58%, and the average rate of the number of items with tendency toward significant difference were approximately 4%. Based on this, an increase in ability and awareness on approximately 58% of the items is recognized.

For the exercise type class, the average ratio of the number of rating items recognized for significant difference between pre and post rating score of ability and awareness was approximately 41%, while the average rate of the number of items with tendency toward significant difference was 13%. Based on this, an increase in ability

and awareness on approximately 41% of the items is recognized.

Significant difference has been recognized for all 30 rating items for the experiment type class. Based on this, an increase in ability and awareness on all of the items, in other words 100% of the items is recognized.

As the result of conducting significant test on general awareness, it divided into subjects that showed significant increase for over 70% of items within lecture type and exercise type, and subjects with significant increase for less than 43% of items. By corresponding to such separation, 10 subjects are divided into large subject and small subject for the elongation of awareness.

On the other hand, 6 subjects were surveyed for awareness related to subjects. All such subjects showed increase in more than 72% of the items. General awareness has significantly increased for every subject, and awareness related to subject has also shown significant increase.

7.2. Results of Principal Component Analysis for Rating Score of Awareness and the Number of Activities

For each subject, we will use 124 (=4 x 31) information about each average rating score and overall average rating score for pre and post of 30 items of ability and awareness survey, average elongation of 31 items, and average number of activities useful for improvement of 31 awareness items. For the following, 124 information is called "4 types of data".

In order to identify what kind of characteristics are found in individual subject group, principal component analysis was conducted through the use of variance-covariance matrix method. The factor loadings for principal component 1 and 2 were 51.5% and 22.5%, respectively. The cumulative factor loadings for such principal components were 73.9%. The items that showed large amount of principal component 1 were average elongation of 30 items, average post-rating score of 7 items, and the number of activities of 7 items. Based on this, component 1 is called "rating score related to average elongation". The items with large principal component 2 were prior average rating score of 12 items and average number of activities of one item. Most of these scores were positive coefficients. Based on these findings, it is called "rating score related to pre survey" for question items. With respect to 124 information of the rating scores and average number of activities, we believe they can mostly be explained by these 2 principal components.

When looking at component matrix obtained from principal component analysis, the coefficient is negative for prior average rating score, and positive for post-average rating score, average elongation and average number of activities. Since the principal component gets larger as elongation and the number of activities gets larger, we believe that principal component score shows the learning effect. The principal component score is shown at lower end of [Table 3](#). Based on this principal component score, we can see that subject with high learning effect is in order of subject I, J, E and so on. Furthermore, we were able to understand that subject with high learning effect is mostly in order of experimental type, exercise type, and lecture type class.

7.3. Categorization of Subject through Cluster Analysis on Awareness and the Number of Activities

By performing cluster analysis as a variable on principal component 1 and 2 obtained from section 7.2 concerning 4 types of data related to awareness, we have categorized 10 subjects that are object of analysis into 3 clusters (groups). Three groups are shown on Fig.1 by using score of principal component 1 and 2.

Subject (circular seal) belonging to group 1 (G1) is shown as 5 subjects shown on bottom left corner. Post-average rating score, average elongation, and the number of activities for all items are lowest among 3 groups. 5 subjects which are (Introduction to computer science), B (Basic information technology II), C (Computer history), D (Introduction to e-learning), and G (Web programming I) are named "lecture type class" group. For Subject G, by roughly using up 2/3 of the class time, grammatical matters and program examples corresponding to that day are explained, along with explaining the exercise program. After such explanation, by referring to exercise program through roughly 1/3 of the class time, the students were asked to create and submit the program for exercise problems. Since this subject is exercise-centered subject and therefore was categorized as exercise type, the student's respond for awareness showed that it belonged to lecture type. The reason may be that the number of activities shown on [Table 3](#) is less than other 2 exercise type subjects and that it looks similar to lecture type subject.

Group 2 (G2, triangular seal) is shown as 2 subjects on top left. Among 3 groups, the average prior rating score and the number of activities for all items are shown to be highest. The post-rating score is higher of the three groups. This group showed small amount of increase with showing of average elongation being smaller than the overall average. Since the subjects of this group are 2 subjects which are F and H, they will be named "exercise type class".

Group 3 (G3, quadrangular seal) is shown as 3 subjects on the right. The post-average rating score and average elongation scored the highest. The average number of activities is the second most among subject groups. Since the subjects of this group are classified as E, I, and J, this group is named "experiment type class". For subject E, lecture were explained for 3 sessions. For the following one session, an exercise in drawing up learning guidance plan which is the purpose of the lecture, was conducted at personal computer room. We have implemented 12 sessions by repeating this kind of cycle for 3 times per every 4 sessions of class development. Afterwards, students were assigned to make presentation on their carefully produced learning guidance plan, and were assigned to make peer assessment and to draw-up report. Since this subject is lecture-centered subject, therefore it was categorized as lecture type at the beginning. But on contrary, student's respond for awareness showed that it belonged to experiment type. The reason for such response may be that it looks similar to the original 2 subjects that were categorized as experiment type, since as shown on [Table 3](#), and the prior rating score looks similar to the original experiment type of 2 subjects, along with

average elongation being larger than other lecture type subjects.

Four types of data for each group (prior/post rating score of awareness, average elongation, and the number of activities) are shown on Table 4, where m and SD mean average and standard deviation, respectively. The variance analysis result is shown on Table 5 concerning these four types of data between groups, where SS, df, MS, F, and p mean sum of squares, degree of freedom, mean square, F value, and p value, respectively. Based on this, in regards to average elongation, the effect of condition showed significance ($F(2,297) = 180.4, p < .001$). We therefore conducted a multiple comparison through Tukey method. The result is shown on far right of Table 5. Significant difference was found between groups G1 and G3 and between groups G2 and G3 for the average elongation. No significant difference was found between group G1 and

G2. Based on this, we were able to understand that awareness of group G3 “experiment type class” has larger elongation than G2 “exercise type class” and G1 “lecture type class”.

Table 4. Comparison between rating value of pre and post attitude, average elongation, and the number of activities for each group

Group	No. of sub-jects	Rating value						No. of activities	
		Pre		Post		Elongation			
		m	SD	m	SD	m	SD	m	SD
G1	5	4.4	0.7	4.9	0.5	0.5	0.5	1.4	0.3
G2	2	4.8	0.5	5.3	0.5	0.5	0.3	2.3	0.5
G3	3	4.0	0.4	5.6	0.4	1.6	0.4	2.2	0.4
Total	10	4.3	0.7	5.1	0.7	0.83	0.6	1.8	0.5

Table 5. Results of analysis of variance and multiple comparison on the average elongation of attitude for each group

Items	Analysis of variance						Multiple comparison		
	Factor	S S	df	M S	F	p	G1:G2	G2:G3	G3:G1
Pre-awareness	Condition	22.4	2	11.2	30.6	***	<	>	<
	Error	108.7	297	0.4					
Post-awareness	Condition	27.8	2	13.9	61.0	***	<	<	>
	Error	67.7	297	0.2					
Elongation	Condition	70.4	2	35.2	180.4	***	=	<	>
	Error	57.9	297	0.2					
No. of activities	Condition	45.3	2	22.6	166.6	***	<	=	>
	Error	40.4	297	0.1					

*** p<.001.

The effect of condition for average number of activities showed significance ($F(2,297) = 166.6, p < .001$). We therefore conducted a multiple comparison through Tukey method. The result showed that no significant difference was found between the number of activities for group G3 and G2. Significant difference was found between the numbers of activities for groups G3 and G1. Based on this, we were able to understand that the number of activities of G3 “experiment type class” and G2 “exercise type class” are larger than G1 “lecture type class”.

7.4. Sampling of Group’s Important Items Based on Discriminant Analysis

We conducted discriminant analysis for 3 types of classes obtained in section 7.3 by doing cluster analysis for 124 average values of 4 types of data by combining rating score of prior/post awareness, its elongation, and the number of activities. Items with average for 4 types of data being larger than the total average are the important item for the group. Based on this, the important items for each group are as follows. The important items for lecture type group G1 are the 19 items of prior rating score. We can therefore identify that for group G1, more than half of prior rating score are considered important. It means that group G1 is a subject group that these items are large.

The important items for exercise type group G2 are item 29 in prior rating score, 26 items in post rating score, 2 items in average elongation, and 29 items in the number of activities. We can therefore see that for group G2, almost all of prior rating value, post rating value, and the number of activities are considered important. It means that group G2 is a subject group that these items are large.

The important items for experimental type group G3 are all 31 items of post rating score, elongation and the number of activities. Based on this, the rating score of awareness for group G3 showed more increase in the post than group G1 and G2. It is also considered that listed number of activities for group G3 is more.

From such findings, we are able to understand that awareness is increased in the order of group “experiment type class G3”, “exercise type class G2”, and “lecture type

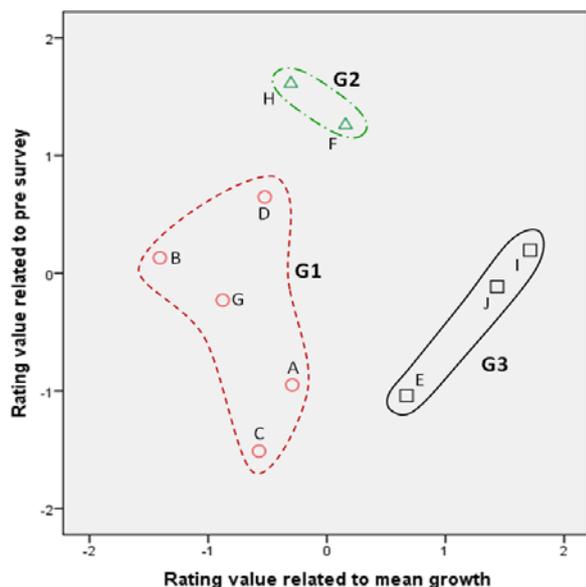


Figure 1. Subject group classified by cluster analysis

class G1.” This finding leads to the same order as commonly shared idea and image for the improvement of motivation.

7.5. Results of Principal Component Analysis on Utilized Media

Using the 5 levels on frequency for utilized media in Table 2, principal component analysis were conducted based on covariance matrix. The factor loadings of principal component 1 and 2 were 40.3% and 20.2%, respectively. The cumulative factor loadings for such components came out to be 60.6%.

As a result, the factor loadings of component were positive large values for small test answers, small test, notebook to arrange lecture contents, browsing of small test answer, etc. They were negative large values for PC, document which explains, experiment book, peer evaluation, exercise program and problems, etc. Therefore, it was found that the principal component represents an indication on the frequency of utilized media required for the lecture.

The principal component scores obtained by the principal component analysis using the 5 levels on frequency for utilized media are shown in the bottom of Table 2. As a result, the principal component scores for subjects of lecture type are positive larger values all in all and the scores for subjects of the experiment type was found to be negative greater values all in all.

Small test, the answer, notebook to arrange lecture contents, textbooks, etc. are more frequently used, the larger the principal component scores based on frequency for utilized media become in the positive direction. Experiment book, PC, peer evaluation on work are more frequently used, the higher the principal component scores become in the negative direction.

7.6. Average Time for Each Activity Required for Each Subject

The average time required for each activity in during class for each subject is shown in Table 6. The time required for the activities that was performed in class of 15 times is converted in terms of class of the 90 minutes.

Therefore, the total of the average time for each subject is 90 minutes.

In most subjects of groups of "lecture type class G1", it takes more than half of time for lecture. The rest time is used in order to perform the exercise and small test. However, in subject G it takes more than half of time to exercise, as it was first classified into exercise type.

In the "exercise type class G2", it takes more than half of time to explain the answer of exercises or problems. Some lectures are also conducted.

In the "experiment type class G3", it takes more than half of time to create the work. The rest time is used to do lecture, to evaluate the work, and to create the report. However, in subjects E, as it was first classified into lecture type, it takes more than half of time to do lecture.

Principal component scores obtained by the principal component analysis using the average time in Table 6 are shown in the bottom of Table 6. The longer the time to actually address on making things such as the creation of work and solving problems, the larger this principal component score becomes in the negative direction. The longer the time for lecture, the larger it becomes in the positive direction. Therefore, it was found that the principal component score represents an indication on the length of time for making things and experiential activities.

As mentioned in Section 7.2, the principal component scores obtained by the principal component analysis using average of pre and post rating values of survey for awareness related to ability, the average elongation, and average No. of activities shown on the lower end of Table 3 represent the learning effect (improvement of awareness). Correlation coefficient r between the two principal component scores representing the time for these experiential activities and the learning effect is $r = -0.84^{**}$. It is recognized that the coefficient means significant strong correlation. It is found that longer experiential activity time means larger improvement of awareness.

Correlation coefficient between the two principal component scores of the frequency for utilized media and the time required to activity in class is $r = 0.81^{**}$. It is recognized that the coefficient means significant strong correlation. It is found that the higher frequency of use media means longer time required to activity.

Table 6. Average time for each activities required for each subject

Subject Contents	Introduction to Computer	Introduction to Information Technology	History of Computer	Introduction to e-Learning	Web Programming	Exercise for Fundamental Information Technology Engineer Examination	Exercise for Operations Research	Teaching Method of Information Studies	Experiment to Create Learning Material in CAI	Experiment to Produce Slides of Storytelling
Type of class	Lecture G1					Exercise G2		Experiment G3		
Kind of activities	A	B	C	D	G	F	H	E	I	J
Lecture	55	55	65	55	30	0	23	53	10	10
Answer to small test	5	5	5	5	0	0	0	0	0	0
Answer to exercises	0	0	0	0	5	70	15	0	0	0
Exercises	20	20	10	20	55	20	52	0	0	0
Creating of works	0	0	0	0	0	0	0	23	49	49
Evaluating activities	0	0	0	0	0	0	0	8	17	17
Writing of reports	0	0	0	0	0	0	0	6	14	14
Small test	10	10	10	10	0	0	0	0	0	0
Principal component score	0.83	0.83	0.99	0.83	0.42	-1.22	0.13	0.10	-1.46	-1.46

8. Discussion

Through conducting of cluster analysis by viewing principal component 1 and 2 obtained in Section 7.2 concerning 4 types of data which is 124 values of rating score for awareness, elongation, and the number of activities as variable, we have categorized 10 subjects that are object of analysis into 3 groups. As such result, the subjects that turned out to be different from the first category were subject E and subject G. Subject E viewed as a lecture type class was categorized into experiment type group. Subject G viewed as an exercise type was categorized into lecture type group.

The average required time per activities during each subject's class session is shown on Table 6. The average required time was obtained by converting the required time for activities implemented throughout 15 class sessions into 90 minute single class session. Based on this, the total of average required time for each subject is regarded as 90 minutes.

For most of group "lecture type class G1", more than half of average required time is used for lecture, and the remaining time is used to implement exercise and mini tests. However, when looking at subject G, over half of the time is used for exercise just as it was initially categorized under the exercise type.

For "exercise type class G2", over half of the time is used to exercise or to explain answers of problems. Partial lecture is also conducted for this class.

For "experiment type class G3", over half of the time is used for work creation, and the remaining time is used for lecture, rating activity of work, and drawing up report. However, for subject E, just as its initial categorization into lecture type, over half of the time is used for lecture.

The principal component score obtained from principal component analysis through the use of average required time is to be shown on bottom edge of Table 6. When time engaged in actually making something such as work creation and problem solving becomes long, the tendency of such principal component score seems to enlarge toward negative direction, and seems to enlarge toward positive direction when there is long lecture time. Based on such observation, we are able to understand that it revealed the index for the length of time being used for work creation and experience oriented activities.

As mentioned in Section 7.2, we were able to understand that the principal component score obtained through principal component analysis that uses 4 types of data listed under bottom edge of Table 3 shows the effect of learning (increase in awareness). The correlation coefficient between two principal component scores that shows such experience oriented activity time and effect of learning came out to be $r = -0.84$. It is recognized to have strong correlation for its significance. Such finding shows that as the experience oriented activity time becomes longer, so does the improvement in awareness.

As you can see, the finding shows that the average required time for implemented activities causes great influence on awareness improvement. In specifics, it shows that having students engage in actual making of object such as work creation and having them solve problems are proving to be effective for awareness

improvement. However, only activities during class session are not the contributing factor for the awareness improvement. Because "class" is generally composed by activities that are "in-class" and "outside of class". Out of target subjects, students neither engage in work creation nor problem solving during class session which are subject A, B, C, and D. Such subjects are carefully arranged so that "in-class" activities can be supplemented by reviewing and evaluating them among each other "outside of class" through draw-up of reports and registering them on LMS. Such report include draw-up of document that explains terms brought up during lecture by looking them up outside of the class, report that introduces historical figures, or report on designing a class that uses e-learning. Through these activities, increase in awareness is recognized in all subjects.

The principal component analysis was conducted by using the 5 levels of the usage frequency of media. However, the analysis was conducted by excluding "lecture by slide, level of term recognition survey form, awareness survey form, lecture plan and method explanation form, learning through lecture slide, rating sheet, question mail, and notice board" that are used at same degree for all of the subjects. Obtained principal component score is shown on bottom edge of Table 2. Media with large and positive principal component 1 were mini test, lecture sorting note, text book, and exercise problem form. Media with large and negative and large items were PC, experiment form, peer assessment of work, and manual.

The finding suggests that as mini test, lecture sorting note, text book, exercise problem form, etc., which are characteristically utilized in lecture, are used more, the principal component score for utilized media also tends to get larger. The finding suggests that as the unique media utilized in experiment such as PC, mutual assessment, experiment form, etc. are used more, the principal component score for utilized media also tends to get smaller.

The correlation coefficient between principal component scores concerning utilized media and awareness came out to be $r = -0.69^*$. The medium degree of correlation is significantly recognized for its significance. The finding shows that increase in awareness is more in subjects that utilizes media necessary for experience oriented activities.

9. Conclusion

With respect to 10 subjects that implemented blended class, significant difference test was conducted using rating values of awareness. Principal component analysis was conducted for average score of 124 items of 4 types of data related to ability and awareness. 10 subjects were categorized through cluster analysis on awareness and the number of activities. Discriminant analysis was conducted for 3 types of classes to find the important item for the group. Principal component analysis was conducted for the use degree of the media and the mean time required of the activity. Subjects were arranged using principal component scores. Correlation analysis is conducted using principal component scores to find relation between 3 kinds of principal component scores.

As such results, the followings were obtained:

1. For lecture type class G1, the average number of rating item recognized for significant difference or such tendency was approximately 50.7%.
2. For exercise type class G2, the average number of rating items recognized for significant difference or such tendency was approximately 63.3%.
3. For the average of experiment type class, significant difference was recognized for most of the rating items, and the average number of rating items recognized for significant difference was approximately 98.9%.
4. As results of the significant difference tests for general awareness, the subjects in the lecture type and the exercise type are divided into subjects whose number of significantly improved item are 70% or more and is 43% or less. In response to it, subjects are divided into subjects with small elongation of awareness and subjects with large one.
5. Awareness related to subject improved with the items more than 72% for all of subjects.
6. With respect to all of the subjects including general awareness and awareness related to subjects, significant improvement is shown on average rating score for all of awareness items.
7. Due to the change of affiliation of 2 subjects, 10 subjects can be categorized into 3 groups which are "experiment type class G3", "exercise type class G2", and "lecture type class G1" through principal component 1 and 2.
8. The awareness improves in the order of group "experiment type class G3", "exercise type class G1", and "lecture type class G2", and this finding is in the order of commonly shared idea and image.
9. Awareness of "experimental type class G3" gave indication of greater elongation than that of "exercise type class G2" and "lecture type class G1".
10. Awareness of subjects improves mostly in order of Group "experimental type class G3", "exercise type class G2", and "lecture type class G1".
11. As the experience oriented activity time gets longer, the improvement in awareness is also increased.
12. More increase in awareness is shown on subjects that utilize media necessary for experience oriented activities.

As a future challenge, not just limiting to these 10 subjects that were object of this analysis, but we would also like to analyze rating score of ability and awareness survey for other subjects, to further solidify the information gained in this paper.

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