Comparing Activities Useful for Improving Consciousness in Two Modules Applying Blended Learning: 'AI Technology' and 'Artificial Intelligence'

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Abstract

Target subject is a module called 'AI Technology', which applied the ideas of blended learning. Firstly, lecture-style teaching was conducted with presentation slides in order to explain the contents of a textbook. Secondly, students were required to do exercises and quizzes. By using the last eight weeks, they were asked to create presentation slides outside a class to introduce the up-to-date topics on artificial intelligence. These slides were mutually evaluated among them so that they developed their own slides based on the feedback before the tenth week of the course for the second round of mutual evaluations. Improving consciousness of a module is meaningful. To know the reasons is more significant. For such occasions activities useful for improving consciousness of a module in 'AI Technology' are found. Then it is compared with my previous research outcome of the module, 'Artificial Intelligence'. Students are categorized into four groups with degree scales of consciousness by principal component analysis. This paper reports their results.

1. Introduction

Learning styles differ according to students: in other words, there is no perfect medium to fit all. Applying multiple media in the classroom, therefore, allows to support the various types of learning and to deepen students' understanding of course contents [1] [2]. Several studies point out the recent trend that e-learning is applied to the classrooms in Japanese higher education [3]. Arakawa et al. [4] proposed an educational approach for students to repeatedly participate in a cycle of preparation, participation and review of a module by providing exercises for acquiring knowledge necessary for understanding the subjects on programming. They concluded that this approach was effective for the development of their logical thinking techniques.

My previous research also proved the fact that e-learning supports students' learning activities including course preparation and review [5], [6]. In the academic year 2004, I gave lectures on artificial intelligence with presentation slides and gave quizzes in the last ten minutes of each class at a selective module called 'Artificial Intelligence' [7]. Outside the classroom, students were able to learn the course contents with the lecture slides and exercises through an e-learning system [8]. In this way, it was aimed to enhance the understanding of the subject by autonomous learning. It was reported that they were also encouraged to record the course contents in lecture notebooks provided by the author [8], [9].

In this study, I will report contents of a module called 'AI Technology', which also applied the ideas of blended learning and was similar to contents of 'Artificial Intelligence' [10]. After listening to a 60-minute lecture, students were required to do an exercise for 20 minutes and a quiz for 10 minutes in each class. Quizzes were based on the contents that students have previously learnt. Furthermore, they were asked to submit lecture notebooks just after the mid-term and final exams. As a final task, they created presentation slides for introducing the latest topics on AI technology. The slides were evaluated by the course participants and the feedback was returned to each of them for the development of the slides. After resubmission, the slides were again assessed by students.

Course contents of 'Artificial Intelligence' and 'AI Technology' resemble except the final tasks. In the former module, students were required to submit reports on designing a learning support system whereas the latter asked them to create presentation slides for introducing the latest topics on AI [7]. Although the previous studies mentioned above examined learning effects of students by using multiple media, the difference between the effects depending on various usages of the same medium is not yet investigated. The difference of learning effects was revealed by statistically comparing the levels of understanding technical terms and consciousness towards competency [10]. This research, therefore, attempts to identify activities useful for improving consciousness as the difference of learning effects depending on the different tasks. Students are categorized into four groups with degree scales of 30 items of consciousness by principal component analysis. Feature of student groups is examined.

2. Course design and contents

Target subject is a selective module called 'AI Technology', targeted for third year students at the Department of Information Science in A University. It consisted of 90-minute lessons for fifteen weeks. The number of student participants of this module was 36.

A lesson consisted of an explanation of a quiz given at the previous week as review, a 60-minute lecture with presentation slides, a 20-minute exercise and a quiz. Exercises aimed to stabilize students' understanding of the contents of a lecture by answering questions on the lecture notebooks. The course instructor observed the students and answered questions individually. If necessary, he explained the ideas and solutions of the questions on a blackboard. Students also answered a few quizzes for the last 10 minutes by using a textbook [11] or other resource for reference.

Students were encouraged to use lecture notebooks for course preparation and review. It aimed to enhance students' understanding of the course contents by answering 196 questions in 37 pages. In this way, the cycle of (1) lectures, (2)

Table 1. Lesson plan of 'AI Technology'

Time	Lecture Contents	Lecture								e-learning			
		No. of slides	Text	No. of pages in the text	Documents distributed	Sheet of Exercise	Short test	Answer slide of short test	Survey of technical terms	Awareness survey	Downloading files	Slides to introduce on AI	Observation	Evaluation sheets
1	Lesson plan, Understanding survey of technical terms, Awareness survey, 1.1 What is Artificial Intelligence?, 1.2 Research field of Artificial Intelligence, 1.3 History of Artificial Intelligence, 1.4 The Fifth Generation Computer	18	Chapter 1	10	Lesson plan, Lecture notebook No.1	Exercise 1	Short test 1		Pre-understanding survey of technical terms	Pre-awareness survey	Evaluation sheet			Survey of technical terms and awareness
2	2.1 Knowledge bases, 2.2 Semantic networks, 2.3 Frame theory, 2.4 Production rule, 2.5 Predicate logics	25	Chapter 2	10	Lecture notebook No.2	Exercise 2	Short test 2	Short test 1						
3	2.6 Reasoning, 3.1 What is an expert system?, 3.2 Structure of an expert system, 3.3 Kind of expert systems, 3.4 Production system	39	Chapter 3	17.5	Lecture notebook No.3	Exercise 3	Short test 3	Short test 2						
4	3.5 AI language, 3.6 Knowledge engineer, 3.7 Certainty factor, 3.8 Explanation function, 3.9 Choice of rules, 3.10 Knowledge acquisition, 4.1 What is fuzzy?	11	Chapter 3	4.5		Exercise 4	Short test 4	Short test 3						
5	4.2 Fuzzy set, 4.3 Fuzzy operation, 4.4 Agreement degree, 4.5 Fuzzy reasoning	19	Chapter 4	10	Lecture notebook No.4, explanation sheet of final task	Exercise 5	Short test 5	Short test 4			Framework slide to introduce the latest topics on AI			
6	4.6 Fuzzy control, 5.1 Neural network and neuro computer, 5.2 Characteristic of neuro computers, 5.3 Structure of brains, 5.4 Principle of neuro computers, 5.5 Structure of neuro computers	23	Chapter 5	9.1	Lecture notebook No.5	Exercise 6	Short test 6	Short test 5						
7	Midterm examination						Examination sheet							
8	5.6 Neuro chip, 5.7 Application of neuro computers, 7.1 Treatment method of natural languages, 7.2 Context-free grammar, 7.3 Augmented transition network grammar, 7.4 Semantic networks	16	Chapter 7	8.5	Lecture notebook No.6	Exercise 7	Short test 7	Short test 6						
9	7.5 Case grammar, 7.6 CD theory, 7.7 Montague grammar, 7.8 Analysis of Japanese, 7.9 Structure of natural language processing system, 7.10 Application of natural language processing system	25	Chapter 7	10.5		Exercise 8	Short test 8	Short test 7			Registration of complete slide to introduce	Submission of complete slide to introduce	Observation slides to introduce	
10	8.1 The present conditions of machine translation system, 8.2 Translation method of machine translation, 8.3 Problems of machine translation system, 9.1 The history of robots	18	Chapter 8	9	Lecture notebook No.7	Exercise 9	Short test 9	Short test 8						
11	9.2 Intelligence robot capability, 9.3 Various robots	21	Chapter 9	13.6	Lecture notebook No.8	Exercise 10	Short test 10	Short test 9						Self-evaluation and other evaluation
12	10.1 A merit and problems of sound recognition, 10.2 Method of voice inputting, 10.3 Speech understanding, 10.4 Application of speech recognition technology, 10.5 Voice syntheses	15	Chapter 10	4.6	Lecture notebook No.9	Exercise 11	Short test 11	Short test 10			Registration of other evaluation		Observation on other evaluation	
13	12.1 Artificial life, 12.2 Intellectual agents, 12.3 Genetic algorithm, 12.4 Games	14	Chapter 12	6.8	Lecture notebook No.10	Exercise 12	Short test 12	Short test 11			Registration of revised slide to introduce	Submission of revised slide to introduce	Observation revised slides to introduce	
14	12.5 Quantum computer, 12.6 Data mining	9	Chapter 12	4.6		Exercise 13	Short test 13	Short test 12			Registration of other reevaluation			Self-reevaluation and other reevaluation
15	Understanding survey of technical terms, Awareness survey, Class questionnaire							Short test 13	Post-survey of technical terms	Post-awareness survey			Observation on other reevaluation	Other reevaluation, survey of technical terms and awareness

exercises, (3) quizzes and (4) lecture notebooks was repeated to develop the students' understanding of the course.

As a final task, students created presentation slides for introducing the latest topics on AI by using and expanding the knowledge on this field during the last part of this program. Firstly, handouts of how to make slides and what to include in them were given to students. Secondly, they downloaded six slides as a framework for creating their own presentation slides. Contents for presentation consisted of the followings: (1) the history of how a topic has been developed; (2) the research area in the field of AI; (3) the reasons why a student was interested in the topic; (4) the content of the topic; (5) the influence of the topic over other fields or technologies in the past or in the future; (6) what s/he deepened the understanding after the research; (7) research interests in the field of AI including (i) the reasons and (ii) the understanding and (8) references. After they submitted them, they registered online and downloaded others' slides for mutual learning. In this way, they were able to broaden the knowledge relating to AI technology and AI itself. Furthermore, they observed and evaluated others' slides so that they could improve their own slides according to the feedback. Through such interactions among students, the module successfully established the students' understanding of the course subject.

3. Analysis results

In the survey on the students' consciousness-raising after taking the program, effective activities for developing their consciousness were also asked. The results were analyzed by cross tabulation in terms of consciousness and activities. Based on the table from the cross tabulation, consciousness and activities were analyzed by cluster analysis. Furthermore, χ^2-test is conducted by using the cross tabulation tables by the clusters. If the result was significant, residual analysis was also carried out in order to explain the cluster of activities effective for developing the cluster of consciousness.

This study also investigated the different learning effects between the two modules, 'AI Technology' and 'Artificial Intelligence'. Effective activities for consciousness-raising were also comparatively analyzed to identify the different reasons of how students improve their consciousness.

Students are categorized into four groups with degree scales of 30 items of consciousness by principal component analysis. Feature of student groups is examined.

In this paper, numbers in brackets signify item numbers of consciousness whereas numbers without brackets signify item numbers of activity.

3.1. Activities effective for consciousness-raising in 'AI Technology'

At the post-course questionnaire, students were required to choose effective activities for raising their consciousness (see Table 2) from 33 activities (see Table 3). The total number of activities selected was 3,834, 106.5 per student. The relationship between consciousness towards competence and activities was shown on a 45 × 33 table of cross tabulation.

Table 2. Number of effective activities chosen for consciousness

Consciousness	Total
(1) Interest in and curiosity about computers	90
(2) Understanding of computers	94
(3) Computer operation skills	97
(4) Computer usage methods and broadening of situations	91
(5) Ability to set challenges, ability to discover problems	94
(6) Ability to plan, to do things in a planned manner	90
(7) Cultivation of understanding of knowledge learned	86
(8) Ability to study by oneself, ability to learn	85
(9) Ability to gather information, ability to conduct research	84
(10) Ability to sort through related information or data	86
(11) Ability to analyse information	83
(12) Ability to express thoughts in writing	75
(13) Ability to express thoughts through media other than writing	73
(14) Ability to talk to and explain to others comprehensively	72
(15) Ability to make presentations	67
(16) Ability to listen to others and to ask questions to others	74
(17) Communication ability	73
(18) Ability to appropriately self-evaluate one's thoughts	71
(19) Ability to appropriately evaluate other people's thoughts	71
(20) Ability to correct and improve on one's own thoughts	79
(21) Ability to pursue matters deeply, ability to explore matters	93
(22) Ability to execute, ability to practice, ability to put into action	97
(23) Ability to cooperate and to learn concertedly	79
(24) Sense of accomplishment, sense of satisfaction	87
(25) Sense of fulfilment, sense of achievement	88
(26) Ability to solve problems	92
(27) Ability to construct and create knowledge	94
(28) Ability to think, consider and come up with ideas by oneself	90
(29) Creativity/ability to create	84
(30) Interest in and curiosity about this field	88
(31) Interest about the artificial intelligence	87
(32) Learning will about the artificial intelligence	94
(33) Will to work on a final task	104
(34) Ability to accomplish a final task till the last	103
(35) Ability to understand the thought of the person	81
(36) Ability to understand the introduction slide of other people	75
(37) Knowledge about the artificial intelligence	104
(38) Knowledge about knowledge and the reasoning	83
(39) Knowledge of the expert system	83
(40) Knowledge of the fuzzy	82
(41) Knowledge of the neuro computer	83
(42) Knowledge of the natural language processing	83
(43) Knowledge of the machine translation	81
(44) Knowledge of the intelligent robot	81
(45) Knowledge of the sound recognition	83
Average	3834

3.2. Categorizing consciousness by cluster analysis using the number of activities effective for consciousness-raising

A table of cross tabulation consists of 45 items of consciousness towards competence as rows and 33 activities as columns by counting the number of activities effective for consciousness-raising. Based on this table, items of consciousness as cases and activities as variables were analyzed by cluster analysis by means of Ward's method. Dividing the dendrogram at the dissimilarity 10, consciousness was categorized into three clusters (Clusters I-III).

Table 3. Number of effective activities chosen for raising their consciousness

Activity	Total
01. Listening to lectures	749
02. Getting an image of the whole lecture	233
03. Asking friends questions about lecture topics	95
04. Asking a teacher questions about lecture topics	17
05. Preparing	116
06. Reviewing	178
07. Studying using the textbook	78
08 Taking a quiz.	122
09. Listening to the answer of quiz	155
10. Answering to the exercise during class	14
11. Examining the content of lecture notebooks	87
12. Summarizing the lecture notebook	363
13. Studying for the exam using the notebook	47
14. Studying for the middle exam	35
15. Studying for the final exam	133
16. Using Word	79
17. Using Excel	79
18. Using PowerPoint	96
19. Asking using e-mail	0
20. Writing on the bulletin board	2
21. Reading the bulletin board	2
22. Evaluating the improved force and consciousness	21
23. Evaluating recognition rate of technical terms	8
24. Listening to about final task creating slides for introducing the topics	41
25. Asking a teacher about final task creating slides for introducing the topics	6
26 Asking questions to friends about final task creating slides for introducing the topics	52
27 Determining the content of the slides for introducing the topics	102
28. Examining the contents of slides for introducing the topics	229
29. Creating a topic introduction slide by summarizing the contents examined	315
30. Evaluating yourself about slides for introducing the topics	120
31 Reading explanation of other's slides for introducing the topics	122
32 Evaluating others' topics for introducing the topics	135
33. Other	3
Average	3834

The horizontal axis signifies dissimilarity whereas the vertical axis is consciousness.

Cluster I consists of 18 items of consciousness including (38), (39), (40), (41), (44), (45), (42), (43), (37), (31), (32), (30), (7), (8), (1), (2), (4) and (3). The average frequency of effective activities selected for 18 types of consciousness was 87.5, slightly higher than the total mean. The frequencies of (37), (3), (32), (2), (4) and (1) were relatively high. Cluster I, thus, is 'consciousness towards understanding computers and knowledge of AI'.

Cluster II consists of 19 items including (14), (15), (12), (13), (28), (29), (22), (27), (33), (34), (24), (25), (26), (9), (21), (10), (11), (5) and (6). The average frequency of effective activities selected for these types of consciousness was 87.2, slightly higher than the total mean. The frequencies of (33), (34), (22), (27), (5), (21), (26), (28) and (6) were relatively high. Cluster II indicates 'consciousness towards competence to set up and undertake a task on schedule'.

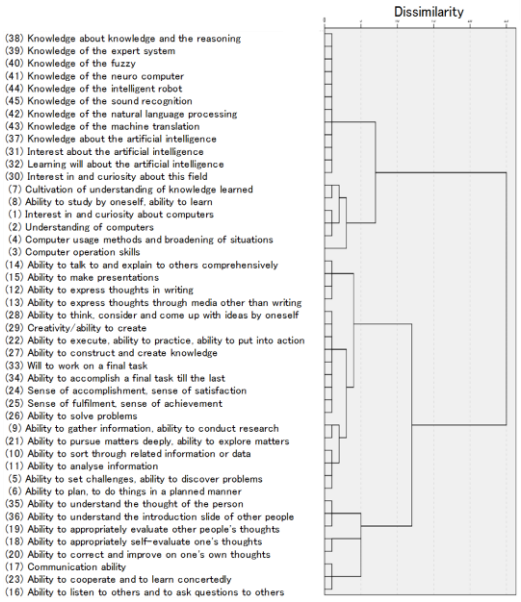

Figure 1. Dendrogram of consciousness clusters determined using cluster analysis

Cluster III consists of 8 items of consciousness including (35), (36), (19), (18), (20), (17), (23) and (16). The average frequency of effective activities selected for these types of consciousness was 75.4, slightly lower than the total mean. The frequencies of all items were almost the same. Cluster III is 'consciousness towards competence to mutually evaluate, develop and understand a task '.

3.3. Categorizing activities by cluster analysis using the number of activities effective for consciousness-raising

Based on a table of cross tabulation used in 3.2, activities as cases and items of consciousness as variables were analyzed by cluster analysis by means of Ward's method. Dividing the dendrogram at the dissimilarity 7, activities were categorized into three clusters (Clusters 1-3). The horizontal axis signifies dissimilarity whereas the vertical axis is activity.

Cluster 1 consists of 29 activities including 19, 21, 20, 25, 33, 23, 10, 4, 22, 13, 14, 24, 3, 26, 16, 18, 17, 31, 32, 7, 11, 9, 15, 8, 6, 5, 27, 2 and 30. The average frequency of effective activities selected for 29 types of activity was 62.6, slightly lower than the total mean. Particularly, frequencies of 2, 6, 9, 32 and 15 were high. Cluster 1, therefore, is 'activities to grasp an image, listen to a solution, learn and evaluate'. Cluster 2 consists of 3 activities including 28, 29 and 12. The average frequency of effective activities selected for 3 types of activity was 257.2, slightly higher than the total mean. All frequencies were high

so that this cluster is 'activities of note-taking and creating presentation slides for introducing a topic'. Cluster 3 has only one activity 1, 'to listen to a lecture' so that it is 'an activity to listen to a lecture'.

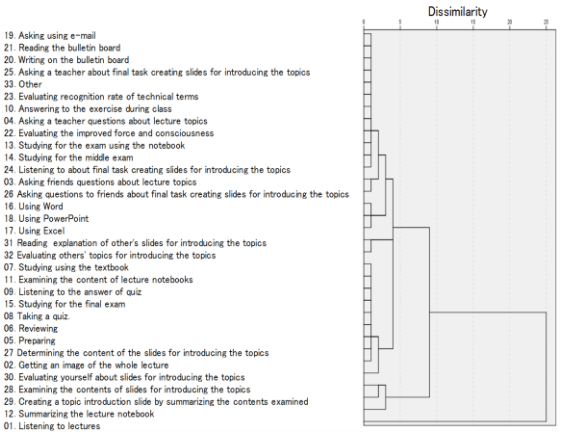

Figure 2. Dendrogram of activity clusters determined using cluster analysis

3.4. Results of analyses: activities effective for consciousness

A table of cross tabulation about consciousness and activities consists of 45 rows and 33 columns. Frequencies of cells in each cluster mentioned in the previous section were aggregated (see Table 4 on the upper left). This table was used as a 3×3 contingency table for χ^2-test. As a result, the deviation was significant ($\chi^2(4)=301.1$, $p<.001$). Table 4 on the lower left shows the result of residual analysis. Cells showing positive residual (with * on significance probability of Table 4) signify particularly effective activities.

The cells showing significance identify the activities effective for raising students' consciousness towards competence. For example, it was found that Activity Cluster 1, 'activities to grasp an image, listen to a solution, learn and evaluate', is useful for developing Consciousness Cluster III, 'consciousness towards competence to mutually evaluate, develop and understand a task'. Activity Cluster 2, 'activities of note-taking and creating presentation slides for introducing a topic', is effective for enhancing Consciousness Cluster II, 'consciousness towards competence to set up and undertake a task on schedule'. Finally, Activity Cluster 3, 'an activity to listen to a lecture', is useful for raising Consciousness Cluster I, 'consciousness towards understanding computers and knowledge of AI'.

Table 4. χ^2-test and residual analysis of the table of cross tabulation about consciousness and activity clusters

Cluster of Activity / Cluster of Consciousness	Observed frequency				Expected frequency		
	1. Activities to grasp an image, listen to a solution, learn and evaluate	2. Activities of note-taking and creating presentation slides for introducing a topic	3. An activity to listen to a lecture	Total	1. Activities to grasp an image, listen to a solution, learn and evaluate	2. Activities of note-taking and creating presentation slides for introducing a topic	3. An activity to listen to a lecture
I. Consciousness towards understanding computers and knowledge of AI	843	277	455	1575	894.7	372.6	307.7
II. Consciousness towards competence to set up and undertake a task on schedule	880	562	214	1656	940.7	391.8	323.5
III. Consciousness towards competence to mutually evaluate, develop and understand a task	455	68	80	603	342.5	142.7	117.8
Total	2178	907	749	3834	2178.0	907.0	749.0
	Adjusted residual				Significance probability		
I. Consciousness towards understanding computers and knowledge of AI	−3.4	−7.4	12.2				***
II. Consciousness towards competence to set up and undertake a task on schedule	−4.0	13.1	−9.0			***	
III. Consciousness towards competence to mutually evaluate, develop and understand a task	10.1	−7.8	−4.2		***		

*** p<.001

3.5. Comparison of effective activities for consciousness-raising between 'AI Technology' and 'Artificial Intelligence'

In order to compare the activities effective for students' consciousness-raising between 'AI Technology' and 'Artificial Intelligence', this section utilized 30 items of general consciousness. The number of effective activities in both modules was 33 and 34 respectively. 25 items shown in Table 5 on the left were analyzed as the common activities. 30 items of consciousness and 25 items of activities were analyzed by cross tabulation and the results were added according to each cell in order to create a table of cross tabulation of these two modules.

Table 5. Effective activities for raising consciousness in both modules

No	Activities in AI Technology	Selected number	Activities in Artificial Intelligence	Selected number
1	01. Listening to lectures	749	01. Listening to lectures	50
2	02. Getting an image of the whole lecture	233	02. Getting an image of the whole lecture	11
3	03. Asking friends questions about lecture topics	95	03. Asking friends questions about lecture topics	8
4	04. Asking a teacher questions about lecture topics	17	04. Asking a teacher questions about lecture topics	5
5	05. Preparing	116	05. Preparing	11
6	06. Reviewing	178	06. Reviewing	15
7	07. Studying using the textbook	78	07. Studying using the textbook	0
8	08 Taking a quiz.	122	08 Taking a quiz.	5
	09. Listening to the answer of quiz	155		
			09. Learning through lecture slides	17
			10. Evaluating about learning through lecture slides	11
9	10. Answering to the exercise during class	14	11. Learning through exercise problems	17
			12. Evaluating about learning through exercise problems	9
10	11. Examining the content of lecture notebooks	87	16. Examining the content of lecture notebooks	23
11	12. Summarizing the lecture notebook	363	17. Summarizing the lecture notebook	68
12	13. Studying for the exam using the notebook	47	18. Studying for the exam using the notebook	21
13	14. Studying for the middle exam	35	23. Studying for the middle exam	33
14	15. Studying for the final exam	133	24. Studying for the final exam	34
			25. Seeing the results of the middle exam	7
15	16. Using Word	79	15. Using Word	24
16	17. Using Excel	79	14. Using Excel	18
	18. Using PowerPoint	96		
17	19. Asking using e-mail	0	13. Asking using e-mail	5
	20. Writing on the bulletin board	2		
	21. Reading the bulletin board	2		
			19. Listening to academic lectures	22
			20. Listening to the academic lecture and write a report	15
			21. Rewriting the report by elaborating it.	9
			22. Completing the report.	17
18	22. Evaluating the improved force and consciousness	21	33. Evaluating the improved force and consciousness	26
	23. Evaluating recognition rate of technical terms	8		
19	24. Listening to about final task creating slides for introducing the topics	41	26. Asking questions about the concept of learning support system.	6
20	25. Asking a teacher about final task creating slides for introducing the topics	6	27. Asking the teacher about the learning support system	12
21	26 Asking questions to friends about final task creating slides for introducing the topics	52	28. Asking questions to friends about the learning support system	16
22	27 Determining the content of the slides for introducing the topics	102	29. Determining the contents of the learning support system to be conceived	11
23	28. Examining the contents of slides for introducing the topics	229	30. Examining the contents of the learning support system	15
24	29. Creating a topic introduction slide by summarizing the contents examined	315	31. Conceiving the contents studied as a learning support system	19
	30. Evaluating yourself about slides for introducing the topics	120		
			32. Summarizing the learning support system in a report	19
	31 Reading explanation of other's slides for introducing the topics	122		
	32 Evaluating others' topics for introducing the topics	135		
25	33. Other	3	34. Other	2
Total		3834	Total	581

Cluster analyses were applied like in 3.2 and 3.3 and both consciousness and activities were categorized into three clusters.

3.5.1. Effective activities for consciousness-raising from the tables of cross tabulations of AI Technology and Artificial Intelligence. Based on the tables of cross tabulation mentioned above, frequencies of the cells according to the clusters were aggregated to create a 3×3 table of cross tabulation as shown in Table 6 on the upper left. It was also analyzed by χ^2-test as a contingency table. The results showed that the deviations of frequencies were significant ($\chi^2(4)=319$, $p<.001$). Next, residual analysis is conducted. These significant cells identify the activities effective for consciousness-raising towards competence.

The results revealed (1) that Activity Cluster 1, 'activities of review and exam preparation', was useful for raising Consciousness Cluster II,

'consciousness towards competence of cooperating, communicating and listening', and Cluster III, 'consciousness towards interest and understanding of computers'; (2) that Activity Cluster 2, 'activities to research and organize information' was effective for Consciousness Cluster I, 'consciousness towards the competence of setting up, learning and undertaking a task' and (3) that Activity Cluster 3, 'an activity to listen to lectures' was useful for Consciousness Cluster III.

Table 6. X^2-test and residual analysis of the table of cross tabulation about consciousness and activity clusters in the combination between 'AI Technology' and 'Artificial Intelligence'

Activity Cluster / Consciousness Cluster	Observed frequency				Expected frequency		
	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures	Total	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures
I. Consciousness towards the competence of setting up, learning and undertaking a task	807	625	243	1675	874.4	513.3	287.3
II. Consciousness towards competence of cooperating, communicating and listening	243	67	64	374	195.2	114.6	64.1
III. Consciousness towards interest and understanding of computers	265	80	125	470	245.4	144.0	80.6
Total	1315	772	432	2519	1315	772	432
	Adjusted residual				Significance probability		
I. Consciousness towards the competence of setting up, learning and undertaking a task	−5.7	10.2	−5.0			***	
II. Consciousness towards competence of cooperating, communicating and listening	5.4	−5.8	0.0		***		
III. Consciousness towards interest and understanding of computers	2.0	−7.1	6.0		*		***

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

3.5.2. Effective activities for consciousness-raising in the module 'AI Technology'. Based on the table of cross tabulation concerning the module of 'AI Technology', frequencies of the cells according to the clusters were aggregated to create a 3×3 table of cross tabulation as shown in Table 7 on the upper left. It was also analyzed by χ^2-test as a contingency table. The results showed that the deviations of frequencies were significant ($\chi^2(4)=417$, $p<.001$). Next, residual analysis is conducted. These significant cells identify the activities effective for consciousness-raising towards competence. The difference from the table of two modules was that Activity Cluster 1, 'activities of review and exam preparation' was not effective for Consciousness Cluster III, 'consciousness towards interest and understanding of computers'.

3.5.3. Effective activities for consciousness-raising in the module 'Artificial Intelligence'. Based on the table of cross tabulation concerning the module of 'Artificial Intelligence', frequencies of the cells according to the clusters were aggregated to create a 3×3 table of cross tabulation as shown in Table 8 on the upper left. It was also analyzed by χ^2-test as a contingency table. The results showed that the deviations of frequencies were significant ($\chi^2(4)=193$, $p<.001$). Next, residual analysis is conducted. These significant cells identify the activities effective for consciousness-raising towards competence. The commonality between the results of both modules was that the significant cells were identical whereas the difference was that the significance levels of Activity Cluster 1 and 3 in 'Artificial Intelligence' were low (5%).

3.6. Categorizing Students by Principal Component Analysis

In the academic year 2015, 36 students answered the questionnaires with 30 items concerning consciousness before and after the course participation in AI Technology. The developments between these two data were analyzed by principal component analysis. The results showed that the total rate of information in the first and second components was 54.3 % (47.3% and 7.0% respectively) from the variance ratio, meaning that the data could be explicable by two factors. Looking at a component matrix after adjustment, all thirty items in the first component were positive. Particularly Items (1) 'interest towards computer', (8) 'learning ability', (19) 'ability to properly evaluate others' ideas' and (26) 'problem-solving ability' showed higher coefficients. Therefore the first component was called 'total consciousness'. The second component included sixteen positive items and particularly (12) 'ability to explain own ideas linguistically', (13) 'ability to express ideas non-linguistically', (17) 'communicative competence' and (18) 'ability of self-assessment of ideas' showed

Table 7. X^2-test and residual analysis of the table of cross tabulation about consciousness and activity clusters in 'AI Technology'

Consciousness Cluster \ Activity Cluster	Observed frequency				Expected frequency		
	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures	Total	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures
I. Consciousness towards the competence of setting up, learning and undertaking a task	626	536	213	1375	674.2	446.3	254.5
II. Consciousness towards competence of cooperating, communicating and listening	182	58	59	299	146.6	97.1	55.3
III. Consciousness towards interest and understanding of computers	204	76	110	390	191.2	126.6	72.2
Total	1012	670	382	2064	1012	670	382
	Adjusted residual				Significance probability		
I. Consciousness towards the competence of setting up, learning and undertaking a task	−4.5	8.9	−5.0			***	
II. Consciousness towards competence of cooperating, communicating and listening	4.4	−5.2	0.6		***		
III. Consciousness towards interest and understanding of computers	1.4	−6.1	5.5				***

*** p<.001

Table 8. X^2-test and Residual Analysis of the table of cross tabulation about consciousness and activity clusters in 'Artificial Intelligence'

Consciousness Cluster \ Activity Cluster	Observed frequency				Expected frequency		
	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures	Total	1. Activities of review and exam preparation	2. Activities to research and organize information	3.. An activity to listen to lectures
I. Consciousness towards the competence of setting up, learning and undertaking a task	181	89	30	300	199.8	67.3	33.0
II. Consciousness towards competence of cooperating, communicating and listening	61	9	5	75	49.9	16.8	8.2
III. Consciousness towards interest and understanding of computers	61	4	15	80	53.3	17.9	8.8
Total	303	102	50	455	303	102	50
	Adjusted residual				Significance probability		
I. Consciousness towards the competence of setting up, learning and undertaking a task	−2.0	3.5	−0.6			***	
II. Consciousness towards competence of cooperating, communicating and listening	2.2	−2.4	−1.3		*		
III. Consciousness towards interest and understanding of computers	1.5	−4.1	2.4				*

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

higher coefficients. Therefore, the second component was called 'competence of expression and self-assessment'.

Scores of principal components concerning the developments of values between pre- and post-course participation were analyzed as variables by cluster analysis. In this way, 36 students were categorized into four clusters (see Figure 3). The horizontal axis signifies the first component (total consciousness) whereas the vertical axis is the second component (competence of expression and self-assessment). Figure 3 from right to left shows Group 1 (□, N=5), Group 2 (○, N=10), Group 3 (△, N=19) and Group 4 (＋, N=2) according to the levels of total consciousness as the degrees of consciousness-raising.

Group 1 (○) consists of students who felt that their consciousness developed the most. Group 2 (□) has a moderate level of consciousness-raising. Groups 3 (△) and 4 (＋) consider that they did not much raise total consciousness.

Looking at items whose standardized canonical discriminant function coefficients were high, positive coefficients were observed in (17) 'communicative competence' as highest (19.8) and (4) 'expanding the usage of computers in various scenes and occasions ' as the second highest (14.7). On the contrary, negative coefficients were observed in (26) 'problem-solving ability' as the highest, followed by (16) 'ability of listening to others' opinions' and (2) 'understanding of computers'. It is seen that these high coefficients contribute to the categorization of students into four groups. It is probably because the outcomes vary according to their efforts for creating presentation slides for introducing topics on artificial intelligence.

A mean of all values in Group 1 was slightly higher than the total mean of all items. This means that students in Group 1 considered all items as important so that they felt that consciousness towards all items rose. In Group 2, 26 items except Items (12) 'ability to explain own ideas linguistically', (16) 'ability of listening to others' opinions', (29) 'creativity' and (30) 'interest towards this field of study' showed high coefficients. This means that students in this group considered most of the items as important so that they felt that consciousness-raising occurred in most of the items. Coefficients in Groups 3 and 4 were lower than the total mean, showing that there was no important item. Therefore students in Group 3 considered that their consciousness levels to all items did not develop well. Finally, it seems that students in Group 4 felt no development of consciousness towards competence in all related items due to the fact that there were no positive values in the means.

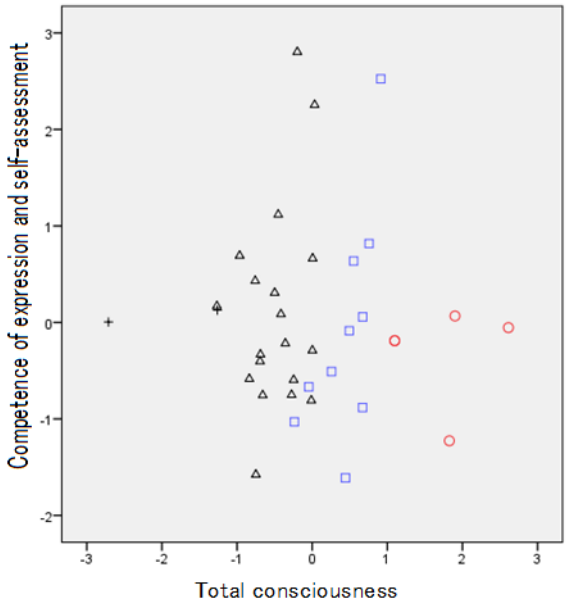

Figure 3. Categorization of students into four groups by the two principal components from cluster analysis

4. Discussion

4.1. Activities effective for consciousness-raising

As mentioned in 3.4, it was found that Activity Cluster 1, 'activities of review and exam preparation', was useful for raising Consciousness Cluster III, 'consciousness towards competence to mutually evaluate, develop and understand a task'. Activity Cluster 1 consists of Items 2 'grasp the whole image of the lectures', 6 'review', 27 'select a topic to introduce in presentation slides', 15 'prepare for final exam', 3 'ask questions about the contents of lectures to course mates', 5 'prepare for a course participation'', 17 'use Excel' and 16 'use Word'. This shows that reviewing and preparing for the module and the exam, selecting a topic for the final task and asking questions were useful for evaluating, developing and understanding a task by cooperating.

It was also revealed that Activity Cluster 2, 'activities of note-taking and creating presentation slides for introducing a topic', was effective for enhancing Consciousness Cluster II, 'consciousness towards competence to set up and undertake a task on schedule'. Activity Cluster 2 consists of Items 29 'create presentation slides by organizing the information of research', 12 'write down main points on a lecture book' and 28 'investigate a topic to introduce in the presentation slides'. This shows that making slides by organizing information and eliciting and recording the main points on a lecture book were effective for raising consciousness towards the competence of setting up and undertaking a task on schedule.

Finally, it was found that Activity Cluster 3, 'activity to listen to lectures' was useful for Consciousness Cluster I, 'consciousness towards understanding computers and knowledge of AI'. This means that learning activities to listen to lectures were effective for enhancing students' interest towards computers and expanding the usage. Because the module was about artificial intelligence which was practically learned through using computers, it raised the interest and understanding to computers and knowledge of AI.

4.2. Comparison of Effective Activities for Consciousness-Raising between 'AI Technology' and 'Artificial Intelligence'

As analyzed in 3.5, tables of cross tabulation in terms of consciousness and activities in two modules were combined into one table. It was then analyzed by cluster analysis for categorizing consciousness and activity. In this way, activities effective for consciousness-raising were identified. According to these clusters, tables of cross tabulations of the two

modules were created. They were analyzed by χ^2-test and residual analysis in order to compare the effective activities. Cells with significant differences were identical although the only differences were significance levels. The significance level in AI Technology was higher than that in Artificial Intelligence. The reason why the significance level of the latter module was lower than the former was probably because the actual frequency was relatively less so that the significance levels of Clusters 1 'activity relating to review and exam preparation' and 3 'activity relating to listening to lectures' became low (5%).

4.3. Characteristics of student clusters categorized by cluster analysis using consciousness towards competence in general

The values of consciousness towards competence were analyzed by principal component analysis in order to identify principal component scores. They were then analyzed by cluster analysis to categorize students into four clusters explained in 3.6. Means of consciousness towards competence in general and the course subject and of understanding technical terms in these clusters are shown in Table 9. The names of student clusters were given according to their characteristics of the means.

All means of Cluster 1, 'students to have greatly raised their whole consciousness', were higher than the total means, showing the highest development of consciousness in four clusters. On the contrary, Cluster 2, 'students to have greatly raised their consciousness towards the course subject' showed the higher means in both consciousness than the total means, but the mean of technical term remained the same as the total mean. This group is the second best in the development of consciousness-raising. In Cluster 3, 'students to have moderately raised their consciousness', the means of consciousness were lower than the total means whereas the one of technical terms remained the same as the total mean. This group showed the moderate degree of consciousness-raising. Finally, all means of Cluster 4, 'students to lower their consciousness' were lower than the total means, showing the lowest development of consciousness in four clusters.

Looking at Table 9, it is considered that the means of the consciousness-raising towards both competence in general and the course subject have relations in these four Student Clusters although the means of consciousness and technical terms do not. This is also seen from correlation coefficients. A correlation coefficient (r) between the means of consciousness significantly has a moderate level of correlation (r=0.50** (F(1,34)=11.3)).

Correlation coefficients between the mean of understanding technical terms and the mean of either consciousness towards competence in general or the course subject were r=0.14 (F(1,34)=0.7) and r=0.18 (F(1,34)=1.1) respectively. The results showed no significant correlations, meaning that consciousness-raising does not affect the development of knowledge. This means that knowledge does not necessarily increase even though students develop consciousness. Although both the levels of knowledge and consciousness enhanced on the whole, the development of knowledge did not relate to the consciousness-raising; rather, some students increased the consciousness and others did not regardless of the development of consciousness.

Table 9. Means of Two Types of Consciousness and of Understanding Technical Terms and Standard Deviations in Student Clusters

Cluster name	Number of students	Consciousness towards competence in general		Consciousness towards competence in the course subject		Understanding technical terms	
		m	SD	m	SD	m	SD
Students to have greatly raised their whole consciousness	5	2.56	0.54	2.47	1.12	1.78	0.97
Students to have greatly raised their consciousness towards the course subject	10	1.27	0.35	2.40	1.16	1.60	0.61
Students to have moderately raised their consciousness	19	0.35	0.37	1.75	0.72	1.66	0.76
Students to lower their consciousness	2	−1.15	0.72	0.73	0.00	0.36	0.06
Average in total	－－	0.83	0.99	1.97	1.09	1.64	0.74

5. Conclusion

This paper attempted to firstly identify activities effective for students' consciousness-raising in 'AI Technology' was examined. The results of it and 'Artificial Intelligence' were compared. The research findings were as follows;

(1) In 'AI Technology', Activity Cluster 1, 'activities to grasp an image, listen to a solution, learn and evaluate', is useful for developing Consciousness Cluster III, 'consciousness towards competence to mutually evaluate, develop and

understand a task ’. Activity Cluster 2, ‘activities of note-taking and creating presentation slides for introducing a topic’, is effective for enhancing Consciousness Cluster II, ‘consciousness towards competence to set up and undertake a task on schedule’. Activity Cluster 3, ‘an activity to listen to a lecture’, is useful for raising Consciousness Cluster I, ‘consciousness towards understanding computers and knowledge of AI’.

(2) Activities effective for students’ consciousness-raising in both modules were identical except their significance levels.

(3) In ‘AI Technology’, students were categorized into four clusters according to their characteristics by means of principal component analysis and cluster analysis.

For further research, it is possible to attempt utilizing multiple media or applying a same medium in a different way and time in order to identify various learning effects. Such research outcomes surely contribute to create more effective pedagogical environment in the classrooms.

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