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Comparison of Technical Terms and Consciousness of Blended Classes in '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. Questionnaires concerning students' understanding technical terms of the field and consciousness-raising towards competence were also conducted before and after the programs. The learning effects of a module in 'AI Technology' are compared with my previous research outcome of the module, 'Artificial Intelligence'. The reasons of difference between both modules are discussed. This paper reports their results.

Keywords: *Blended learning, class analysis, learning effects, creating presentation slides, e-learning.*

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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 supporting the various types of learning and to deepen students' understanding of course contents (Adachi, 2007; Bersin, 2004; Bonk & Graham, 2006; Miyaji, 2009). Functions of e-learning to expand learning opportunities are useful to improve the existing teaching approaches by collaborating with the face-to-face classroom activities (Mochizuki et al. 2003; Nishimori et al. 2003; Thorne, 2003). For example, students take advantage of more opportunities to prepare and review the contents of modules on the websites. Such repeated learning allows them to firmly grasp what they learn in the classroom. It is also possible for them to study the contents anytime they like after the class when they attended it and could not attend it.

My pedagogical aim was to foster problem-solving skills of university students by combining creative tasks and evaluation activities. It is a current requirement in higher education that teachers increase students' learning opportunities by supporting their preparation and review of the attended courses anywhere and anytime. In order to meet such needs, I applied the ideas of blended learning into a module called 'Introduction to Computer' (Miyaji and Yoshida, 2005). This program consisted of exercises on lecture notebooks, e-learning (incl. (1) self-study with presentation slides on course contents, (2) task-based learning and (3) interactive learning and assessment of teaching materials created by students) and quizzes. As an extracurricular task, students were asked to create teaching materials for explaining some of the technical words introduced in the course contents as assignment outside the class. The technical words appeared in the course contents. It was reported that the course worked effectively for their learning (Miyaji, Yoshida & Naruse, 2007). It was also proved that questionnaires on their levels of understanding the course subject increased the interaction between teachers and students, leading to the further pedagogical effect.

Several studies point out the recent trend that e-learning is applied to the classrooms in Japanese higher education (Saito & Kim, 2009; Arakawa, Ueki & Fuyuki, 2004) 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. Suzuki and Saishu (2005) instructed students to use an e-learning system for preparation and review of two modules, 'Programming' and 'Introduction to Information Network'.

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They reported that this approach was useful for students who had a moderate level of interest to the subject and proposed to enhance the learning effects by tutoring based on the analysis of the students' task results. Horita, Murakami & Morishita (2003) applied mini-lectures, simple teaching materials on the website and exercise books in the classroom. After the classroom analysis, they concluded that the ratio of learning progress in a group of students who achieved better results after the course was significantly high.

My previous research also proves the fact that e-learning supports students' learning activities including course preparation and review (Miyaji & Yoshida, 2005; Miyaji et al., 2007). In the academic year of 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'. Outside of the classroom, students were able to learn the course contents with the lecture slides and exercises through an e-learning system. In this way, it was aimed to enhance the understanding of the subject by autonomous learning. They were also encouraged to record the course contents in lecture notebooks provided by the author. The learning effects were reported (Miyaji, 2009a).

In this study, the learning effects of a module called 'AI Technology', which also applied the ideas of blended learning will be reported. 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. The exercise and quizzes were based on the contents that students have learnt in the lecture. Furthermore, they were asked to submit lecture notebooks for incorporating the evaluation of the notebook in the record 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 improvement 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. Although the previous studies mentioned above examined learning effects of students by using multiple media (Miyaji, 2009b; Miyaji, 2011), the difference between the effects depending on various usages of the same medium is not yet investigated. This research, therefore, attempts to identify the difference of learning effects depending on the different tasks by statistically comparing the levels of understanding technical terms, consciousness towards competency, mutual evaluations and rates to present slides in two classes. Then, these results are discussed.

Course Design and Contents

Course Contents

Target subjects are 'AI Technology' and 'Artificial Intelligence' of a selective module for third year students at the Department of Information Science in a university. It consisted of 90-minute lessons for fifteen weeks. Tables 1 and 2 show course content and lesson plan of 'AI Technology' respectively. Tables 3 and 4 show course content and lesson plan of 'Artificial Intelligence' respectively. The numbers of student participants of two modules were 36 and 30 respectively. Tables 1 and 3 shows the number of presentation slides for lectures and the number of teaching materials in a lecture notebook.

Course Design

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 cover Table 1. The number of presentation slides for lectures and the number of teaching materials in a lecture notebook in 'AI Technology'

Table 1. Course content of 'AI Technology'

Chapter	Section	No. of slides	No. of problems in notebook	No. of pages in the text
1 What is Artificial Intelligence?	1・1 What is Artificial Intelligence?	2	2	1.0
	1・2 Artificial Intelligenceの研究分野	6	3	4.0
	1・3 History of Artificial Intelligence	3	2	1.0
	1・4 The Fifth Generation Computer	7	14	4.0
2 Knowledge and reasoning	2.1 Knowledge bases	3	4	1.0
	2.2 Semantic networks	7	7	1.5
	2.3 Frame theory	8	12	5.0
	2.4 Production rule	3	13	1.0
	2.5 Predicate logics	4	3	1.5
	2.6 Reasoning	7	3	3.0
3 Expert system	3.1 What is an expert system?	3	2	1.5
	3.2 Structure of an expert system	3	3	1.0
	3.3 Kind of expert systems	4	6	1.5
	3.4 Production system	11	7	6.0
	3.5 AI language	11	4	4.5
	3.6 Knowledge engineer	3	4	1.0
	3.7 Certainty factor	2	2	1.0
	3.8 Explanation function	1	1	0.5
	3.9 Choice of rules	1	1	0.5
	3.10 Knowledge acquisition	2	5	0.5
4 Fuzzy	4.1 What is fuzzy?	2	2	1.0
	4.2 Fuzzy set	7	3	4.0
	4.3 Fuzzy operation	6	1	3.0
	4.4 Agreement degree	2	1	1.0
	4.5 Fuzzy reasoning	4	1	2.0
	4.6 Fuzzy control	2	2	1.0
5 Neuro computer	5.1 Neural network and neuro computer	2	2	0.6
	5.2 Characteristic of neuro computers	6	5	2.0
	5.3 Structure of brains	6	4	2.0
	5.4 Principle of neuro computers	3	4	2.0
	5.5 Structure of neuro computers	4	1	1.5
	5.6 Neuro chip	2	2	0.5
	5.7 Application of neuro computers	1	1	0.5
7 Natural language processing	7.1 Treatment method of natural languages	2	3	1.3
	7.2 Context-free grammar	5	3	3.2
	7.3 Augmented transition network grammar	4	2	1.7
	7.4 Semantic networks	2	1	1.3
	7.5 Case grammar	3	2	1.7
	7.6 CD theory	5	1	0.3
	7.7 Montague grammar	4	2	2.0
	7.8 Analysis of Japanese	6	2	2.5
	7.9 Structure of natural language processing system	4	1	2.8
	7.10 Application of natural language processing system	3	1	1.2
8 Machine translation	8.1 Present conditions of machine translation system	3	1	1.2
	8.2 Translation method of machine translation	9	4	4.8
	8.3 Problems of machine translation system	6	4	3.0
9 Intelligent robot	9.1 The history of robots	6	3	2.6
	9.2 Intelligence robot capability	3	6	1.5
	9.3 Various robots	12	2	9.5
10 Sound recognition	10.1 A merit and problems of sound recognition	5	2	1.2
	10.2 Method of voice inputting	3	3	1.0
	10.3 Speech understanding	4	3	1.4
	10.4 Application of speech recognition technology	3	3	1.0
	10.5 Voice syntheses	4	2	2.0
12 Other Topics	12.1 Artificial life	2	4	1.0
	12.2 Intellectual agents	3	2	0.8
	12.3 Genetic algorithm	5	4	3.0
	12.4 Games	4	3	3.0
	12.5 Quantum computer	3	3	1.0
	12.6 Data mining	2	2	0.6
Sum		253	196	118.7

Table 2. Lesson plan of 'AI Technology'

Time	Lecture Contents	Lecture								e-learning		
		No. of slides	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	Uploading files	Browsing
1	Lesson plan, Understanding survey of technical terms, Awareness survey, Section 1.1, 1.2, 1.3, 1.4	18	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	Section 2.1, 2.2, 2.3, 2.4, 2.5	25	10	Lecture notebook No.2	Exercise 2	Short test 2	Short test 1					
3	Section 2.6, 3.1, 3.2, 3.3, 3.4	39	17.5	Lecture notebook No.3	Exercise 3	Short test 3	Short test 2					
4	Section 3.5, 3.6, 3.7, 3.8, 3., 3.10, 4.1	11	4.5		Exercise 4	Short test 4	Short test 3					
5	Section 4.2, 4.3, 4.4, 4.5	19	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	Section 4.6, 5.1, 5.2, 5.3, 5.4, 5.5	23	9.1	Lecture notebook No.5	Exercise 6	Short test 6	Short test 5					
7	Midterm examination					Examination sheet						
8	Section 5.6, 5.7, 7.1, 7.2, 7.3, 7.4	16	8.5	Lecture notebook No.6	Exercise 7	Short test 7	Short test 6					
9	Section 7.5, 7.6, 7.7, 7.8, 7.9, 7.10	25	10.5		Exercise 8	Short test 8	Short test 7			Complete slide to introduce	Complete slide to introduce on AI	Slides to introduce
10	Section 8.1, 8.2, 8.3, 9.1	18	9	Lecture notebook No.7	Exercise 9	Short test 9	Short test 8					
11	Section 9.2, 9.3	21	13.6	Lecture notebook No.8	Exercise 10	Short test 10	Short test 9				Self-evaluation and other evaluation	
12	Section 10.1, 10.2, 10.3, 10.4, 10.5	15	4.6	Lecture notebook No.9	Exercise 11	Short test 11	Short test 10			Other evaluation		Other evaluation
13	Section 12.1, 12.2, 12.3, 12.4	14	6.8	Lecture notebook No.10	Exercise 12	Short test 12	Short test 11			Revised slide to introduce	Revised slide to introduce	Revised slides to introduce
14	Section 12.5, 12.6	9	4.6		Exercise 13	Short test 13	Short test 12			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		Other reevaluation, survey of technical terms and awareness	Other reevaluation

Table 3. The Number of presentation slides for lectures and the number of teaching materials in a lecture notebook in 'Artificial Intelligence'

Chapter	Section	No. of slides	No. of exercises	No. of problems in notebook
1. Artificial Intelligence and Knowledge Engineering	1.1 Knowledge	9	13	4
	1.2 Information processing in the brain	7	6	6
	1.3 Artificial intelligence	7	9	6
	1.4 Knowledge engineering	12	19	6
	1.5 Expert system	8	10	3
	1.6 Cognitive science	6	3	3
2. Knowledge Representation	2.1 Kind of knowledge	9	20	8
	2.2 Necessity of knowledge representation	5	7	4
	2.3 Semantic network	14	16	11
	2.4 Frame theory	14	25	20
	2.5 Production system	23	29	17
3. CAI	3.1 Significance of CAI	7	16	8
	3.2 Construction of CAI	6	6	2
	3.3 Learning pattern of CAI	28	23	17
	3.4 Devices to improve the learning effects of CAI	5	2	1
4. Intelligent CAI	4.1 History of intelligent CAI	9	9	9
	4.2 Basic construction of intelligent CAI	7	13	7
	4.3 Knowledge base of teaching materials	13	11	7
	4.4 Student model	27	25	19
	4.5 Tutoring rule base	11	10	8
	4.6 User interface	8	4	2
	4.7 Inference engine	7	2	2
	4.8 Answer matching and diagnosis processing	9	3	2
	4.9 Exercise generation	10	5	4
	4.10 Learning history	6	2	3
	4.11 Question and answer	16	3	3
Total		283	291	182

Table 4. Lesson plan of 'Artificial Intelligence'

Time	Lecture Contents	Lecture						e-learning		
		No. of slides	Documents distributed	Short test	Answer slide of short test	Survey of technical terms	Awareness survey	Downloading files	Uploading files	Browsing
1	Advance questionnaire, Section 1.1, 1.2, 1.3	23	Lesson plan, Lecture notebook No.1	Short test 1		Pre-understanding survey of technical terms	Pre-awareness survey	Evaluation form	Survey of technical terms and awareness	
2	Section 1.4, 1.5, 1.6, 2.1	29	Lecture notebook No.2	Short test 2	Short test 1					
3	Section 2.2, 2.3	19		Short test 3	Short test 2					
4	Section 2.4, 2.5	17		Short test 4	Short test 3					
5	Section 2.5	20		Short test 5	Short test 4					
6	Section 3.1, 3.2, 3.3, 3.4	46	Lecture notebook No.3	Short test 6	Short test 5					
7	Explanation for planned study support systems, Exercise by e-learning		Explanation sheet of final task		Short test 6			Explanation form for planning study support systems		
8	Midterm examination			Examination sheet						
9	Section 4.1, 4.2, 4.3	29	Lecture notebook No.4	Short test 7				Registration of slides to introduce planned study support systems	Submission of complete slide to introduce planned study support systems	Observation slides to introduce
10	Section 4.4, 4.5, 4.6, 4.7	53		Short test 8	Short test 7				Self-evaluation and other evaluation	
11	Section 4.8, 4.9, 4.10, 4.11	41		Short test 9	Short test 8					
12	Peer assessment for planned study support systems		Peer assessment form		Short test 9			Registration of other evaluation form		Browsing on other evaluation
13	Exercise by e-learning							Registration of revised slide to introduce	Submission of revised slide to introduce	Browsing revised slides to introduce
14	Peer assessment for planned study support systems, posteriori questionnaire		Peer assessment form			Post-understanding survey of technical terms	Post-awareness survey	Registration of other reevaluation form	Self-reevaluation and other reevaluation	
15	Final examination								Survey of technical terms and awareness	Browsing on other reevaluation

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 the blackboard. Students also answered a few quizzes for the last 10 minutes by using the textbook (Touchi, 2010) or other resource for reference. Students were encouraged to use lecture notebooks for course preparation and review. It was 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) exercises, (3) quizzes and (4) lecture notebooks was repeated to develop the students' understanding of the course.

As a final task, students in 'AI Technology' 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. Meanwhile, students in 'Artificial Intelligence' created presentation slides for designing a learning support system and introducing it. 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. 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 Artificial Intelligence 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. In this way, the class blended a lecture with e-learning.

E-learning Contents

E-learning was applied as one of the approaches to support students' learning outside the classroom. Its purpose was to deepen their understanding of the course contents. Functions of e-learning included: (1) observing students' presentation slides introducing the latest topics on 'AI Technology' or introducing a learning support system designed on 'Artificial Intelligence'; (2) downloading learning resources and evaluation sheets; (3) uploading files for submission; (4) e-mailing to the instructor for questions and (5) checking notices. Apart from this, this study also provided students with lecture notebooks for autonomous learning (see Figure 1).

Contents of Presentation Slides Created in 'AI Technology' and 'Artificial Intelligence'

The final task of program in 'AI Technology' was to investigate the latest topics on AI and to summarize it into six presentation slides. The aim was to enhance students' knowledge on AI technology and AI itself by deepening and expanding the course contents by applying what they learned in the classroom. 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.

The final task of the program in 'Artificial Intelligence' was to design a learning support system and to introduce it by six presentation slides. Contents for presentation consisted of the followings: (1) content (motivation, learning subject person, an aim, learning item); (2) learning function (learning contents, problems, a commentary, and a term search have to concretely describe more than one); (3) screen constitution (concretely drawing a screen); (4) (i) knowledge base of teaching materials (Write the knowledge representation such as the teaching materials, problems, the commentary, etc. This expression is used for answer matching and diagnosis processing.); (ii) instruction strategy (learning method to a learning state of the student model); (5) (i) inference mechanism (Explain method to interpret and educe the contents which are memorized in a knowledge base using a concrete example.); (ii) student model (This is information to use in instruction strategy.); (iii) method to learn (Write a step in a flowchart or enumeration form.); (6) (i) answer evaluation method (method to collate and to evaluate an answer); (ii) diagnosis processing method (method to diagnose the error of the answer); (iii) system configuration (necessary database and module program unit).

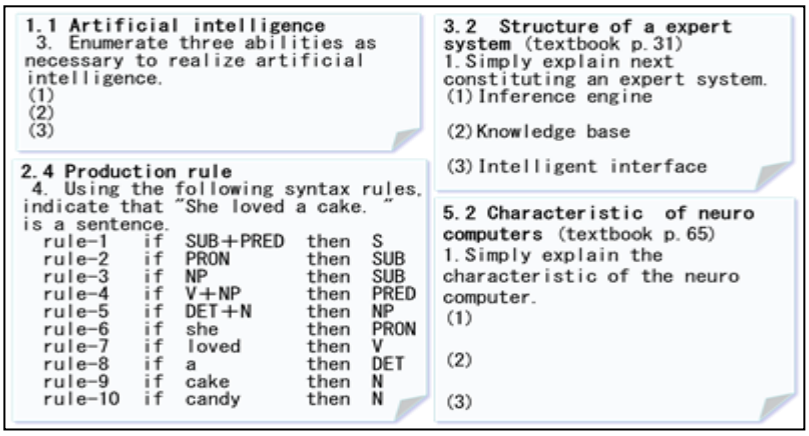

Figure 1. An extract of a lecture notebook on 'AI Technology'

Mutual Evaluations of Presentation Slides

On the sixth week (before a month of submission), the purpose and the procedure of the final task were instructed in the classroom by providing two sheets of handouts. Later on, students downloaded a PowerPoint file including six slides explaining the contents of presentation. They were required to use them as a framework, add what they researched on them and submit them to a server before the ninth week. The author then combined all the submitted slides into one file and uploaded it on the e-learning system so that the students were able to download them for observation and evaluation. Students observed and evaluated them and submitted the evaluation sheets online.

The evaluation in the sheet was pasted and reorganized according to each student into a new Excel file that was available for downloading one day after the submission. Based upon the feedback, students modified and improved their slides. Then, they resubmitted them before the thirteenth week. They were again mutually evaluated among students until the fifteenth week and the evaluation sheets were submitted. They were again pasted and reorganized according to each student into a new Excel file that became available for downloading on the next day of submission.

Analyses Results

Questionnaire surveys about the understanding of technical terms in the subject of AI technology and consciousness towards competence were conducted before (the first week) and after (the final week) the program. The former survey investigated whether students developed the knowledge in this field throughout the module whereas the latter aimed to identify the effects of their consciousness-raising after participating in the blended learning environment. The data of the surveys were analyzed by a t-test. 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, $\chi 2$-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. The consciousness-raising and the improvement of the level of understanding technical terms were also explained by multivariate analysis. By comparing the first round of mutual evaluations of presentation slides with the second round, learning effects of interactions among students and between the instructor and students were also demonstrated.

This study also investigated the different learning effects between the two modules, 'AI Technology' and 'Artificial Intelligence'. Firstly, the improvements of the levels of understanding technical terms after participating in the programs were compared. Secondly, the degrees of consciousness-raising towards competence were statistically examined between the two modules. Thirdly, effective activities for consciousness-raising were also comparatively analyzed to identify the different reasons of how students improve their consciousness. Finally, how students evaluated others differently according to tasks was also identified.

In this paper, it is considered that a significant difference is observed if a significance level is 5%. Signs such as 'm', 'SD', 't', and 'p' signify 'mean', 'standard deviation', 'test statistics' and 'significance probability' respectively. Significance levels of 0.1%, 1%, 5% and 10% are shown as ***, **, *, + respectively. Numbers in brackets signify item numbers of consciousness whereas numbers without brackets signify item numbers of activities.

The Improvement of the Levels of Understanding Technical Terms

A survey on the understanding of 78 technical terms (Mochizuki et al., 2003; Nishimori et al., 2003) relating to the course contents of a module, 'AI Technology', was conducted twice before (the first week) and after (the fifteenth week) the program. The number of participants was 36.

A five-item scale (5: I know; 4: I know a little; 3: I don't know in detail but I've heard of it; 2: I don't know well; 1: I don't know) was applied for the survey. The means of pre and post-participation of the course were 2.2 and 3.8 respectively. The results of paired t-tests of all 78 terms and pre and post-participation are shown on lower end of Table 5. The significant difference was observed (significance level = 0.1%) in the results. The level of understanding has improved on the whole, showing that the knowledge of technical terms developed after participating in the program.

Furthermore, a t-test of each term was also conducted, showing significant differences in all of 78 terms. This means that students' understanding improved after participating in the program.

Comparing the Levels of Understanding Technical Terms between 'AI Technology' and 'Artificial Intelligence'

This section compares the enhancement of understanding the technical terms introduced in both two modules, 'AI Technology' and 'Artificial Intelligence'. Although the course contents of these modules resemble, final tasks required to students differ. In the former program, which was thoroughly examined the learning effects by conducting blended learning in my previous study in 2005 (Miyaji, 2009; Miyaji, 2011), students were required to submit reports on designing a learning support system whereas the latter asked course participants to create presentation slides for introducing the latest topics on AI. This research, therefore, attempts to identify the different learning effects depending on the different tasks by statistically comparing the improvements of the levels of understanding technical terms.

Table 5. Improvement of the level of understanding technical terms in the course 'AI Technology' and 'Artificial Intelligence'

AI Technology									
No	Technical Terms	Pre		Post		Elongation		t-test	
		m	SD	m	SD	m	SD	t	p
1	Degree of coincidence	2.0	1.0	3.9	0.9	1.8	1.1	9.7	***
2	Genetic algorithm	2.2	1.1	3.8	0.9	1.6	1.1	8.6	***
3	Interface	3.3	0.8	4.0	0.9	0.7	1.0	3.9	***
4	Semantic analysis	2.4	1.0	3.9	0.8	1.6	1.0	9.6	***
5	Semantic network	2.2	1.0	3.9	0.9	1.7	1.1	9.1	***
6	Expert system	2.0	1.0	4.0	0.9	1.9	1.2	9.8	***
7	Voice synthesis	2.9	1.1	4.0	0.9	1.2	1.2	5.8	***
8	Sound recognition	3.2	0.8	4.0	0.9	0.8	1.0	5.1	***
9	Speech understanding	2.7	1.0	4.1	0.9	1.4	1.2	6.8	***
10	Chaos	2.4	1.0	3.4	1.0	1.0	1.2	4.8	***
11	Certainty factor	2.0	1.1	3.8	1.0	1.7	1.3	7.8	***
12	Augmented transition grammar	1.7	0.9	3.4	1.1	1.7	1.2	8.4	***
13	Case grammar	1.6	0.9	3.7	1.1	2.1	1.2	10.6	***
14	Image recognition	3.1	1.0	4.1	0.9	1.1	1.0	6.7	***
15	Image understanding	2.6	1.2	4.1	1.0	1.5	1.3	6.8	***
16	Sensitivity processing	1.9	0.9	3.6	1.0	1.8	1.0	10.5	***
17	Machine learning	2.2	1.0	4.0	0.9	1.8	1.0	11.3	***
18	Machine translation	2.5	0.9	4.0	0.8	1.5	1.0	9.2	***
19	Machine translation system	2.4	1.0	4.0	0.8	1.6	1.0	8.9	***
20	Morphological analysis	1.9	1.0	3.4	1.2	1.6	1.1	8.4	***
21	Parsing	2.1	1.1	3.8	0.9	1.7	1.2	8.2	***
22	Syllogism	2.5	1.1	3.8	0.9	1.3	1.0	7.8	***
23	Threshold	2.3	1.2	3.8	1.0	1.4	1.1	7.6	***
24	Natural language processing	2.2	1.2	3.9	0.9	1.8	1.1	9.7	***
25	Synapse	2.5	1.1	3.8	1.0	1.3	1.0	7.9	***
26	Predicate logic	2.2	1.0	3.8	0.9	1.6	1.1	8.7	***
27	Information filtering	2.1	0.9	3.6	1.0	1.6	1.0	9.8	***
28	Artificial life	2.9	1.1	4.0	1.0	1.2	1.1	6.3	***
29	Artificial intelligence	3.2	0.9	4.3	0.9	1.1	0.9	7.4	***
30	Inference	2.6	1.0	4.1	0.8	1.4	1.1	7.7	***
31	Inference engine	2.1	1.0	3.9	0.9	1.9	1.1	10.4	***
32	Inference ability	2.1	0.9	3.8	0.9	1.7	1.0	10.3	***
33	Property inheritance	1.9	1.0	3.7	1.0	1.8	1.2	9.3	***
34	Declarative knowledge	1.7	0.9	3.6	0.9	1.9	1.1	10.4	***
35	Fifth-generation computer	2.6	0.9	4.0	0.8	1.4	1.2	7.2	***
36	Knowledge acquisition	2.1	1.0	3.8	1.1	1.8	1.1	9.1	***
37	Knowledge engineering	1.9	1.0	3.7	1.1	1.7	1.2	8.2	***
38	Knowledge representation	2.1	1.0	3.8	1.1	1.7	1.1	8.7	***
39	Knowledge base	2.0	0.9	4.0	0.9	2.0	1.0	11.8	***
40	Intellectual agent	1.6	0.9	3.8	1.1	2.1	1.1	10.8	***
41	Intelligent robot	2.5	1.0	4.1	0.8	1.5	1.2	7.3	***
42	Data mining	1.8	0.9	3.8	1.2	1.9	1.1	10.7	***
43	Daemon	2.1	1.0	3.5	1.0	1.5	1.2	7.5	***
44	Procedural knowledge	1.8	1.0	3.6	1.1	1.8	1.1	10.2	***
45	Default value	2.5	1.2	3.8	1.0	1.3	1.3	5.6	***
46	Transfer method	2.0	1.1	3.6	1.0	1.6	1.1	8.6	***
47	Knowledge engineer	1.7	0.9	3.6	1.0	1.9	1.0	10.9	***
48	Neural network system	1.8	1.0	3.7	0.9	1.9	0.9	11.9	***
49	Neural network	1.8	1.0	3.8	0.8	2.0	0.9	12.6	***
50	Neuro computer	1.9	1.0	3.8	1.0	1.8	1.0	10.7	***
51	Neuro chip	2.0	1.0	3.6	1.0	1.6	1.0	9.4	***
52	Cognitive science	1.9	1.0	3.6	1.1	1.6	1.1	8.2	***
53	Structure of the brain	2.5	1.0	3.8	0.9	1.3	1.1	6.5	***
54	PC	3.8	1.1	4.2	0.8	0.4	1.2	2.1	*
55	Pivot method	1.9	1.1	3.5	1.0	1.6	1.2	8.0	***
56	Fuzzy	1.7	0.9	3.9	1.0	2.2	1.1	12.0	***
57	Fuzzy operation	1.7	0.9	3.8	0.9	2.1	1.0	12.2	***
58	Fuzzy set	1.7	0.9	4.6	4.9	2.9	4.7	3.7	***
59	Fuzzy reasoning	1.6	0.9	3.8	1.0	2.2	1.0	12.3	***
60	Fuzzy control	1.6	0.9	3.8	1.0	2.2	1.0	12.3	***
61	Facet	1.5	0.8	3.6	1.0	2.0	1.0	11.8	***
62	Reasoning with the frame	1.8	1.0	3.8	0.9	1.9	1.1	10.0	***
63	Frame theory	1.7	0.9	3.8	1.0	2.0	1.2	10.2	***
64	Production system	1.6	0.8	3.8	0.9	2.2	1.0	13.1	***
65	Production rule	1.6	0.8	3.8	0.9	2.2	1.0	12.6	***
66	Context-free grammar	1.6	0.9	3.5	1.0	1.9	1.0	11.2	***
67	Parallel computation	2.5	1.1	3.8	0.9	1.4	1.2	6.7	***
68	Membership function	1.5	0.8	3.6	1.0	1.9	1.1	10.9	***
69	Montague grammar	1.5	0.8	3.6	1.0	2.1	1.0	12.6	***
70	Quantum computer	2.4	1.0	3.8	0.9	1.4	1.0	8.4	***
71	Choice of the rule	2.1	1.2	3.6	1.0	1.4	1.2	7.3	***
72	Robot	3.2	1.2	4.0	1.0	0.9	1.2	4.2	***
73	AI language	2.4	1.2	3.9	0.9	1.4	1.4	6.2	***
74	AND tree	2.6	1.3	3.9	0.8	1.3	1.5	5.0	***
75	Conceptual Dependency theory	2.0	1.1	3.5	1.0	1.4	1.2	6.9	***
76	LISP	1.7	0.9	3.6	1.1	1.9	1.1	10.2	***
77	OR tree	2.5	1.2	3.8	0.9	1.3	1.4	5.3	***
78	PROLOG	1.7	0.9	3.6	1.1	1.8	1.2	8.8	***
Average		2.2	0.5	3.8	0.2	1.6	0.4	37.1	***

Artificial Intelligence									
No	Technical terms	Pre		Post		Elongation		t-test	
		m	SD	m	SD	m	SD	t	p
1	PC	4.9	0.5	4.7	0.9	-0.1	0.7	1.0	
2	Knowledge	3.8	0.6	4.3	0.5	0.5	1.4	1.8	+
3	Data	4.3	0.5	4.5	0.5	0.2	1.2	0.9	
4	Information	4.1	0.5	4.4	0.5	0.3	1.2	1.2	
5	Inference	3.2	0.6	4.3	0.5	1.1	1.6	3.6	**
6	Expertise	3.7	0.6	4.3	0.5	0.5	1.3	2.3	*
7	Problem solving	3.9	0.6	4.0	0.6	0.1	1.4	0.5	
8	Decision support	1.7	0.5	3.6	0.6	1.9	1.1	9.5	***
9	Knowledge base	1.7	0.5	4.1	0.6	2.3	1.3	9.9	***
10	Inference engine	1.5	0.4	3.9	0.6	2.4	1.4	9.2	***
11	Intelligent computers	2.1	0.6	4.0	0.6	1.9	1.3	7.9	***
12	Neuron	2.4	0.7	4.0	0.6	1.6	1.6	5.4	***
13	Learning	4.3	0.5	4.5	0.5	0.2	1.1	1.0	
14	Memory	4.3	0.5	4.3	0.5	0.1	1.3	0.3	
15	Presumption	3.6	0.6	4.0	0.6	0.4	1.5	1.4	
16	Inductive inference	1.9	0.6	3.4	0.5	1.5	1.5	5.4	***
17	Deductive reasoning	1.3	0.4	3.1	0.5	1.7	1.2	7.5	***
18	Intelligence	3.8	0.6	4.2	0.6	0.4	1.2	1.8	+
19	Artificial intelligence	3.2	0.6	4.3	0.5	1.1	1.5	4.0	***
20	Knowledge engineering	1.9	0.5	3.9	0.6	2.1	1.5	7.4	***
21	Resolution principle	1.1	0.2	2.7	0.6	1.6	1.1	8.0	***
22	Knowledge expression	2.0	0.7	3.9	0.6	1.9	1.7	5.9	***
23	Use of knowledge	2.0	0.7	3.9	0.6	1.9	1.7	5.9	***
24	Acquisition of knowledge	2.1	0.6	4.0	0.6	1.9	1.7	6.2	***
25	Expert system	1.7	0.5	4.1	0.6	2.4	1.6	8.2	***
26	Knowledge processing system	1.3	0.4	3.4	0.6	2.1	1.5	7.4	***
27	Heuristics	1.0	0.0	2.4	0.5	1.4	1.1	7.2	***
28	Declarative knowledge	1.0	0.0	2.7	0.6	1.7	1.2	7.7	***
29	Factual knowledge	1.0	0.0	2.8	0.7	1.8	1.3	7.4	***
30	Procedural knowledge	1.0	0.0	3.0	0.7	2.0	1.5	7.4	***
31	Knowledge-based system	1.1	0.2	3.7	0.5	2.6	1.1	13.3	***
32	Semantic network	1.2	0.3	4.3	0.5	3.1	1.2	13.4	***
33	Inheritance of property	1.3	0.3	3.5	0.6	2.2	1.4	8.5	***
34	Frame-based representation	1.3	0.3	4.1	0.6	2.9	1.3	11.6	***
35	Production rule	1.0	0.0	3.8	0.6	2.8	1.2	12.3	***
36	Blackboard model	1.1	0.2	3.8	0.6	2.7	1.3	11.2	***
37	Database	3.6	0.7	4.1	0.6	0.5	1.5	2.0	+
38	CAI	3.0	0.8	4.1	0.6	1.1	1.5	4.0	***
39	CAI courseware	1.3	0.4	2.6	0.5	1.3	1.2	5.6	***
40	Intelligent CAI	1.5	0.5	3.7	0.5	2.2	1.5	7.9	***
41	Teaching expertise	1.3	0.3	3.2	0.6	1.9	1.4	7.4	***
42	Guidance strategy	1.4	0.4	3.5	0.6	2.1	1.7	6.7	***
43	Knowledge base of teaching materia	1.2	0.3	3.3	0.6	2.1	1.4	8.4	***
44	Student model	1.5	0.5	3.7	0.6	2.2	1.5	7.9	***
45	Exercise generation	2.0	0.7	4.0	0.6	2.0	1.8	6.0	***
46	Knowledge for user interfaces	1.4	0.4	3.3	0.6	1.9	1.4	7.4	***
47	Kind of bug	1.5	0.4	3.4	0.5	1.9	1.1	9.5	***
48	Method of Answer matching	1.4	0.4	3.5	0.6	2.1	1.3	9.1	***
49	Learning history	2.7	0.8	3.9	0.6	1.3	1.5	4.5	***
50	Question and answer method	2.1	0.7	3.7	0.5	1.7	1.7	5.2	***
Average		2.2	0.2	3.8	0.4	1.6	0.8	11.0	***

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

There are thirteen terms in common between two modules (see Table 6). The number of questionnaire participants on the levels of understanding technical terms was 36 in the module 'AI Technology' and 30 in 'Artificial Intelligence'. Table 6, on the right, shows the results of independent t-tests concerning the difference of the levels of understanding the technical terms in pre and post-course participation. The results showed that there is a tendency of the significant

difference between the means of the enhancement for 'AI Technology' and that for 'Artificial Intelligence'. This means that the knowledge in the latter module tends to increase in whole more than the former program after participation.

The comparison of all the thirteen means of the enhancement of the technical term understanding in both modules was conducted by t-test. The results showed that the knowledge of '35 Production rule', '34 Frame representation' and '32 Semantic network' in the latter module increase and that of '10 Inference engine' tends to increase more than the former program after participation. On the other hand, the results showed that the knowledge of '1 PC' in the latter module does not increase more than that in the former program after participation.

Table 6. Comparisons of the levels of understanding common technical terms between 'AI Technology' and 'Artificial Intelligence'

AI Technology						Artificial Intelligence						Comparison	
No	Technical Terms	Elongation		t-test		No	Technical Terms	Elongation		t-test		t-test	
		m	SD	t	p			m	SD	t	p	t	p
65	Production rule	2.2	1.0	12.6	***	35	Production rule	2.8	1.2	12.3	***	2.3	*
34	Declarative knowledge	1.9	1.1	10.4	***	28	Declarative knowledge	1.7	1.2	7.7	***	1.0	
31	Inference engine	1.9	1.1	10.4	***	10	Inference engine	2.4	1.4	9.2	***	1.7	+
63	Frame theory	2.0	1.2	10.2	***	34	Frame representation	2.9	1.3	11.6	***	2.8	**
44	Procedural knowledge	1.8	1.1	10.2	***	30	Procedural knowledge	2.0	1.5	7.4	***	0.5	
6	Expert system	1.9	1.2	9.8	***	25	Expert system	2.4	1.6	8.2	***	1.3	
33	Property inheritance	1.8	1.2	9.3	***	33	Property inheritance	2.2	1.4	8.5	***	1.2	
5	Semantic network	1.7	1.1	9.1	***	32	Semantic network	3.1	1.2	13.4	***	4.8	***
36	Knowledge acquisition	1.8	1.1	9.1	***	24	Knowledge acquisition	1.9	1.7	6.2	***	0.5	
38	Knowledge representation	1.7	1.1	8.7	***	22	Knowledge representation	1.9	1.7	5.9	***	0.7	
30	Inference	1.4	1.1	7.7	***	5	Inference	1.1	1.6	3.6	**	1.1	
29	Artificial intelligence	1.1	0.9	7.4	***	19	Artificial intelligence	1.1	1.5	4.0	***	0.2	
54	PC	0.4	1.2	2.1	*	1	PC	−0.1	0.7	1.0		2.2	*
Average		1.7	0.4	13.0	***	Average		1.9	0.8	8.0	***	1.8	+

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

Consciousness-Raising towards Competence in General

Questionnaires with 30 items (see Table 4) about consciousness-raising towards competence in general were also conducted before (the first class) and after (the final class) the program of 'AI Technology'. A nine-degree scale was applied as: 1. Not at all agree; 3. Slightly agree; 5. Agree a little; 7. Certainly agree and 9. Strongly agree. Table 7 shows the results of: (1) the average rating values of pre and post-course; (2) means of consciousness-raising; (3) standard deviation; (4) t-value and (5) significance probability. The number of questionnaire participants (both pre and post-course participation) was 36.

The t-test results of the means of consciousness-raising in all 30 items showed significant differences (significance level = 0.1%). This means that the whole consciousness towards competence in general became high after participating in the program.

After conducting a t-test of the mean of consciousness-raising of each item, 28 items showed significant differences (see Table 7) except items (1) and (30). This means that the program mostly developed students' consciousness towards competence in general mentioned in the questionnaires.

Item (1), 'Interest towards computer', was already the highest in the pre-course questionnaires (= 6.4). This may be the reason why it did not develop significantly. On the other hand, Item (30), 'Interest towards this area of study', did not develop. Because there was no significant difference between the average rating values of pre and post-course, the values of consciousness towards the course subject were analyzed by t-test. As a result, all 15 items showed significant differences (significance level = 0.1%) as shown in Table 8. This means that the consciousness towards the course subject developed on the whole.

A t-test of each item concerning the consciousness towards the course subject showed that students significantly raised their consciousness towards 13 items, and one item showed the tendency of significant difference as shown in Table 8. Only Item (33), 'Motivation to undertake a task', did not show any significant difference. It was found that most of the items in 'AI Technology' were significantly developed, particularly the knowledge of the contents of this program.

The items of consciousness were categorized into two: (1) consciousness towards competence and (2) consciousness towards the course subject. Means of consciousness-raising of both categories were analyzed by t-test and the results showed significant difference ($t(43)=3.6$, $p<.01$). This indicates that the latter category has developed more than the former. One of the reasons is the fact that the mean of consciousness towards the subject in the pre-course was lower than competence.

Table 7. Results of t-tests concerning the consciousness-raising towards competence in general before and after participating in 'AI Technology' and 'Artificial Intelligence'

Consciousness related to ability	AI Technology				Artificial Intelligence				t-test between two modules	
	Elongation		t-test		Elongation		t-test			
	m	SD	t	p	m	SD	t	p	t	p
(1) Interest in and curiosity about computers	0.4	1.9	1.3		0.5	1.0	1.9	+	0.3	
(2) Understanding of computers	0.8	1.3	3.5	**	0.9	1.3	2.6	*	0.6	
(3) Computer operation skills	0.9	1.5	3.7	***	0.7	1.9	1.5		0.4	
(4) Computer usage methods and broadening of situations	0.8	1.6	2.9	**	0.7	1.6	1.7		0.1	
(5) Ability to set challenges, ability to discover problems	0.9	1.6	3.5	**	1.2	1.6	2.7	*	0.7	
(6) Ability to plan, to do things in a planned manner	0.8	1.3	3.3	**	1.3	1.6	3.2	**	1.6	
(7) Cultivation of understanding of knowledge learned	1.0	1.3	4.4	***	1.3	1.8	2.7	*	0.8	
(8) Ability to study by oneself, ability to learn	1.1	1.3	5.1	***	1.4	1.5	3.4	**	0.7	
(9) Ability to gather information, ability to conduct research	0.6	1.6	2.3	*	0.5	2.1	1.0		0.2	
(10) Ability to sort through related information or data	1.1	1.6	4.0	***	0.9	1.5	2.3	*	0.4	
(11) Ability to analyse information	1.0	1.4	4.3	***	0.9	1.9	1.8	+	0.2	
(12) Ability to express thoughts in writing	0.9	1.2	4.4	***	1.3	1.5	3.1	**	1.2	
(13) Ability to express thoughts through media other than writing	0.8	1.6	2.8	**	1.3	1.5	3.2	**	1.3	
(14) Ability to talk to and explain to others comprehensively	1.3	1.5	5.1	***	0.5	1.5	1.1		2.1	+
(15) Ability to make presentations	1.0	1.3	4.3	***	1.1	2.0	2.0	+	0.2	
(16) Ability to listen to others and to ask questions to others	0.8	1.5	3.1	**	0.9	1.6	2.0	+	0.2	
(17) Communication ability	0.9	1.2	4.4	***	1.2	1.6	2.7	*	0.9	
(18) Ability to appropriately self-evaluate one's thoughts	0.7	1.7	2.3	*	0.7	1.7	1.6		0.2	
(19) Ability to appropriately evaluate other people's thoughts	0.9	1.6	3.3	**	0.3	1.4	0.7		1.7	
(20) Ability to correct and improve on one's own thoughts	0.9	1.3	4.0	***	0.9	1.5	2.1	+	0.1	
(21) Ability to pursue matters deeply, ability to explore matters	1.0	1.7	3.4	**	1.5	2.2	2.5	*	1.0	
(22) Ability to execute, ability to practice, ability to put into action	1.1	1.3	4.9	***	1.1	1.6	2.6	*	0.1	
(23) Ability to cooperate and to learn concertedly	0.8	1.6	2.8	**	0.9	1.9	1.7		0.3	
(24) Sense of accomplishment, sense of satisfaction	0.6	1.5	2.2	*	1.2	1.0	4.3	***	2.0	+
(25) Sense of fulfilment, sense of achievement	0.5	1.4	2.2	*	1.2	1.2	3.7	**	2.0	+
(26) Ability to solve problems	1.1	1.5	4.4	***	1.3	2.1	2.2	*	0.4	
(27) Ability to construct and create knowledge	1.0	1.3	4.8	***	1.3	1.8	2.8	*	0.8	
(28) Ability to think, consider and come up with ideas by oneself	0.7	1.5	2.8	**	0.7	1.9	1.3		0.1	
(29) Creativity/ability to create	0.7	1.5	2.8	**	1.2	2.3	2.0	+	1.0	
(30) Interest in and curiosity about this field	0.1	1.6	0.4		0.9	1.3	2.7	*	2.3	*
Average	0.8	0.2	19.3	***	0.9	0.3	16.6	***	1.6	

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

Table 8. T-tests of consciousness towards the subject in 'AI Technology'

Awareness related to ability	pre		post		Elongation		t-test	
	m	SD	m	SD	m	SD	t	p
(31) Interest in and curiosity about Artificial Intlligence	5.7	1.6	6.3	1.5	0.6	1.6	2.2	*
(32) Motivation for learning about Artificial Intlligence	5.5	1.5	6.1	1.4	0.6	1.4	2.4	*
(33) Will to address on a final task	5.3	1.4	5.7	1.4	0.4	1.7	1.5	
(34) Ability to accomplish for a final task till the last	5.5	1.3	6.0	1.3	0.5	1.3	2.3	*
(35) Ability to understand the thought of others	5.3	1.5	5.9	1.4	0.6	1.7	2.0	+
(36) Ability to understand the introduction slide of others	5.1	1.6	6.0	1.3	1.0	1.7	3.5	**
(37) Knowledge about the Artificial Intelligence	3.3	1.6	5.8	1.3	2.5	2.0	7.4	***
(38) Knowledge about knowledge and the reasoning	3.2	1.5	5.5	1.3	2.3	1.6	8.5	***
(39) Knowledge of expert system	2.6	1.5	5.5	1.4	2.9	1.5	11.2	***
(40) Knowledge of fuzzy	2.3	1.3	5.3	1.4	3.0	1.7	10.2	***
(41) Knowledge of neuro computer	2.2	1.2	5.3	1.4	3.1	1.6	11.2	***
(42) Knowledge of natural language processing	2.6	1.5	5.7	1.5	3.1	1.7	10.8	***
(43) Knowledge of machine translation	2.4	1.3	5.3	1.4	2.9	1.8	9.9	***
(44) Knowledge of intelligent robot	2.5	1.3	5.5	1.4	3.0	1.7	10.2	***
(45) Knowledge of sound recognition	2.5	1.6	5.8	1.5	3.2	1.9	10.1	***
Average	3.7	1.4	5.7	0.3	2.0	1.1	6.5	***

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

Comparison between 'AI Technology' and 'Artificial Intelligence' Concerning the Consciousness-raising towards Competence in General

The right part of Table 7 shows the consciousness-raising towards competence before and after participating in the course of 'Artificial Intelligence'. The comparison between 'AI Technology' (N = 36) and 'Artificial Intelligence' (N = 30) is also shown next to it in Table 7.

Means of pre-course and post-course consciousness and of the degrees of consciousness-raising between them in both programs were analyzed by t-test. The number of items showing either significant differences or the tendency of significance was [28 and 0] respectively for 'AI Technology' and [16 and 6] respectively for 'Artificial Intelligence'. The number of items developed in the former module was slightly more than the latter.

The means of pre and post-course consciousness and the degrees of consciousness-raising between both modules were also analyzed by t-test. The results indicated that only Item (2) in the pre-course mean showed the significant difference and that items (12) and (29) showed the tendency of significant difference. Concerning the means in the post-course consciousness, there was no significant difference. In terms of the means of the degrees of consciousness-raising, only Item (30) showed significant difference whereas Items (14), (24) and (25) had the tendency of significant difference as in the right of the Table 7.

These results showed that there was no much difference between the means of the degrees of consciousness-raising in both modules even though there was a slight difference in the number of items showing either significant differences or the tendency of significance. Items showing significant differences or the tendency of difference were: (30) 'Interest towards this field of study', (14) 'Competence to explain a topic clearly', (24) 'Satisfaction' and (25) 'Sense of accomplishment'.

The Contents and Developments of Mutual Evaluations of the Final Task in 'AI Technology' and 'Artificial Intelligence'

'AI Technology' had taken place in 2015, and students were required to research the latest topics of artificial intelligence and create six presentation slides for introducing what they investigated as the final task. After students observed others' slides outside the class, they were asked to evaluate them according to twelve items seen in Table 9. They developed the slides based upon the evaluations. The revised slides were again observed and evaluated by the students to see whether they were improved or not. A 5-rating scale, 1. Not at all good; 2. Not good; 3. Don't know; 4. Good and 5. Very good, was applied for evaluation.

The number of students who submitted their slides for either the first or second submission was 28 (78%) and 32 (89%) respectively. The number of students who filled in and submitted evaluation sheets for either the first or second round of mutual evaluation was 22 and 23 respectively. Means of the values of twelve items in the first and second evaluations were analyzed by t-test (see the results in Table 9) and significant differences were observed in the results (significant level = 0.1%). This means that the whole evaluations in the second round were higher than the first round.

After analyzing the means of the first and second round evaluations for each item by t-test, all twelve items showed significant differences (significance level = 0.1%). This proved that students properly developed their slides through interactions with others.

Students were also asked to give free comments in the last part of the evaluation sheets. The ratio of free comments described and the number of characters in the first and second evaluations were 74.0% and 21.5 characters, 70.5% and 16.4 characters respectively. Comments in the first evaluations included advice and compliments such as: (1) 'It was necessary to give examples'; (2) 'It may be better to explain more in detail to fill the empty space on the slide'; (3) 'I was able to learn various usages of artificial intelligence'; (4) 'I clearly learned about…' and (5) 'The structure of the presentation helped me arouse my interest towards the topic'. In the second evaluations, students positively commented as follows: (1) 'The presentation became much clearer for reading'; (2) 'The whole slides were much more developed than the previous ones'; (3) 'The layouts of characters were well designed so that it was very easy to look through the slides'; (4) 'Information of the topic has developed' and (5) 'The contents have been developed well'. Such mutual evaluations by sharing compliments and advice became an effective interaction for their learning.

In a module of 'Artificial Intelligence', students were required to design a learning support system and to introduce it by six presentation slides as the final task. Other activities and rating scale were the same as those in 'AI Technology'. The number of students who submitted their slides for the first and second submission was 23 (77%) and 22 (73%) respectively. The number of students who filled in and submitted evaluation sheets for either the first or second round of mutual evaluation was 19 and 17 respectively. Means of the values of fifteen items in the first and second evaluations were analyzed by a t-test (see the results in Table 10) and significant differences were not observed in the results. This means that the whole evaluations in the second round were not different from the first round.

Table 9. Evaluations of the presentation slides for introducing topics on 'AI Technology'

Classification	Evaluation items	First time		Second time		t-test	
		m	SD	m	SD	t	p
Explanation	(1)Is the configuration of the whole explanation appropriate?	3.4	0.8	3.8	0.8	8.2	***
	(2)Does the explanation correspond to a title?	3.6	0.9	4.0	0.8	8.2	***
	(3)Is the explanation interested?	3.5	0.9	3.8	0.8	5.5	***
	(4)Is there a device easy to understand for the explanation?	3.3	0.9	3.6	0.8	5.7	***
	(5)Could introduced topics be understood?	3.4	0.8	3.7	0.7	7.1	***
Slide	(6)Does the explanation correspond to each slide?	3.6	0.8	4.0	0.7	9.8	***
	(7)Is there a device easy to understand for the explanation in the slides?	3.2	0.9	3.6	0.9	7.2	***
	(8)Is the configuration of the whole slide appropriate?	3.4	0.8	3.8	0.8	9.6	***
	(9)Is the background of the slide appropriate?	3.5	0.8	3.8	0.8	6.5	***
	(10)Are the size of the character and the color appropriate?	3.6	0.8	3.9	0.8	6.8	***
	(11)Is the thing using for explanation appropriate?	3.6	0.8	3.8	0.9	4.8	***
(12)How much is the extent that is interested in the introduced topics?		3.5	0.7	3.8	0.8	8.9	***
Average		3.5	0.5	3.7	0.6	6.4	***

*** p<.001

Table 10. Evaluations of the presentation slides for introducing topics on 'Artificial Intelligence'

Evaluation items	First time		Second time		T-test	
	m	SD	m	SD	t	p
(1) Appropriateness of learning contents	3.8	0.8	3.7	0.6	0.7	
(2) Appropriateness of learning function	3.7	0.7	4.1	2.6	1.4	
(3) Appropriateness of screen structure	3.3	1.4	3.5	1.2	0.9	
(4) Appropriateness of knowledge base of teaching materials	3.5	1.0	3.5	1.0	0.0	
(5) Appropriateness of instructional strategy	3.6	0.9	3.5	1.0	0.7	
(6) Appropriateness of inference engine	2.9	1.4	3.0	1.2	0.2	
(7) Appropriateness of student model	3.5	1.1	3.4	1.0	0.8	
(8) Appropriateness of learning method	3.7	1.0	3.6	0.8	0.9	
(9) Appropriateness of the method to evaluate an answer	3.2	1.1	3.4	0.9	1.5	
(10) Appropriateness of the method to diagnose a bug	3.1	1.1	3.4	0.8	2.3	*
(11) Appropriateness of system configuration	3.1	1.2	3.3	0.9	1.4	
(12) Explanation usingcorrect expressions	3.6	0.7	3.6	0.8	0.2	
(13) Appropriateness of the quantity of teaching materials	3.5	0.8	3.5	0.8	0.5	
(14) Plainness of content of teaching material	3.7	0.7	3.6	0.8	1.0	
(15) Presence of originality	3.4	0.8	3.6	0.7	2.2	*
Average	3.4	0.6	3.5	0.6	0.8	

* p<.05

Comparing Submission rate on the Presentation Slides in 'AI Technology' and 'Artificial Intelligence'

The final task of 'AI Technology' was to create presentation slides for introducing the latest topics on an artificial intelligence after investigating them, whereas the task in 'Artificial Intelligence' was to design a system that supports learning contents with the interest with an artificial intelligence. The final task was evaluated by the course participants after observing the other works and evaluation sheet was submitted. The feedback from other students was returned to each of them for the improvement of the works. After resubmission, the works were again assessed by students and the evaluation sheet was submitted again. In this way, the works were submitted twice.

The submission rates of two times in 'AI Technology' was 28 (78%) and 32 (89%) respectively, whereas the submission rates of two times in 'Artificial Intelligence' was 22 (74%) and 16 (53%) respectively.

The result of unpaired t-test on submission rates in 'AI Technology' and 'Artificial Intelligence' showed that the t-value for two times were t=2.8** and t=4.6*** respectively and were significant difference with significance level 1% and 0.1%. This means that both of submission rates for 'AI Technology' were more than those of 'Artificial Intelligence'.

Discussion

The Improvement of the Levels of Understanding Technical Terms: Reasons

After a paired t-test of the levels of understanding 78 technical terms in both pre and post-course participation in 'AI Technology', it was found that the whole level of understanding in the post-course participation was significantly higher, showing that students' knowledge of artificial intelligence increased after attending the module. The result of a paired t-test of the level of understanding of each term in both pre and post-course participation showed significant differences in all of 78 terms. This also proves that the knowledge of these terms increased after the module. By listening to lectures and doing exercises and quizzes, students seem to come across and comprehend many technical terms. Furthermore, the procedure including investigating an interesting topic on artificial intelligence, organizing what they researched in presentation slides and observing and evaluating others' presentations helped them to deepen their understandings towards the current topics on artificial intelligence.

Comparing the Levels of Understanding Technical Terms between 'AI Technology' and 'Artificial Intelligence'

The means of levels of understanding technical terms in pre and post-course participation in both modules were analyzed by t-test. The number of items showing significant differences was 78 (100%) in 'AI Technology' and 40 (80%) in 'Artificial Intelligence'. The former module had more items with significant differences than the latter. This result also proved that 'AI Technology' increased students' knowledge of technical terms more effectively than 'Artificial Intelligence'.

Means of the development of understanding in all thirteen common terms showed significant effectiveness in both 'AI Technology' and 'Artificial Intelligence'. This shows that knowledge of technical terms in both modules increase, and the elongation of the knowledge in 'Artificial Intelligence' is more than that in 'AI Technology'.

The means of elongation of understanding four terms in 'Artificial Intelligence' was more than those in 'AI Technology'. The levels of understanding those terms in pre-survey of 'AI Technology' were higher than those in 'Artificial Intelligence'. The levels of understanding those terms in post-survey of both modules were not different. As the results, it is supposed that elongations of understanding in 'Artificial Intelligence' were more than those in 'AI Technology'.

The means of elongation of understanding one term 'PC' in 'AI Technology' was higher than that in 'Artificial Intelligence'. The reason of such results probably derives from the fact that the content of the former module includes more computer utilization than that of the latter.

The content of 'AI Technology' was easier in whole than that of 'Artificial Intelligence'. The submission rate of reports in 'AI Technology' was higher than that of the latter because students felt that the final task of 'AI Technology' was easier than that in the latter. Those results also mean that the higher level of contents effects more understanding technical terms.

Consciousness-Raising towards Competence: Reasons

This study divided consciousness into two types: consciousness towards competence in general (1-30) and the course subject (31-45). The number of the items showing significant differences in the former type of consciousness was 28. The rate of consciousness-raising was $28/30 = 0.93$.

Looking at the items in detail, it is seen that Items (7), (10) and (16) improved through listening to lectures and doing exercises and quizzes. Concerning the consciousness-raising of (2), (3), (4) and (15), using computers for creating presentation slides must have helped. Students also raised their consciousness towards (5), (6), (7), (8), (9), (10), (11), (12), (13), (14), (21), (22), (27), (28) and (29) in order to decide and research the topics, and organize what they investigated in the presentation. By sharing the slides for observation and evaluation, Items of consciousness (18), (19) and (23) were improved. After that, they developed their own slides again based on the feedback from others. Through this process, Items (17), (20) and (26) were improved. Finally, Items (24) and (25) were improved after accomplishing the task. In this way, competence relating to what they experienced in the classroom enhanced greatly.

Items that did not show any significant differences were (1) 'interest towards computer' and (30) 'interest towards this area of study'. Because the means were already the first and second highest in the pre-course questionnaire, they would not show the significant differences.

Concerning the consciousness-raising towards the course subject, thirteen items showed significant differences whereas an item displayed the tendency of significant difference. The rate of consciousness-raising was $14/15 = 0.93$. Means of the consciousness-raising of both types of consciousness were 0.83 and 1.97 respectively. When these means were analyzed by a t-test, a significant difference was observed. The result showed that the consciousness towards the course subject was raised more effectively than the consciousness towards competence ($t(43)=3.6$, $p<.001$). In fact, it was found that the mean of the latter consciousness was greatly improved after the course participation.

It is considered that the pedagogical approach used in this study explained in Chapter 2 was more effective for raising students' consciousness towards the course subject than competence. In order to raise consciousness towards competence, it is crucial to encourage students to participate more actively in the classroom tasks. One of the ideas may be to simplify the exercises for lower-level students so that they will be motivated more to challenge themselves.

Comparison between 'AI Technology' and 'Artificial Intelligence' Concerning the Consciousness-raising towards Competence

Means of the degrees of consciousness-raising before and after the course participation in both programs were analyzed by a t-test. The number of items showing significant differences was 28 (93%) in 'AI Technology' and 16 (53%) in 'Artificial Intelligence'. The number of items developed in the former module was more than the latter.

The t-test between the means of the degrees of consciousness-raising in both modules was also conducted. The results indicated that only Item (30) showed a significant difference whereas Items (14), (24) and (25) had the tendency of significant difference.

The reason why Item (30) did not develop was probably because it was already the second highest mean in the pre-course questionnaire in both programs. Furthermore, the mean in 'AI Technology' was even higher than that in 'Artificial Intelligence'. Because there was no further space for the enhancement in the former module and the degree of consciousness-raising in the former was less, the degree of consciousness-raising in the latter module improved more.

The results of Items (14), (24) and (25) probably relate to the difficulty of the final task. The final task of 'AI Technology' was relatively easier than that of 'Artificial Intelligence' so that most of the students could complete the presentation slides. Because it required them to organize and explain what they investigated, Item (14) 'competence to explain a topic clearly' developed more in the former module. On the contrary, (24) 'satisfaction' and (25) 'sense of accomplishment' developed more in the latter module due to the difficulty of the task to design a learning support system applying AI.

In consequence, these results showed that there was no much difference between the means of the degrees of consciousness-raising in both modules.

The Comments and the Developments of Mutual Evaluations of the Final Tasks in AI Technology and Artificial Intelligence

In 'AI Technology', students were required to research the latest topics of artificial intelligence and create six presentation slides for introducing what they investigated as the final task. The slides were submitted for mutual observation and evaluation for a week. Based upon the feedback, they developed and resubmitted the slides for the second round observation and evaluation. The results of the second round evaluation were analyzed by a t-test. The results showed that the values of all twelve items became significantly higher, proving the fact that the interaction between students by pointing out problems and giving advice in the mutual evaluations effectively worked for the development of their slides.

In a module 'Artificial Intelligence', students were required to design a learning support system and to introduce it by six presentation slides as the final task. Other activities and rating scale were the same as those in 'AI Technology'. The number of students who submitted their slides for the first and second submission was 23 (77%) and 22 (73%) respectively. The number of students who filled in and submitted evaluation sheets for either the first or second round of mutual evaluation was 19 and 17 respectively. Means of the values of fifteen items in the first and second evaluations were analyzed by a t-test (see the results in Table 10), and significant differences were not observed in the results. This means that the whole evaluations in the second round were not different from the first round. In this module, it means that advice in the mutual evaluations was not useful because the interaction between students effectively did not work.

About Comparison between 'AI Technology' and 'Artificial Intelligence' Concerning Submission Rate of the Final Tasks

As the results of t-test on population rate each time, both of submission rates for 'AI Technology' were more than those of 'Artificial Intelligence'. Because the final task of 'AI Technology' which creates presentation slides for introducing the latest topics was easier than the task in 'Artificial Intelligence' which designs a system for supporting learning, submission rate in 'AI Technology' was higher than that in 'Artificial Intelligence'. This indicates that the latter category has improved more than the former. One of the reasons was the fact that the mean of consciousness towards the subject in the pre-course was lower than competence in general.

Conclusion

This paper attempted to firstly identify the learning effects of 'AI Technology', a module applying the ideas of blended learning, by analyzing the means of the level of understanding technical terms and the degree of consciousness-raising towards competence by means of the t-test. Secondly, the results were compared with the ones of 'Artificial Intelligence', and a module also applying blended learning in my previous research in order to demonstrate the different learning effects between the two programs. The research findings were as follows;

(1) The means of the levels of understanding technical terms in the pre and post-course participation of 'AI Technology' were analyzed by a paired t-test. The result showed a significant difference, meaning that the level of understanding developed after attending the module.

(2) Technical terms introduced in 'AI Technology' were analyzed by a t-test and all of them showed significant differences. This means that students' knowledge on these terms increased after participating in the module.

(3) Because the means of the elongation of understanding concerning all thirteen technical terms commonly introduced in both modules were raised significantly in both modules, it is suggested that the amount of knowledge in both modules increases in whole.

(4) Comparing the means of the elongation of understanding, the mean of the elongation of understanding technical terms in 'AI Technology' was significantly lower than that in 'Artificial Intelligence'. This means that the pedagogical effectiveness of the former module in terms of the understanding technical terms was lower than the latter.

(5) On the whole, students' consciousness towards competence in general was raised in 'AI Technology'.

(6) A mean of consciousness-raising of each item relating to consciousness towards competence in general in 'AI Technology' showed that students raised consciousness towards 28 items except Item (1) and (30).

(7) Concerning the mean of consciousness-raising of each item relating to consciousness towards the course subject in 'AI Technology', students raised their consciousness towards thirteen out of fifteen items. One item showed the tendency of significant difference.

(8) The mean of the consciousness-raising towards the course subject was higher than that towards general consciousness.

(9) The degrees of consciousness-raising in both modules did not have difference.

(10) The values of all twelve items round mutual evaluations for the final task in 'AI Technology' significantly developed in the second round.

For further research, activities effective for enhancing students' consciousness were compared with two modules. In addition, 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 would contribute to create more effective pedagogical environment in the classrooms.

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