Relation between Response and Understanding Levels in the Blended Class Using Clicker

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Abstract

In a blended lecture centering exercises the students were asked to solve problems on paper, provided with explanatory materials, further explained by using slides, and then asked to reply their understanding level by using clickers. They were also asked to reply answers of some computational problems by using the clickers, and to reply with clickers when attendance was checked at the beginning of class.

Questionnaire surveys were then carried out both before and after the class to identify how much the degree of recognition and attitude of the students had changed in the classes that utilized the clickers. Analysis results of the surveys have been reported already. Using the reaction of the clicker system, we analyze changes in the response of the problem and the understanding level, and correlation between them. Then scores in the groups of upper and lower ranks are compared. Then the results are reported.

1. Introduction

The clicker is one of the opinion aggregation tools "realizing two-way communication in real time". At an educational institution, the seminar of the company, and a lecture, we can collect the opinions of the participant instantly, and this attracts attention as the tool which can display a result [15]. The clicker system which can perform a question and answer in class, and count (graphical representation) on the spot is used in an educational front.

In an educational institution, practice of the active learning using the clicker is reported as a class response system [14]. It is reported that there are improvement in the retention rate, the real-time feedback on the understanding degree, maintenance of the concentration, and the increase of the attendance as an effect of the clicker, according to Suzuki, et al. [15]. Bojinova and Oigara revealed that clickers are useful tools for enhancing student learning and performance [2]. It was found that clicker questions improved memory for teaching materials two days later compared to the controls without clicker, provided that immediate feedback was given about each question [4]. After a lot of empirical studies were reviewed, Liu, et al. reported that clicker usage in traditional lectures may enhance students' attention and participation [5].

The author carries university education forward to raise the problem-solving ability that has adopted manufacturing and evaluation activity [9]. Courses are developed so that a variety of students can increase chance to learn, prepare for lessons and review their lessons "anytime and anyplace", as support of the lectures [7]. As the part, the author practices a blended class for an introductory subject of information science. I reported that I developed the class that put a lecture, e-learning, a small test, a lecture notebook and so on together and was effective [6]. The author also practiced a blended class similar to the introductory subject for a special subject of the information science and received the same effect as it. In addition, the similar effect was recognized even if students were required individually to fill out a lecture notebook by e-learning after having done a mini-lecture and take a small test lastly [8, 10]. A lot of such blended classes are practiced in particular in Japan and improve learning effect by mutual supplement of lectures and e-learning [9].

In this way, I understood that I could improve a participation degree and the concentration ratio to a class by using the clicker. Therefore, in a practice subject of University A, I developed a blended class using a clicker. About using the clicker for a class, I reported that I made a questionnaire survey and confirmed the effect similar to that of the previous study [11]. In addition, I analyzed it to know how the recognition of terms and the consciousness of the learner changed by a class using clicker and reported the result [11]. In this paper, analysis as shown below are conducted and then the results are reported. Correlation analysis, among correct answer ratio of the problem, understanding levels after offering the commentary and after the practice; Significance test of the score (FE) of the problems in Fundamental Information Technology Engineer Examination and the score (PT) of the problems in the final examination after the class; Significance test of the understanding level after offering the commentary and after the practice; Analysis to compare scores of upper and lower ranks for FE and PT.

2. Details and planning of the lectures

The course is exercises on the subject of information at University A. Teaching contents involve the Fundamental Information Technology

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Engineer Examination (FE) as the theme. The classes took place as 15 ninety-minute sessions. The total number of students was 74.

The purpose of the lecture was to deepen their understanding of information technology involve by solving the actual morning problems from the FE. providing explanations, and completing the exercises. The purpose of this was to enable the students to answer 60% or more of the morning problems of the FE correctly and thus pass the examination. It was also to improve their ability to solve various problems that is typically needed in actual society, through activities that deepen their knowledge of information technology.

The FE's past problems in the three times of the first, fifth and tenth week by 40 problems each to achieve the goal were on the test. The total number of problems reached 120. The answer result of these problems before an explanatory is abbreviated to FE. 74 problems were selected from the 120 problems and were in the final examination. The result of the response is abbreviated to PT.

80 problems are tested in a real FE. Therefore, 120 problems equals to one and a half times the FE. The FE is one of the national examinations, which the Ministry of Economy, Trade and Industry authorizes that the level of "knowledge and skill" as the Information Technology Engineer is to some extent or more than it, based on "Act on Facilitation of Information Processing" [16]. The examination consists of morning and afternoon problems. 80 problems are created in basic knowledge as the morning problem. Seven problems are chosen from IT common knowledge edifice, database, network, security, quasi-language, program design, programming language problem as the afternoon problem [16].

The students were first asked to solve the 40 actual morning problems of the FE after the manual of lecture plan was distributed and explained in the first week. The handout that explained ten problems was distributed in the second week. The slides displaying a distribution chart of choice and the percentage of correct responses for each problem were shown. An explanation was provided based on the handouts via explanatory slides. The students were then asked to reveal their understanding level using clickers. Therefore, the lesson was conducted by the flow of displaying a choice distribution chart, explaining, and confirming the understanding level.

The distributed handout includes the problems, the answers, the description of terms, how to solve them, and an explanation of each choice. References are listed in the last of the handout. The problem of the FE is an objective test form to choose an alternative from 4 choices. The explanations required approximately one to two pages for each problem. The related terms and so on have also been described as much as possible. They were asked to write questions on question forms and submit them at the end of the class. The responses to the questions were then provided at the beginning of the next class.

There are 24 calculation problems of 120 problems. The exercises were provided by similar problems with different values after the explanation. Then the students were also asked to select one from 4 choices of the similar problems by using a clicker. The similar problems were explained. The students were asked to respond the understanding level by using a clicker. Because the calculation problems were difficult to understand in comparison with other problems, they were explained twice in this way. In addition, if the students can understand how to solve the calculation problem, we thought that it was easy to lead a correct answer of the real problem. Five problems were chosen among the calculation problems that I did not explain with the exception of the 120 problems explained. A task was asked students to answer the 5 similar problems to them in the thirteenth week. We enabled the students to download and to use the framework. The students were asked to submit task as a report.

3. Contents of e-learning

The following functions of e-learning are allowed to increase the impact of the course:

Learning through the explanatory slides - Students can read and learn the explanatory slide outside of a classroom.

Learning through the exercise - Students can answer and learn the problem of the FE. After a response, they can confirm a correct answer and can read the explanation. They can address each of the ten problems.

Downloading the document - As a document, students can download a course outline manual, an assessment sheet, the framework of the report, the explanatory manual.

Uploading the submission - Students can upload the assessment sheet and the report file.

Posting - reading the bulletin board and question email.

4. Use of the clickers

The introduction of clickers into the class, through bidirectional and thus more effective presentations, improve the lectures, which conventionally had tended to be rather one-way. The card terminal (clickers) such as the TV wireless remote controller is taken every week in the classroom. It is put on a teacher's desk. Students take one of the clickers. After

a student received a clicker, for confirmation present, a student is asked to input two digits of a year of entrance to school and two digits of student number. The clicker is used to respond the understanding level on the commentary and the answer of problem during class.

The students were asked to identify their understanding levels of the explanation, and their answers to the similar problems. The students can easily use the clickers as they only need to press the key of the number they have selected. The results of all the students can then be immediately displayed on the site. After the class, a student is asked to return it to the teacher's desk.

This study utilized the 3eAnalyzer of Kimura Information Technology as the clickers [3]. With this system a receiver inserted into the USB port of a PC is used to receive the responses from the clickers. The 3eAnalyzer supports six types of slides: questionnaire, percentage of correct answers, score, votes, sign-in, and number. The following three were used in the class as the clickers:

- Student attendance check - Using the number slides, attendance was checked by inputting 4 digits that comprised the 2 digits of a year of entrance to school and the 2 digits of the student number.

- Response on the understanding level of the explanation - Using the questionnaire slides, the students were asked to reply with regard to the understanding level after the explanation.

- Answer to the similar problem - Using the slides for the percentage of correct answers, the students were asked to solve the similar problem to the FE problem and then choose an answer among four choices during the class.

5. Results of analysis

An exercise lesson on the subject of information was conducted. A survey on the degree of term recognition was conducted to identify the changes in the student's level of knowledge. An attitude survey on their capabilities was conducted to pinpoint the changes in their awareness. The analysis results have already been reported [12]. In this paper, about 76 students' responses for 74 common problems in the Fundamental Information Technology Engineer Examination (FE) and the final examination (PT), the correlation analysis were conducted between correct answer ratio of the problem, understanding level after the commentary, correct answer ratio after the practice and understanding levels after the practice. The significance test is conducted between the scores of the FE and that of PT, and between the understanding levels after the commentary and after the practice. Analysis is conducted between students with lower and upper scores on the FE and PT.

The analysis results are explained in the following. Hereafter, it can be considered that there was a significant difference when the significance level in the significance test was 5% or smaller. The codes m, SD, t, and p indicate the mean, standard deviation, test statistic, and p value, respectively. In addition, significant levels 0.1%, 1%, 5%, and 10% show ***, **, *, and + respectively.

5.1. Correlation Analysis

The correlation Analysis, among correct answer rate before the class, understanding level after the commentary, correct answer rate and understanding level after the practice are detailed below:

5.1.1. Correlation between correct answer rate of the FE and PT. A correlation coefficient between the mean correct answer rate of the FE and PT was found for 74 problems. The correlation coefficient is 0.52 and significant ($F(1,72)=26.2$, $p<.01$). This shows there is a moderate correlation between the two mean correct answer rates. It is thus clear that the higher the average correct answer rate of the FE, the higher the average correct answer rate of PT.

5.1.2. Correlation between the correct answer rate of the FE and the understanding level after the commentary. A correlation coefficient between the mean correct answer rate of the FE and the understanding level after the commentary was found for 74 problems. The correlation coefficient is 0.08 and not significant ($F(1,72)=0.52$, $p>.05$). It is rejected that there is correlation between these two variables.

5.1.3. Correlation between the correct answer rate of PT and the understanding level after the commentary. A correlation coefficient between the mean correct answer rate of PT and the understanding level after the commentary was found for 74 problems. The correlation coefficient is 0.18 and not significant ($F(1,72)=2.28$, $p>.05$). It is rejected that there is correlation between these two variables.

5.1.4. Correlation between the correct answer rate and the understanding level after the practice: A correlation coefficient between the correct answer rate and the understanding level after the practice was found for 24 computational problems. The correlation coefficient is 0.28 and not significant ($F(1,22)=1.82$, $p>.05$). It is rejected that there is correlation between these two variables.

5.1.5. Correlation between the understanding level and the correct answer rate of PT after the practice. A correlation coefficient between the understanding level and the correct answer rate of PT

after the practice was found for 15 computational problems. The correlation coefficient is 0.30 and not significant (F(1,13)=2.13, p>.05). It is rejected that there is correlation between these two variables.

5.1.6. Correlation between the understanding levels after the commentary and after the practice. A correlation coefficient between the understanding levels after the commentary and after the practice was found for 24 computational problems. The correlation coefficient is 0.36 and a trend for significant correlation (F(1,22)=3.19, p<.1). This implies that there is a weak correlation between the two understanding levels. It is suggested that the higher the understanding level after the commentary for the computational problems, the higher the understanding level after the practice.

5.1.7. Correlation between elongations in the correct answer rate and in the understanding level. An elongation in the correct answer rate is calculated to subtract the correct answer rate of the FE from the correct answer rate of PT for 74 problems. An elongation in the understanding level by the commentary is calculated to subtract {(correct answer rate of the FE)/25+1} from the understanding level after the commentary for 74 problems. We consider that the understanding level before the class corresponds to the correct answer rate of the FE. The understanding level has five phases. The highest percentage of the correct answer rate is 100%. The correct answer rate is divided by 25 to convert it into the understanding level. The value obtained from it takes 0-4. The value takes 1-5 by adding one to it

A correlation coefficient between the elongation in the correct answer rate and the elongation in the understanding level by the commentary was found for 74 problems. The correlation coefficient is 0.66 and significant (F(1,72)=55.3, p<.01). This shows there is a moderate correlation between the two mean correct answer rate. It is thus clear that the higher the elongation in the understanding level by the commentary, the higher the elongation in the correct answer rate.

5.2. Comparing the score of the FE with the score of PT

The average score of the FE is 22.5 (30.7%) for 76 students. The average score of PT is 49.3 (65.7%) for 76 students. Paired t-test between the average scores of the FE and PT is performed. The result is significant as shown in Table 1 (t(75)=8.7***). This demonstrates that the average score after the class has increased significantly.

Paired t-test between the average scores of the FE before the class and PT after the class is performed for each problem (t(75)=2.2 to 10.2). All 74 problems are significant as the results. Therefore, this means that the average scores of PT for all problems had significantly increased.

Table 1. Comparing the correct answer rate of the FE with that of PT

Problem		Correct answer rate			Test statistic	p
Kind	No.	FE	PT	m		
Technology 1	1	0.21	0.78	0.49	8.02	***
	2	0.13	0.61	0.36	7.01	***
	3	0.33	0.69	0.51	5.16	***
	4	0.14	0.74	0.43	8.71	***
	5	0.47	0.73	0.60	3.88	***
	6	0.42	0.79	0.60	5.32	***
	7	0.34	0.80	0.57	6.46	***
	8	0.30	0.65	0.47	5.00	***
	9	0.32	0.68	0.50	5.15	***
	10	0.31	0.66	0.48	5.00	***
	11	0.22	0.69	0.45	6.70	***
	12	0.14	0.69	0.41	8.05	***
	13	0.44	0.63	0.54	2.71	**
	14	0.36	0.79	0.57	6.10	***
	15	0.31	0.68	0.50	5.23	***
	16	0.35	0.63	0.49	4.01	***
	17	0.29	0.63	0.46	4.86	***
	18	0.21	0.63	0.42	6.12	***
	19	0.23	0.69	0.46	6.56	***
	20	0.25	0.69	0.47	6.27	***
	21	0.27	0.55	0.41	3.97	***
	22	0.16	0.59	0.37	6.32	***
	23	0.33	0.69	0.51	5.12	***
	24	0.13	0.58	0.35	6.73	***
	25	0.05	0.49	0.27	7.08	***
	26	0.16	0.68	0.42	7.56	***
	27	0.31	0.66	0.49	4.94	***
	28	0.41	0.77	0.59	5.07	***
	29	0.33	0.68	0.52	4.72	***
	30	0.40	0.72	0.58	4.35	***
	31	0.31	0.63	0.48	4.35	***
	32	0.14	0.64	0.41	6.83	***
	33	0.14	0.59	0.39	6.16	***
Management	34	0.25	0.65	0.47	5.43	***
	35	0.14	0.55	0.36	5.64	***
	36	0.56	0.79	0.68	3.26	***
	37	0.37	0.59	0.49	3.00	**
	38	0.54	0.81	0.68	3.90	***
	39	0.30	0.59	0.46	3.97	***
	40	0.31	0.58	0.46	3.67	***
Strategy	41	0.18	0.40	0.18	3.85	***
	42	0.29	0.59	0.45	4.14	***
	43	0.50	0.66	0.59	2.23	*
	44	0.26	0.68	0.49	5.67	***
	45	0.30	0.65	0.49	4.78	***
	46	0.53	0.74	0.65	3.01	**
	47	0.29	0.70	0.51	5.63	***
	48	0.24	0.78	0.53	7.24	***
	49	0.43	0.68	0.57	3.38	***
Technology 2	50	0.35	0.62	0.49	3.80	***
	51	0.34	0.55	0.45	2.90	**
	52	0.35	0.71	0.53	5.09	***
	53	0.24	0.70	0.47	6.53	***
	54	0.56	0.84	0.70	4.26	***
	55	0.26	0.49	0.38	3.30	***
	56	0.47	0.73	0.61	3.72	***
	57	0.23	0.65	0.44	5.99	***
	58	0.18	0.64	0.41	6.64	***
	59	0.25	0.66	0.46	5.83	***
	60	0.34	0.61	0.48	3.80	***
	61	0.38	0.54	0.46	2.23	*
	62	0.27	0.58	0.43	4.43	***
	63	0.35	0.56	0.46	2.89	**
	64	0.34	0.63	0.49	4.09	***
	65	0.31	0.71	0.52	5.60	***
	66	0.39	0.77	0.58	5.28	***
	67	0.31	0.53	0.42	3.13	**
	68	0.29	0.67	0.48	5.38	***
	69	0.64	0.88	0.76	3.89	***
	70	0.31	0.48	0.39	2.43	*
	71	0.28	0.54	0.41	3.67	***
	72	0.42	0.73	0.58	4.41	***
	73	0.16	0.55	0.36	5.62	***
	74	0.27	0.54	0.41	3.88	***
m		0.31	0.66	0.50	4.87	***

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

5.3. Comparison between understanding levels after the commentary and after the practice

The average understanding levels after the commentary and after the practice for 24 computational problems is 4.0 and 4.5 respectively for 76 students. T-test without the correspondence is performed for the average understanding levels for 24 computational problems. The results had been significant as shown in Table 2 (t(23)=17.7, p<.001). It demonstrates that the average understanding levels after the practice are significantly higher than that after the commentary.

Next, t-test without the correspondence is performed for each problem. The results had been significant for 22 problems of 24. Therefore, the average understanding levels after the practice had significantly increased.

Table 2. Comparison between understanding levels after the commentary and after the practice

Problem		After the commentary		After the practice		t	p
Kind	No.	m	SD	m	SD		
Technology 1	1	3.96	1.73	4.57	0.84	2.88	**
	2	3.80	1.32	4.58	0.55	5.06	***
	3	4.07	0.69	4.42	0.97	2.70	*
	4	4.05	0.67	4.69	0.35	7.88	***
	5	3.58	1.03	4.24	0.99	4.35	***
	6	4.17	0.80	4.64	0.48	4.67	***
	7	3.58	1.37	4.41	0.96	4.32	***
	8	4.04	0.88	4.62	0.55	4.61	***
	9	4.11	0.67	4.53	0.50	4.39	***
	10	4.00	0.96	4.49	0.60	3.67	**
Management	11	3.79	0.91	4.37	0.70	4.52	***
	12	4.07	0.74	4.63	0.62	5.12	***
Strategy	13	4.19	0.57	4.68	0.28	7.26	***
	14	3.82	0.76	4.44	0.45	6.64	***
	15	3.93	0.75	4.26	0.61	3.21	**
Technology 2	16	4.28	0.61	4.58	0.40	3.76	***
	17	4.07	0.71	4.42	0.45	3.88	***
	18	4.13	0.48	4.45	0.59	3.91	***
	19	3.99	0.59	4.44	0.32	6.01	***
	20	4.12	0.46	4.19	0.44	0.99	
	21	3.99	0.40	4.29	0.41	4.83	***
	22	4.09	0.56	4.45	0.32	5.12	***
	23	3.97	0.77	4.06	0.82	0.76	
	24	4.06	0.51	4.34	0.42	3.69	**
	m	3.99	0.17	4.45	0.16	17.7	***

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

5.4. Analysis between upper and lower in the Fundamental Information Technology Engineer Examination and final examination

Students are divided into two groups of upper and lower rank by 22.5 points in average score of the FE before the class. The number of students is 34 and 42 respectively.

Average scores of the upper and the lower groups for the FE are 28.7 (38.8%) and 17.5 (23.6%) respectively. T-test without the correspondence is performed for average scores of 74 problems. The result had been significant as shown in Table 3 (t(75)=8.0, p<.001). Therefore, this result means that the average score in the group of upper rank is significantly higher than that in the group of lower rank.

Table 3 Analysis between the groups of the upper and lower rank in the FE and PT

Group	N	FE		PT		Elongation			
		m	SD	m	SD	m	SD	t	p
Lower rank	42	17.5	3.6	47.1	18.5	29.5	19.0	10.0	***
Upper rank	34	28.7	8.0	52.0	17.3	23.3	16.1	8.3	***
Whole	76	22.5	8.2	49.3	18.2	26.8	18.0	12.9	***
Upper and lower rank	t	8.0		1.2		1.6		*** p<.001	
	p	***		ns		ns			

T-test without the correspondence is performed for average score of each problem. Therefore, these mean that the average scores in the group of upper rank for 27 problems of 74 are significantly higher than that in the group of lower rank.

Average scores of the upper and the lower groups for PT are 52.0 (70.3%) and 47.1 (63.6%) respectively. T-test without the correspondence is performed for average score of 74 problems. The result had been no significant (t(75)=1.2, p>.05). Therefore, this result means that difference between the average scores in the group of the upper and the lower rank is not significant.

Next, t-test without the correspondence is performed between average scores of the upper and the lower groups for each problem in PT. At the results, significant difference had been recognized in problems 6 and 16. Therefore, this result means that the average score for the two problems in the group of upper rank is significantly higher than that in the group of lower rank. These results mean that difference between the average scores for 72 problems except them in the group of the upper and the lower rank is not significant. From the results of the FE and PT, the average score in the group of upper rank is significantly higher than that in the group of lower rank before the class. However, the difference between them had become less after the class.

T-test with the correspondence is performed between average scores of the FE and PT in the group of lower rank. The results had been significant (t(41)=10.0, p<.001). The results of t-test with the correspondence had been significant between average scores of the FE and PT in the group of upper rank (t(33)=8.3, p<.001). The significant difference had been recognized between average scores of the FE and PT for whole (t(75)=12.9, p<.001). From these results, difference of 11 in a score had been recognized between average scores in the group of the upper and the lower ranks before the class. However, the

difference dwindles to 5 in a score and had become not significant. As the reason, the significant difference had not been recognized between elongation of the group of the upper and the lower ranks. Therefore, this means that the average score in the group of the lower rank rose more than that in the group of the upper rank.

6. Discussion

For correlation analysis, among correct answer rate before the class, understanding level after the commentary, correct answer rate and understanding level after the practice shows that there is a moderate correlation between the mean correct answer rate of the FE and PT. The higher the average correct answer rate of the FE, the higher that of PT. Because the mean score of the FE increased after the class as a whole from results in 5.2, the score of the FE was nearly maintained after the class and increased as a whole.

The four relations among the following variables were no correlation: between the mean correct answer rate of the FE and the understanding level after the commentary; between the mean understanding level after the commentary and the mean correct answer rate of PT; between the mean correct answer rate after the practice and the mean understanding level of the computational problems; between the mean understanding level after the practice and the mean correct answer rate of PT for the computational problems. These results mean that subjective understanding level do not relate the objective correct answer rate.

There is a moderate correlation between the elongation in the correct answer rate and the elongation in the understanding level by the commentary. The higher the elongation in the correct answer rate, the higher the elongation in the understanding level by the commentary.

This means that subjective elongation in the understanding level relates to objective elongation in the correct answer rate.

6.1. For comparing the score of the FE with the score of PT

This demonstrates that the average score after the class has increased as a whole. It was already reported that overall amount of knowledge increased and overall rating value of attitude related to abilities improved through many activities in this class (Miyaji 2014). This relates to results already reported. One of goals in this class is to enable the students to answer 60% or more of the morning problems of the Fundamental Information Technology Engineer Examination correctly and thus pass the examination. This goal has approximately achieved through a lot of activities.

6.3. For comparison between understanding levels after the commentary and after the practice

It is clear from the result in the section 5.1 that the higher the understanding level after the commentary, the higher that after the practice.

It is clear from the result in the section 5.3 that the average understanding levels after the practice had significantly increased than that after the explanation.

These results suggest that the average understanding levels had increased after the practice.

6.2. For analysis between upper and lower in the FE and PT

Difference before the class was acknowledged between the average score in the group of the upper and the lower rank. However, the difference between them had become less after the class. From these results, difference of 11 points in a score had been recognized between average scores in the group of the upper and the lower ranks before the class. However, the difference dwindles to 5 points in a score after the class and had become not significant. It is suggested that this teaching method is more effective for the group of the lower rank.

7. Conclusion

The class of the practice subject in the information system of the university was conducted using clicker. The information in conjunction with the reply of the clicker was analyzed. About 76 students' responses for 74 common problems in the FE and PT, analysis as shown below are conducted and then the results are reported. The findings from these analyses were as follows:

i. There is a moderate correlation between the mean correct answer rate of the FE and PT. The higher the average correct answer rate of the FE, the higher that of PT.

ii. There are no correlations among the following relations: between the mean correct answer rate of the FE and the understanding level after the commentary; between the mean correct answer rate of PT and the understanding level after the commentary; and between the correct answer rate and the understanding level after the practice; between the understanding level and the correct answer rate of PT after the practice.

iii. There is a moderate correlation between elongations in the correct answer rate and in the understanding level. It is thus clear that the higher the elongation in the understanding level by the

commentary, the higher the elongation in the correct answer rate.

iv. The average score of the FE after the class has increased significantly.

v. The average understanding level after the practice is significantly higher than that after the commentary.

vi. The difference in a score had been recognized between average scores in the group of the upper and the lower ranks before the class. However, the difference in a score dwindled after the class and had become not significant.

The correlation analysis among correct answer rate of the problem, understanding levels after offering the commentary, correct answer rate and understanding levels after the practice; Significance test between the score of the problems in the FE and the score of the problems in PT after the class; Significance test between the understanding level after offering the commentary and after the practice; Analysis to compare scores of the upper and the lower rank for FE and PT.

8. References

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