

## **Understanding of Self-Study in a Grouped Flipped Classroom**

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### ***Abstract***

*We previously proposed a method for an effective flipped classroom on the basis of the self-study log information of students. We called this a "grouped flipped classroom." We applied the grouped flipped classroom method to actual lessons in 2017 and 2018. The results revealed that the grouped flipped classroom improved students' performance. In this paper, we examine the issues regarding the method of self-study achievement test (SSAT) when applied to actual lessons in 2018. Specifically, we compare the scores of the SSATs that were conducted with and without supervision.*

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**Key Words:** *Flipped-Classroom, e-Learning, Blended-Learning, Effective Classroom*

**JEL Classification:** *C 19, G13, G 14*

## **1. Introduction**

In a flipped classroom, students study the lesson before coming to class and then obtain more advanced face-to-face learning in class. We previously proposed a flipped classroom method, in which students were divided into three groups before each class on the basis of their e-learning self-study logs and level of understanding [1][2][3]. The three groups included students who studied the lesson and fully understand the contents, those who studied the lesson but did not fully understand the contents, and those who did not study the lesson and therefore did not understand the contents. The face-to-face learning in class was done separately for each group. We called this the “grouped flipped classroom.”

We have shown that this proposed method can promote face-to-face classes according to the degree of understanding at the time of the self-study, and can improve their degree of understanding. In addition, we applied our proposed method to another class [4], compared it with a conventional method without grouping, and showed bottom-up learning to be effective for students with low understanding [5]. Furthermore, we showed that not only bottom-up learning but also advanced classes could be effective for students with high understanding [6][7][8]. We have also developed a tool for automatic grouping that can be applied to actual lessons over a period of half an academic year (16 weeks) [9]. As the grouping effort has been greatly reduced, we applied the above grouped flipped classroom method to actual lessons in the autumn semester of 2017 [10]. We also showed that the application of the proposed method increased test scores [11][12] and conducted a questionnaire evaluation [13][14][15]. Continuing on from fiscal 2017, the grouped flipped classroom was applied to actual lessons over 16 weeks in fiscal 2018, and we showed its effectiveness from the test results [16].

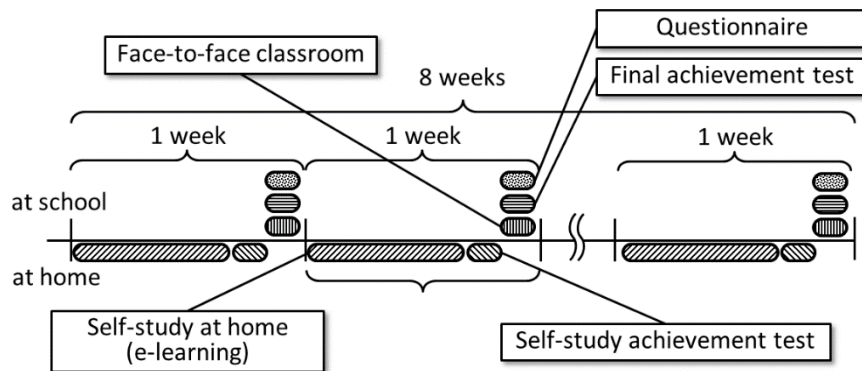
In this paper, we will examine the issues regarding the self-study achievement test (SSAT) used to measure the degree of understanding during self-study when applied to actual lessons in 2018. Specifically, in the class, some students may have struggled to successfully take the SSAT by themselves. To confirm this, the SSAT was conducted again under supervision, and compared with the previous scores.

In Section 2, we describe the details of the application to actual lessons. We compare the results of the SSAT and final achievement test scores, discuss potential causes for the differences, and describe experimental methods, results, and improvement plans in Section 3. We conclude in Section 4.

## **2. Application to Actual Class**

We applied the grouped flipped classroom method to actual lessons of “Practical Training for Basic Java Programming” in the autumn semester of 2017 and 2018 at Shonan Institute of Technology. Fig. 1 shows the overall structure of the flipped classroom for eight weeks.

**Fig 1: Overall Structure of Flipped Classroom Approach**



The one-week flipped classroom consists of self-study at home, a SSAT, a face-to-face class, a final achievement test, and a questionnaire. During self-study at home, we acquired a learning log of how long they spent studying. In the second half of the self-study period, the achievement test is conducted on Moodle, a learning management system. As shown in Fig. 2, the test was constructed using the quiz function of Moodle, where students would write the output of the specific sections of code in a 10-point Java program.

**Fig. 2: Self-Study Achievement Test**



We divided students into three groups by using the log information of self-study time and degree of understanding, and then each group had a face-to-face class. The three groups are as follows: (A) students who can understand the contents, (B) those who cannot understand

because they do not do self-study, and (C) those who cannot understand even though they do self-study for a long time.

At the end of the class, a final achievement test was conducted to measure the final level of understanding, and a questionnaire was conducted on the grouping and the level of difficulty of the class. In the 2018 class, 90 students (87 first years and 3 second years or higher) (we refer to them as Part 1) in the first eight weeks, and 99 students (93 first years and 6 second years or higher) (we refer to them as Part 2) in the last eight weeks.

### 3. Self-Study and Final Achievement Tests

#### 3.1 Issues Regarding Test Result Differences

We compared the scores of the SSAT and the final achievement test for each group in [16]. The comparison results are shown in Figs. 3, 4, 5. The legend of the graphs follows the following regular expression.

(2017|2018) - (1|2)(Total|A|B|C) (Self|Last)

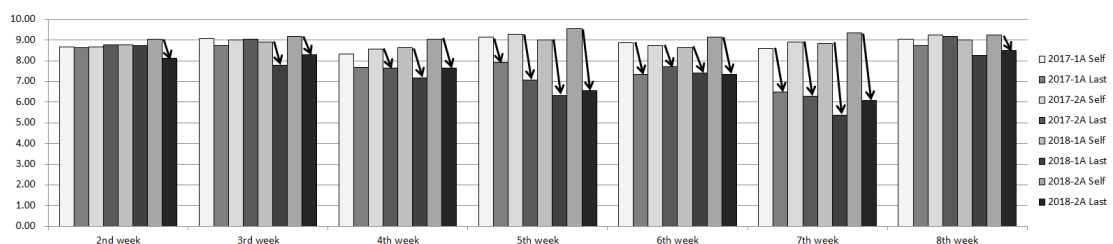
Here, 2017 and 2018 represent the fiscal year, 1 and 2 represent the students in Parts 1 and 2. Total represents the entire group of students. A, B, and C represent groups A, B, and C. In addition, “Self” denotes the SSAT, and “Last” denotes the final achievement test.

For groups B and C, the final achievement test scores were significantly higher than those of the SSAT. However, for group A, as shown in Fig. 3, the final achievement test score was lower.

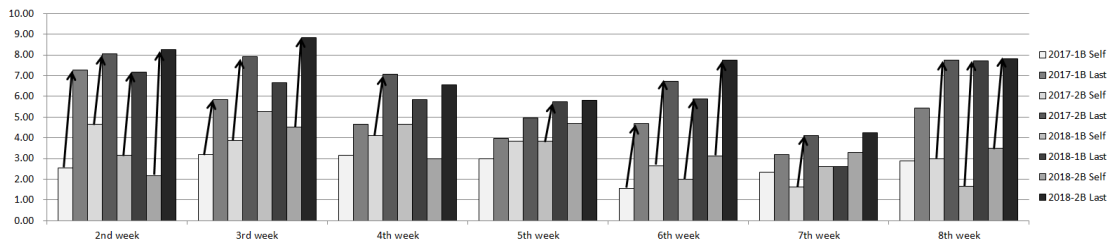
The arrows in Figs. 3, 4, and 5 indicate that there is a difference in the average value at or above the 5% significance level in a *t*-test. The *p*-values in the *t*-tests are shown in Table 1.

There may be a difference in the difficulty level between the SSAT and the final achievement test, but the final achievement test is clearly lower in score, so we would like to clarify the cause of this.

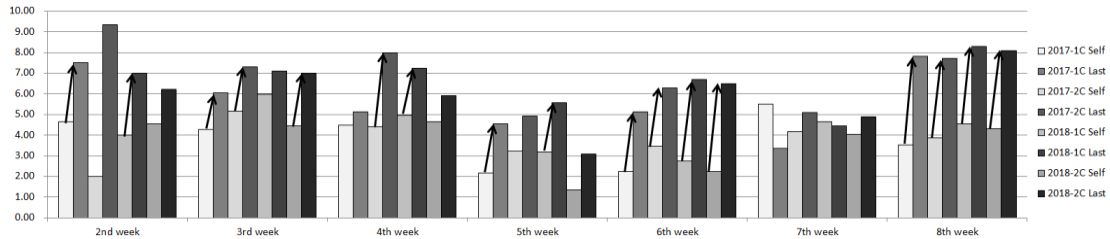
**Fig. 3: Changes in Score between SSAT and Final Achievement Test for Group**



**Fig.4: Changes in Score between SSAT and Final Achievement Test for Group B**



**Fig. 5: Changes in Score between SSAT and Final Achievement Test for Group C**



**Table 1: The *p*-value by *t*-test of the Data Shown in Fig. 3**

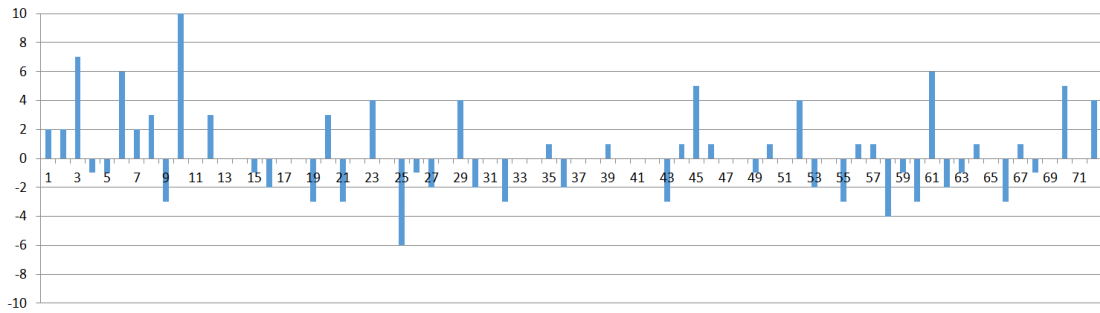
week	2	3	4	5	6	7	8
2017-1A	0.976	0.257	0.083	0.004*	0.007*	0.001*	0.373
2017-2A	0.686	0.892	0.008*	0.000*	0.033*	0.000*	0.757
2018-1A	0.985	0.001*	0.000*	0.000*	0.005*	0.000*	0.170
2018-2A	0.000*	0.004*	0.000*	0.000*	0.000*	0.000*	0.000*

\*:*p* < 0.05

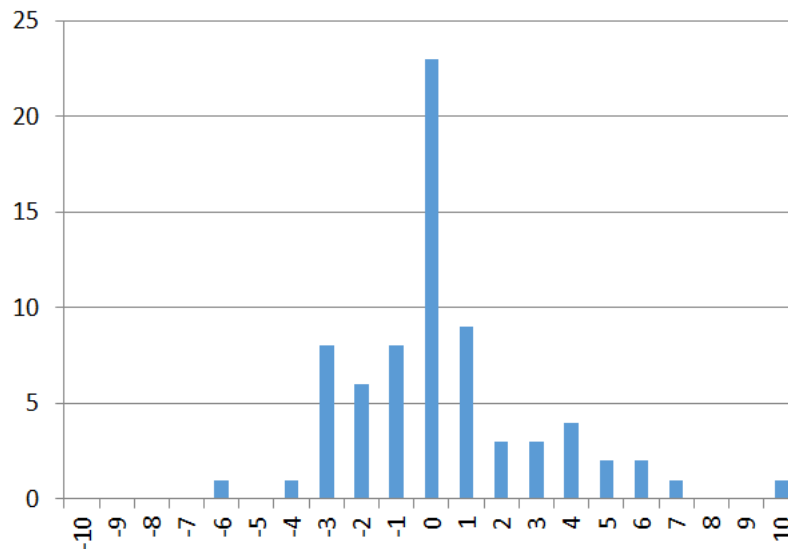
### 3.2 Experimental Method and Results

At the start of the face-to-face class in the fifth week of 2018, the same SSAT students had taken during their self-study was conducted again in the classroom for those in Part 2. The assumption was that by taking the same SSAT they had taken before on their own, their scores should be the same or higher. Fig. 6 shows the difference in scores between the SSAT taken at home and that taken in the classroom. The frequency distribution chart of Fig. 6 is shown in Fig. 7. As shown in Fig. 6 and Fig. 7, 24 students scored lower, even though their scores were expected to be the same or higher as they would be taking the same test again. On the other hand, 25 students scored higher and 23 students scored equally. From the results, it can be said that 33% of students scored lower than before. One assumption is that they probably did not take the SSAT on their own; they worked together with other students.

**Fig. 6: Score Differences in SSAT Conducted without Supervision and Under Supervision**



**Fig. 7: Frequency Distribution Chart of Score Differences in SSAT**



### 3.3 Improvement Plan

We have developed a tool for automatic grouping to be applied to actual lessons [9]. Using this tool, we can group students immediately after they complete the SSAT. In other words, it is possible to conduct a SSAT at the beginning of a face-to-face class and to conduct grouping immediately after the test. As the students will be supervised during the test, this will limiting cheating, requiring them to take the test by themselves.

### 4. Conclusions

In this study, students were classified into several groups on the basis of the relationship between self-study and their level of understanding, and grouped flipped classes were applied to actual lessons for two years. We examined the issues regarding the SSAT used to measure the degree of understanding during self-study when applied to actual lessons in 2018. As a result, we found students who did not take the SSAT on their own did not understand the problems, and there was a high possibility of them asking other students for answers. It is thought that such cheating can be mitigated by conducting a SSAT at the start of face-to-face class. We plan to apply this method to the next year's class.

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