An Analysis of Correlation Between Seat Positions and Achievements of Students

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***Abstract*—It has been a big issue for universities to setup an appropriate environment for their students to learn effectively. Traditionally, professors have been supposed to understand their students, their attitudes to learning, knowledge levels and other factors by themselves. Thanks to the recent development of Information and Communications Technology (ICT), it is possible to collect various kinds of educational data, analyze them, and extract useful knowledge for enhancing education. Such approach is called Educational Data Mining (EDM). This paper, as a part of EDM, deals with the seat occupation data of students in a class. It is often pointed out that students who take seats close to the lecturer tend to have good evaluation scores, or achievements. Our major aim of this paper is to analyze objective data and to investigate how students take their seats, to find if seat locations relate to the students' achievements, and to investigate if distances of seats between students relate to their differences of achievements.**

Keywords-Educational Data Mining; Learning Analytics; Seat Location; Friendship Analysis.

I. INTRODUCTION

In order to let their students learn effectively, universities have been making great efforts. Professors have to educate themselves through faculty development (FD) activities. They are expected to capture what their students are like, including their attitudes to learning, knowledge levels, and other pedagogical features. Recent development of ICT makes it easy to collect various kinds of educational data. In the field of Educational Data Mining (EDM) [11][12], a lot of studies have been carried out for investigating about students.

We have been investigating retrospective evaluation texts of students written in a term-end lectures in some studies on EDM [3] – [10]. Through these studies, we found that students who can study with wider viewpoints have better achievements than those who have narrower viewpoints. In other words, the students who can position new knowledge in their knowledge network what they have already learned are able to get better achievements, such as the term-end examination for evaluating what they have learned in the course.

As was pointed out in [1][2], psychological issues are quite important for students in learning, such as to be well-motivated, to percept meanings of study, and to have appropriate self-images for learning. It is also an important issue for the lectures how and how much they involve the class and help their students have the best achievements out of the lectures. Our studies in educational data analysis intend to contribute to improvements for these issues.

We often observe that the students who take seats close to the lecturer in the classroom are eager to learn more than those who choose far away seats from the lecturer, who seem to have less eagerness for learning. We have been wondering if this observation is true or not.

In this paper, as a part of study about students' attitudes to learning, eagerness to study, etc., we add-up the data of seat positions occupied by students, and investigate further on these issues. We take the term-end examination scores as the index for measuring achievements of students. We investigate how the seat positions of students and their achievements are corelated.

We also observe that students often form groups of friends. They are close to each other, and thus, they like to do things together, including taking nearby seats in the classrooms, chat a lot, and study together. We hypothesize that seat positions and achievements of students in the same group somehow relate to each other. Investigation of this issue is another important aim of this paper.

In the long run, our goal of analysis of educational data is to better understand our students, such as their attitudes towards learning, what they think about their learning style, how we could advise them for better performance, etc. The study conducted in this paper is a part of our approach toward this goal.

The rest of this paper is organized as follows: In Section II, we describe the data we deal with for analysis in this paper. Then, in Section III, we investigate how students take seats in the class and if seat positions relate to the students' achievements. In Section IV, we define the concept of the distance between two students, and then, we investigate if distances of two students relate to the difference of their achievements. Finally, in Section V, we summarize this paper and prospect our future plans.

II. THE TARGET DATA FOR ANALYSIS

The data we deal with in this paper are obtained in a course called "Information Science" in a university in Japan during the semester from September 2013 to February 2014. The course aimed to make the students learn sufficient elementary knowledge about the computer's hardware and software, network, information security, information ethics, etc., and was consisted of 15 lectures.

The number of students who registered for the course was 68. The number of students who actually attended the classes was 67 because one student did not attend the classes

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at all. The students of the course consisted from the first-year to the fourth-year. The attending students were asked to write a mini-report at the end of every class. There was the term-end examination for assessing the student's achievement, which consisted of 3 questions: The first question asked the students to choose appropriate terms for the 20 fill-in-the-blank-places contained in 6 descriptive sentences. The second and the third questions asked them to answer in free-text style. These questions aimed to assess if the students had sufficient knowledge about the technical terms and concepts which they had learned in the classes. We consider the score of this examination as the measuring index of achievement of the student.

Considering the privacy issue of students, we refer each student by his or her sequential number. The seat position records used in this paper are the ones students recorded themselves at each class.

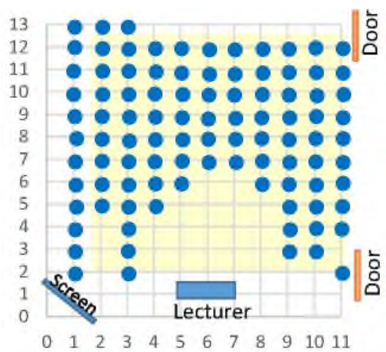

Figure 1. Seats occupied by students at least once

Figure 1 shows the seats occupied by at least once by some students. The lecturer's table was located at the center area of the lower-end of the figure, and a screen was located at the lower-left corner, and two entrance doors were located at the right; one at the lower-right corner and the other, at the top-right corner.

The seats were spanned from 1 to 11 horizontally (or x-direction) and from 2 to 13 vertically (or y-direction). In this paper, we specify a set position by its x- and y-coordinates. For example, the seat (1, 2) is the left-bottom-end seat, which is the closest seat to the screen. The seats at the topmost line with 13 y-coordinate existed only from 1 to 3 in their x- coordinates. There were no seats from 4 to 11. Thus, the seat at (1, 13) is the left-top-most seat and the seat (11, 12) is the top-right-most seat of the classroom.

As we can see easily, quite a few students avoided the seats that are close to the lecturer and thus some seats had been occupied by no students. For example, the seats from (2, 2) to (10, 2) except (3, 2) are never occupied by any students. Among 124 seats, 26 seats are never used, and the rest 98 seats are used at least once.

Table I shows how many times each seat was occupied during the course. The frequencies range from 1 to 16. The seat (10, 11) is the only one which has the maximum frequency of 16. There are 4 seats which have the minimum frequency of 1, namely, (11, 4), (9, 6), (5, 6), (4, 5), and (2, 5).

The right-most column marked as μ, meaning the mean, shows the mean of the respective line, and the bottom line marked as μ shows the mean value of the respective column.

TABLE I. FREQUENCY OF OCCUPATION OF SEATS

	1	2	3	4	5	6	7	8	9	10	11	μ
13	12	11	12									12
12	15	15	7	8	8	12	13	8	12	12	5	10
11	13	8	11	5	13	15	13	4	14	16	13	11
10	12	11	11	6	7	14	11	4	9	12	14	10
9	12	10	12	5	2	12	15	12	6	15	13	10
8	11	12	8	5	10	10	9	8	5	12	13	9
7	9	7	8	4	4	5	4	6	4	6	11	6
6	11	10	11	2	1			3	1	8	12	7
5	12	1	2	1					4	4	8	5
4	3		9						12	14	1	8
3	11		2						14	15		11
2	11		13								3	9
μ	11	9	9	5	6	11	11	6	8	11	9	

According to Table I, we can say that the seats in the areas which are far-end from the lecturer are very popular. For example, the seats surrounded by the areas from 1 to 3 in horizontal, or x-coordinate and from 8 to 13 in vertical, or y-coordinate (i.e., far-left corner) have high values, where the mean value of frequency in this area is 11.

Also, the seats in the area surrounded by from 9 to 11 horizontally and from 8 to 12 vertically (i.e., far-right corner) is also the one that is highly used by students, where the mean frequency is also 11. Furthermore, the seats in the area from 5 to 7 horizontally and from 9 to 12 vertically (i.e., far-middle) also has mean frequency 11. On the contrary, the seats with 4, 5, 8, and 9 in x-coordinate have very low frequency in average, as we can see in the last line of Table I, specifically, 5, 6, 6, and 8, respectively.

As we compare the mean frequencies between the horizontal lines of seats which are shown at the right-most column marked as μ in Table I, the upper area, or the far-from-the-lecturer area, from 7 to 13 in y-coordinate have high values from 9 to 12, whereas the middle area, or the not-far-away-and-not-too-close-to-the-lecturer area, from 5 to 7 in y-coordinate have small values from 5 to 7 in their mean frequencies. The lower area, or the closest-to-the-lecturer area, from 2 to 4 in y-coordinate has the mean frequency values from 8 to 11.

From these observations, we may roughly conclude that both horizontally and vertically, far-end areas are popularly used by students. As we compare the columns horizontally, left-most, middle, and right-most areas are popular, whereas the area between these areas are not so much popularly used. As we compare the lines vertically, the upper half area is most popularly used, and the lower part of the rest areas are the next, whereas the upper area in the lower part is the least popularly used area.

III. SEAT POSITION ANALYSIS

Each student has his or her own seat choosing preference. Some students prefer to occupy the same seat throughout the

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classes, whereas some other students transit a lot from a lecture to the next one. We assume that a group of students who are friends each other might transit together by keeping their seat distances as close as possible throughout the course.

A. Correlation between Seat Positions and Achievements of Students

It is often pointed out that students who take seat near the lecturer are more eager to learn, and thus have better achievements than those who take far-away seats from the lecturer. First of all in this section, we would like to make sure if this observation is true or not in our data.

In order to prepare for further analysis, we give a formalized descriptions of the data and important concepts.

We define $S = \{s_1, s_2, \ldots, s_n\}$, the set of all students. Note $n = 68$ in our case. We also define the set of lectures by $L = \{1, 2, \ldots, m\}$. Note $m = 15$ in our case.

Let $s \in S$ and $l \in L$. Then, the seat data is in the form $seat(s, l) = (x, y)$, where $x \in \{1, 2, \ldots, 11\}$ for x-coordinate and $y \in \{2, 3, \ldots, 13\}$ for y-coordinate. Note that $seat(s,l)$ is undefined if the student s is absent at the lecture l. We also define $Achv(s)$ for student s as the achievement, or examination score, of s. Note $0 \leq Achv(s) \leq 100$ for all s.

We define the concept of achievement value for a seat for preparing later discussions. Let p be a seat position, i.e., $p = (x, y)$ for some x and y so that $1 \leq x \leq 11$ and $2 \leq y \leq 13$. The achievement value $\alpha(p)$ is defined by:

$$\alpha(p) = \frac{\sum_{(s,l) \in so(p)} Achv(s)}{|so(p)|} \quad (1)$$

where $so(p) = \{(s, l) \in S \times L \mid seat(s,l) = p\}$, and $|so(p)|$ is the number of elements of the set $so(p)$.

According to the definition, $\alpha(p)$ is the mean of the achievements of the students who occupied the seat p on the basis of occurrences of occupation. For example, if exactly one student takes the seat p, and no other students take it, then the achievement value of the seat is the same value as the achievement of the occupying student; i.e., $\alpha(p) = Achv(s)$. Note that the student may not attended all the lectures.

Table II and Figure 2 show the achievement values of seats. The size of a circle in Figure 2 is proportional to the achievement value of the seat located as the center of the circle. We can see easily that the size of the circles close to the lecturer, i.e., in the lower area, are bigger than those in the upper area. The rightmost column of Table II shows the mean of the achievement values of the line. They also show that the achievement values are larger in the lines with smaller number, i.e., closer to the lecturer, than those with bigger numbers. Thus, we can conclude that our observation that the students closer to the lecturer have better achievements than those who take far-away, or rear seats.

We are also interested in to know if there is a difference in achievements between the students who sit near the enter/exit doors and those who sit far-away seats from the doors. We could not find clear differences of the size of the circles between left and right areas of the classroom, more specifically, the values range from 52 to 68, with small difference. Thus, we may roughly conclude that there are no significant differences in the achievement of seats between left and right positions.

TABLE II. SEAT POSITION ACHIEVEMENT

	1	2	3	4	5	6	7	8	9	10	11	μ
13	52	56	66									58
12	56	60	47	57	64	60	52	79	89	64	67	63
11	64	50	30	62	62	65	61	46	53	48	69	55
10	61	57	63	57	61	69	60	55	14	61	56	56
9	59	50	55	63	73	61	61	60	37	65	58	58
8	60	56	66	51	66	66	68	67	24	70	62	60
7	70	80	61	55	62	68	61	69	46	67	54	63
6	75	79	60	48	59			69	70	65	56	64
5	43	55	82	25					62	75	63	58
4	78		82						57	86	70	75
3	83		97						79	80		85
2	68		95									81
μ	64	60	67	52	64	65	60	64	53	68	62	

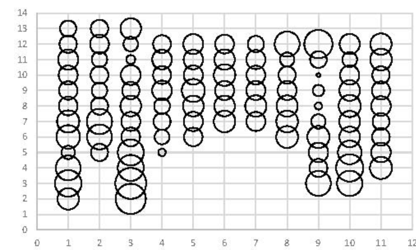


Figure 2. Seat Achevement

TABLE III. COMPARISON OF DOMAIN-ACHIEVEMENTS

	1-3	4-8	9-11
7-13	57.7	62.2	57.9
2-6	73.6	55.3	70.7

We would like to analyze the differences between areas in the classroom. We divide the classroom area into 6 smaller areas; left area by column numbers from 1 to 3, middle area from 4 to 8, and right area from 9 to 11, and front area by line numbers from 2 to 6, and back area from 8 to 13. Table III shows the mean values of achievement of these 6 areas; front-left, front-middle, front-right, back-left, back-middle, and back-right. As we can see easily, front-left and front-right areas have the highest achievement values, followed by the back-middle area, and back-left and back-right areas. The front-middle area has the least, or worst, achievement value.

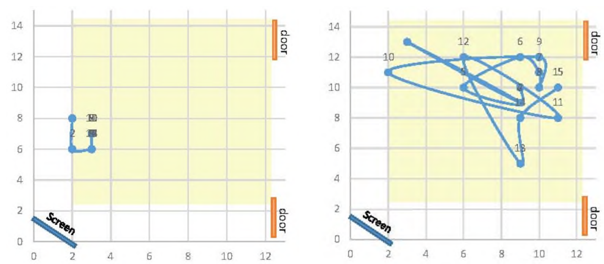
We investigate a significant difference of the mean of the seat achievement α(p) for the six areas in TABLE III using the analysis of variance (ANOVA) test without assuming equal variance. We obtain the results that F = 3.734, num df = 5.000, denom df = 20.061, p-value = 0.01496. The result of the mean difference of seat achievement degree α(p) with a significance level 5%, the p-value is 0.01496. Thus, we can conclude that significant difference holds in at least one pair of 6 areas.

It is interesting to see that the students who sit in front area are diligent and having good achievements in general. It is also interesting that in the back area, students in front of the lecturer may be more diligent than those who sit far-left and far-right seats. We need to investigate further on these results with other lecture data in order to generalize this observation.

B. Seat Transition Length Analysis

In this section, we pay attention to the transitions of seats of students. According to our observation, some students take same seats at every lecture, whereas some students take different seats frequently. It may happen that the seat transitions reflect the student's attitude to learning or some other attitudes which relate to their achievements. We would like to investigate if such kinds of relations exist or not in this section.

Figure 3 shows sample seat transition trajectories of two students 12 and 27. Student 12 is a typical example who keeps their positions, and student 27 is one who transits a lot. Note that the numbers next to the points indicate the lecture number.



(a) Student 12 (b) Student 27

Figure 3. Sample Seat Transition Trajectories: (a) with Small Transition Length, and (b) with Large Seat Transition Length

For a student s ($\in S$), we define the set of attending lectures L_s by $L_s = \{l \in L \mid seat(s, l)$ is defined $\}$. Let $|\cdot|$ be the number of elements of the set. Then, $|L_s|$ is the number of the lectures which the student s has attended. Thus, $0 \leq |L_s| \leq 15$ holds. Where, $|L_s| = 15$ means that the student s attended all the classes, whereas $|L_s| = 0$ means that the student s did not attend the class at all.

Now we define the mean transition length $\tau(s)$ of the student s with $|L_s| > 0$ by:

$$\tau(s) = \frac{\sum_{i=1}^{k-1} d(seat(s.l_i), seatl(s.l_{i+1}))}{k-1} \quad (2)$$

where, there exists a sequence $l_1, l_2, \ldots, l_k$ ($\in L$) for some k (≥ 2) such that $l_1 < l_2 < \cdots < l_k$ and $L_s = \{l_1, l_2, \ldots, l_k\}$. Here, $d(p_1, p_2)$ is the distance function defined for every seat positions p_1 and p_2. Note that $k = |L_s|$. We define $\tau(s) = 0$ if $k = 1$; i.e., $L_s = \{l\}$ for some $l \in L$.

According to our definition, $\tau(s)$ is undefined if the student s did not attend at all. Note that $\tau(s) = 0$ if the student takes the same seat every time he or she attended. Note that the Σ-part of the definition is the accumulated transition distances. Thus, τ is the mean of transitions by only considering the seats when the student (3) attended.

In this paper, we define the distance function d as follows: For any seats $p_1 = (x_1, y_1)$ and $p_2 = (x_2, y_2)$, $d(p_1, p_2) = |x_1 - x_2| + |y_1 - y_2|$. Note $|\cdot|$ in this definition is the absolute value of the number. In our method of analysis conducted in this paper, we may take other distance functions such as Euclidean distance:

$$d(p_1, p_2) = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

TABLE IV. SEAT TRANSITION LENGTH DATA FOR THE STUDENTS FROM 1 TO 10, 12 AND 27.

St.	Total.	#Transitions	τ	Achievement
1	61	12	5.1	46
2	69	12	5.8	55
3	13	14	0.9	63
4	7	12	0.6	56
5	9	11	0.8	49
6	23	14	1.6	53
7	2	14	0.1	80
8	44	14	3.1	82
9	35	14	2.5	59
10	37	12	3.1	74
12	7	14	0.5	57
27	82	14	5.9	75

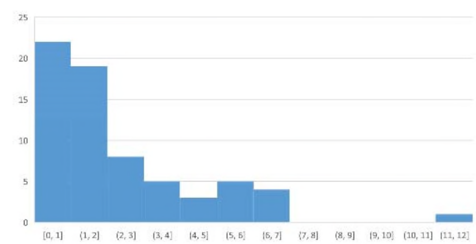


Figure 4. Histogram of Mean Transition Distance

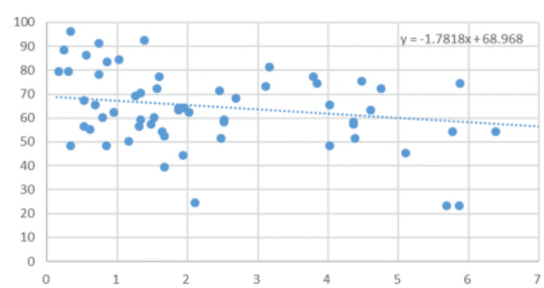


Figure 5. Correlation between mean Seat Transition Length and Achievement

Table IV shows the total transition length, the number of transitions, the value of $\tau(s)$, and the achievement of students from 1 to 10, 12, and 27, as example. As we have

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pointed out in Figure 3, we can numerically confirm our observation by objective data that $\tau(s_{12}) = 0.5 \ll \tau(s_{27}) = 5.9$.

Figure 4 shows a histogram for τ. We can see that the number of students decreases as τ value increases. Thus, many students do not transit a lot. From this result, we can say that the student 12 is a typical example of those who do not transit a lot, whereas the student 27 represents a rare case who transits a lot.

Figure 5 shows how τ values and achievements of students are correlated. The correlation coefficient is -0.253*, which is weak in negative and not uncorrelated. The p-value is 0.04726 in the Pearson product-moment correlation coefficient test. For the students with long transition length τ, i.e., frequently moving students for each lecture, achievements are not very good.

The results of our regression analysis test show that the explanatory variable coefficient = -1.78* and the intercept = 68.96***, adjusted R-squared = 0.04841, p-value = 0.04726.

The seat transition lengths of the top 10 students in achievement, i.e., those who's achievement values are greater than or equals to 80, are less than 2 except student 8, who has 3.14 in seat transition length. The mean seat transition length of these 10 students is 0.77.

It is interesting to see that the worst 10 students in achievement also have smaller transition length. Their achievement value is ≤ 51 and their mean transition length is 2.07. If we avoid the two students who have more than 5 transition length, the remaining 8 students have 1.22 in their transition length.

The students who have roughly from 50 to 80 have a wide range of values in their transition length, where their mean length is 2.39.

IV. SEAT DISTANCES BETWEEN STUDENTS

In this section, we investigate the correlation between seat distances and achievement differences of two students. We have a hypothesis that students who are friends tend to take seats close to each other. They communicate a lot, do things together including studying together. As a result, they might have similar achievements in the term-end evaluation examination. We would like to verify if this assumption is true or not in our data.

To begin with, we define the seat distance (or just distance for brevity) between two students. Let s_1 and s_2 be students ($\in S$). We define the seat distance $\delta(s_1, s_2)$ of s_1 and s_2 by:

$$\delta(s_1, s_2) = \frac{\sum_{l \in L_{s_1} \cap L_{s_1}} d(seat(s_1.l), seat(s_2.l))}{|L_{s_1} \cap L_{s_1}|} \quad (4)$$

when $L_{s_1} \cap L_{s_2} \neq \phi$.

The seat distance is the mean distance of two students when both of them are attending. Thus, $\delta(s_1, s_2)$ is undefined when $L_{s_1} \cap L_{s_2} = \phi$; which includes the case when one student is absent at all the lectures, and when one student attends the class, the other one is absent all the time.

Figure 6 shows the histogram of seat distances. The mean distance is 7.4, and maximum and minimum distances are 18.7 and 1, respectively. Figure 7 shows the histogram of differences of achievement of all the combinations of a pair of students. The number decreases as the difference increases. However, as we compare the mean values of achievement differences of all pairs and only the pairs which have less than or equals to 2, the former value is 24 and the latter is 21 as the difference of achievement score increases. The minimum, maximum, and mean values of the differences are 1, 18.7, and 7.4, respectively.

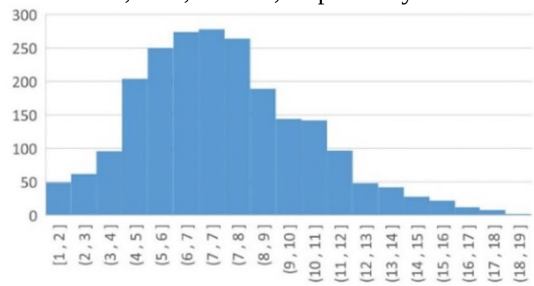

Figure 6. Histogram of Seat Distances between Pairs of Students

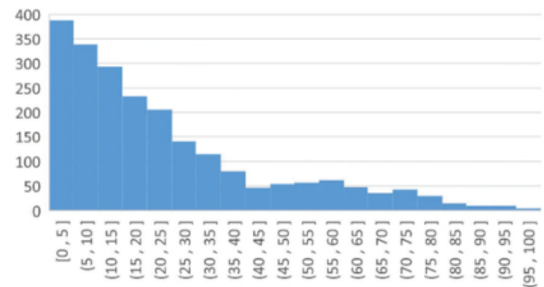

Figure 7. Histogram of Achievement Differences between two Students

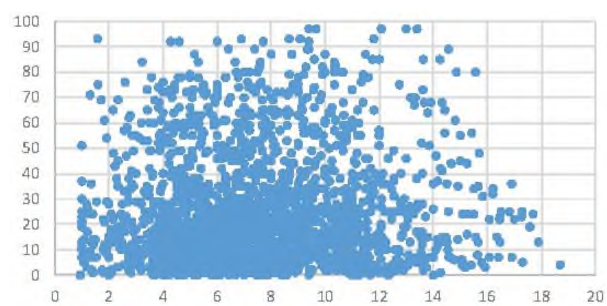

Figure 8. Correlation Between Seat Distance and Achievement Difference Between Two Students

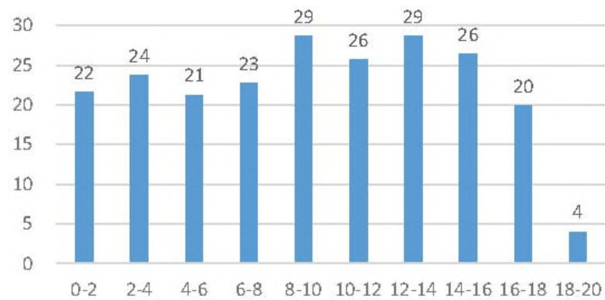

Figure 9. Mean Achievement Differences over the Range of Distance of Students

Figure 8 shows the correlation between the seat distances and achievement difference of every pair of students. From the figure, there seems to have little correlation between them. Actually, their correlation coefficient is a very small positive number of 0.08.

Next, we restrict the range of seat distance to 2 or less than 2, there are 59 cases of pairs of students, which correlation coefficient is 0.08, nearly the same value as that for all data. However, as we compare the mean values of achievement differences of all pairs and only the pairs which have less than or equals to 2, the former value is 24 and the latter is 21, which is somewhat smaller for the intimate student pairs than those in general.

Figure 9 shows the comparison of the mean differences from 0 to 20 by dividing them with the range width of 2. We can see that the values for the intervals 4-6 and 16-18 have smaller difference values than the closest value interval of 0-2. Thus, we cannot say that achievement difference is small when the seat distance is very small. We need to investigate in more detail in order to clarify what conditions are needed in our assumption that friendship of students might induce similarity of their achievements holds.

V. CONCLUDING REMARKS

The major goal of our series of study is to understand about the students, such as their attitudes to the lectures, and to learning in general, their motivation and seriousness to learning, and their styles in learning, and providing them with the best learning environment to them so that they can achieve the most out of the lectures.

Our approach is to extract useful tips for this goal by analyzing objective data obtained in the lectures together with other data collected by the university they are affiliating. By combining these tips and our know-hows obtained from practicing lectures, we should be able to provide them with good and valuable lectures.

In this paper, we take seat position data for analysis. First, we define an index for seat positions which shows how much achievement scores are taken by the students who use the seat. The result showed that the students who take seats close to the lecturer tend to have good achievements, whereas those who take far-away seats achieve rather poorly in general, which supports our observation. However, the result also inspired that some students with high performance may take seats near some far-end corner of the classroom. We need to investigate further with different lecture data on this.

Then, we investigate correlation between the transition lengths and achievements. We found that students who have either high achievements and low achievements rather transit a little length, and achievements of the students in the middle area vary widely from small transition to big transition lengths.

Even though we have some amount of confidence that students who take seat close to each other and transit together in order to keep their close distance might have similar achievement difference. Experimental result inspired that this is not true. One possible interpretation of this result is that there are many students who happen to take seats close to each other without intending to take close seats. We need to investigate further on such possibilities.

Our future study topics include: (1) to investigate the seat data further so that we can extract more valuable tips, (2) to analyze text data of the mini-reports which students had written at the end of each lecture, (3) to apply the similar method presented in this paper to other lecture data and compare them, etc.

ACKNOWLEDGMENT

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