Analyzing the Correlation between Seat Selection, Seat Change, and Academic Performance among University Students

ABSTRACT: This study investigates the correlation between classroom seating choice and academic performance of college students. We examined this relationship using statistical analysis, and our sample consisted of 142 undergraduate students enrolled in the School of Software at the Nanchang Hangkong University. First, over the course of one semester, we collected data on students' seating choice, their final exam results, and other data on student characteristics. Second, we constructed a seat calculation model and used the Pearson correlation coefficient method to quantitatively analyze the data. We then visually displayed the seat selection process using two types of figures, color gradation figures and box-plots. This allowed us to empirically examine the relationship between seat selection and academic performance, as well as the effect of seat change on academic performance and the characteristics of the trajectory of student seat change. The results show that student performance is correlated with seat location and changes in seat location. In general, students seated closer to the front row performed better academically, as did students who did not change seats very often. Finally, we plotted the students' seat change trajectories to investigate their seating choice patterns. We also conducted follow-up interviews with instructors and students to obtain more information about why the observed patterns emerged. This study has important implications for university teachers interested in improving classroom management and student learning based on classroom seating choices.

Keywords: quantitative analysis; Pearson correlation coefficient; visualization; natural verification method; Correlation analysis

1 INTRODUCTION

With the increasing use of computer technology in the classroom, researchers have been focusing on the factors that affect student academic performance. Compared with primary and secondary school classes, one of the biggest changes in university classrooms is the freedom in seating choice. The university classroom is characterized by partner seat selection, random seat selection, and early occupancy. When given free seat selection, many university students prefer to seat in the back row, or next to friends and roommates. Do these choices affect academic performance? What perspectives have been used to study the impact of seating choice on academic performance? These issues have been the focus of scholarly research.

For about a century, there have been studies on the correlation between seating position and academic performance [1]. Their results, however, have yielded different conclusions. Weinstein showed that students who sat in the middle of the front row were more actively engaged in the course, remained focused, and had higher academic performance [2]. Piccerri found that student academic performance was influenced by specific seating and that this influence could be modulated by individual personality [3]. Perkins et al. revealed that seating Location has a significant impact on students' academic performance. They argued that overall student performance tends to decrease as their seating distance from the front of the classroom increases [4].

However, Armstrong and Chang found no evidence that seating position affects

academic performance, even in very large classrooms [5]. Blume looked at levels of attentiveness and hyperactivity among students seated at different locations. They found that severe hyperactivity can impair academic performance, but that students did not particularly benefit from proximity to the teacher's seat[6]. In a study on the relationship between seating choice and academic performance among college students, Jover found that most students were reluctant to sit in the first row, except for the most punctual students, who chose to sit in the first row or near the teacher. However, students' seating choices have little effect on their academic performance [7].

Giselle studied whether seat selection in the classroom is related to motivation. He suggested that the phenomenon of "back-seating" is indeed related to students' interest and motivation. The way students choose their seats affects their classroom participation, their determination to get a good grade, and the amount of attention they pay in class. Others have found that students seated in the front row are more motivated and effective than those seated in the back row [8]. Li investigated the impact of different seating perspectives and elevation on students' visual effects by constructing a discrete weighted model and obtaining the satisfaction function for different seats in the classroom [9]. Joshi considered the effects of seat choice on student engagement [10].

In addition, students' seat choice is also influenced by classroom lighting, temperature, window location, and seat distribution characteristics [11-13].

Is seat choice related to academic performance? We answer this question by implementing the following innovations in our research. First, in terms of research methods, we use the natural verification methods to obtain data, compared with survey questionnaires and other more conventional methods. This ensures the reliability of the data. Second, we analyze both the effect of academic performance on seat selection and the effect of seat selection on academic performance, which allows us to test the relationship from both directions. Third, we investigate the influence of student seat change on their learning as well as the characteristics of student' seat changes. This paper is important for university teachers interested in improving classroom management and student learning based on classroom seating choices.

2 MOTIVATION

In this study, we use statistical analysis to characterize the relationship between seat choice and academic performance, the impact of seat changes on academic performance, and the characteristics of student seat change trajectories.

Our research is guided by the following three questions:

1) Is there a correlation between seat choice and academic performance?

The purpose of Question 1 is to investigate the characteristics of the relationship between classroom seat choice and academic performance. In order to make the results of the inquiry more convincing, we studied this question to find out the effect of seat choice on grades and the effect of grades on seat choice. We present these results visually.

2) What is the impact of seat changes on academic achievement?

Question 2 aims to investigate the impact of seat changes on student achievement. To answer this question, we used the SPSS data analysis software to study the correlation between last average displacement, variance, and academic performance. We then selected

part of the representative student data for analysis and verification.

3) What are the characteristics of the student seat change trajectory?

Question 3 was designed to explore the characteristics of student seat trajectory changes. To answer question 3, we generated the row seat trajectory changes for all students. We produced trajectory change graphs to be investigated for regularity.

3. APPROACH

3.1. Data sources

Our study was based on 2,241 undergraduate students from the School of Software at Nanchang Hangkong University in the Jiangxi Province. To control for the influence of different teachers on student seat selection, we selected three different courses in three different academic years taught by the same teacher. The experiment uses the n natural verification method to collect data. Teachers and teaching assistants manually recorded the data on students' seat locations in the 2018 semester, as well as other relevant student information (see Table 1).

Table 1 Data source specific information

Course	Course features	Academic year	Number of students	Seat location	Basic attributes
C/C++	Platform class/ Practice class	Freshman	63	Check in once a week for 14 weeks.	Name, Sex, Student ID, Score, Score ranking
Software Engineering	Core courses	Sophomore	75	Check in once per week for 13 weeks.	
Web	Elective	Junior	103	Check in once per week for 9 weeks.	

3.2 Research design

In the natural selection method, we analyzed the characteristics regarding students' seating choice and their academic performance. We did not consider the impact of different teachers and classroom sizes on student seat selection.

The data of the seating variables were obtained in three steps. First, we collected information on where each student sat in the classroom, by natural experimentation. Second, the data were preprocessed and the required variables were calculated by using the model. Third, students in every academic year were divided into four groups of A+, A-, B+, and B-. The classroom seats were divided into the first half and the second half for data statistics. The variable definitions are shown in Table 2.

Table 2 Variable definition table

Variable Name	Variable Definition
Academic year	Freshman, sophomore, and junior were respectively labeled A, B, and C.
Ranking	According to the final exam results, students with the same score are ranked the same
Seat ranking	The average of the academic performance rankings of students who occupied the same seat in a semester

	(For example, a seat has been occupied nine times in a semester, perhaps by different students. Then the seat ranking is the average ranking of the student who has selected the seat, not taking absences into account.)
Level of attendance	The total number of times each row of seats was occupied during the semester.
Occupancy rate	The quotient of the number of attendance and the maximum number of students per row.
Grade ranking groups	Ranking is in ascending order and divided into four groups: A+, A-, B+ and B-
Front row occupancy rate	The front row occupancy rate of the ranking group is the ratio of students sitting in the front half of the classroom in each group to that group of students
Sequence of last average displacement	A sequence composed of the Euclidean distance between the nth seat and the n-1th seat of the student
Last average displacement	The average value of the sequence of last average displacement

The main variables in this study are student's seat location and their grades.. First, we defined the academic year and seat in a representation matrix Ai[a_{mn}] for a single course. Ai[a_{mn}] denotes the freshman seat in row m and column n in the i-th class in an academic year A. Unoccupied seats are denoted by NULL.

$$\mathrm{Ai}=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \quad (1)$$

In the experiment, when the seat is used as the basis for counting, we mainly considered the changes in the number of students occupying the seat, including the ranking of students occupying the seat and the number of times the seat was occupied. Thus, we obtained the seat rank, level of attendance, and occupancy rate. The attendance and occupancy rate were both counted in a row. The following models were developed for calculating the seat ranking, level of attendance, and occupancy rate.

$$\text{Seat ranking}=\frac{\mathrm{A1}[a_{mn}]+\mathrm{A2}[a_{mn}]+\cdots\mathrm{Ai}[a_{mn}]}{Count[\,Ai[a_{mn}=0]\,]} \quad (2)$$

$$\text{Level of attendance}_{\beta}=\text{Counta A1}[a_{\beta}]+\cdots+\text{Counta Ai}[a_{\beta}] \quad (3)$$

$$\text{Occupancy rate}=\frac{Level\ \text{of a}ttendance}{i\times \mathrm{n}} \quad (4)$$

i represents the maximum number of classes, n represents the maximum number of seats, and β represents a row.

In general, the variance was used to describe the degree of dispersion of data.

Therefore, in order to study the changes in student seating, we first calculated the variance in student seat changes.

The student seat coordinates are denoted by (x, y), where x denotes rows and y denotes columns. According to Figure 1, the first position in the upper left corner is denoted as (1,1) (excluding the teacher's position). Therefore, the seat sequence of each student is expressed as $[(x_1, y_1), (x_2, y_2), \cdots, (x_i, y_i)]$, and the center point of the student seat is expressed as $(\bar{x}, \bar{y})$. The solution formula is as follows:

$$\bar{x} = \frac{\sum_{q=1}^{i} x_q}{i} \quad , \quad \bar{y} = \frac{\sum_{q=1}^{i} y_q}{i} \qquad (5)$$

Thus, the model of variance can be obtained:

$$S^2 = \frac{\sum_{q=1}^{i} (x_q - \bar{x})^2}{i} \qquad (6)$$

4.RESULTS AND DISCUSSION

In the sections below, we answer and discuss the following research questions.

4.1 Is there a correlation between seat choice and academic performance?

1) To answer this question, we first analyzed the effect of seat location on academic performance.

The seat-corresponding academic performance refers to the seat-based counting benchmark. We used a statistical method to count variables such as seat ranking. In the first stage, we counted the seat ranking, level of attendance, and occupancy rate. In the second stage, we merged all the data and analyzed it with tools such as SPSS and Python.

Stage 1: We first created the color gradation figure representing seat ranking, as shown in Figures 1.1, 1.2, and 1.3. The first row in the figure represents the seat ranking of the first row of students, the second row represents the seat ranking of the second row of students, and so on. In the figure, the position of the blackboard and that of the teacher are marked. The color gradation figure contains three colors, blue, white, and red. The color blue indicates the seat ranks near the top, and red indicates the seat ranks near the bottom. Seats that are occupied less than four times during the semester were ignored.

After observing the color gradation figure and estimating probability according to the frequency of accounting, we divided the three seats for each academic year into the first half and the second half. The frequencies of blue and white seats in the first half were 70.77%, 68.69%, and 76.92%. Therefore, it is reasonable to believe that the students who ranked in the middle and upper half of the first half constituted most of the students, and the corresponding students in the second half ranked relatively low. That is, students who were seated close to the front row generally performed better.

At the same time, by looking at the color gradation figure, we observed that the grades of the students sitting on the edges were slightly lower. To verify this conclusion, we selected

two columns of students on the left side of the wall and two columns on the right side of the wall to calculate their blue and white frequency statistics. The left frequency values are 44.44%, 77.78%, 45.45%, and the right frequency values are 44.44%, 38.89%, 40.91%. We found that, except for sophomores' left frequency value of 77.78%, other frequency values are less than 50%. Therefore, the conclusion that the students seated on both sides ranked slightly lower was confirmed.

At the end of the experiment, we interviewed the teachers and some students to obtain additional insights in order to better understand these results. Interviewees revealed that the seats in the back row and on both sides were not preferred seating locations. This was mainly because the students sitting in those areas were far from the teacher and the blackboard. As a result, they paid less attention in class. Teachers reported that these students often became distracted and were more likely to play with their mobile phones. On the other hand, students who were seated in the front row were more active in terms of class participation, which is also one of the factors affecting academic performance [14].

Therefore, we suggest that teachers should appropriately adjust their interaction with students. They should step off the stage, approach the sides and the back of the classroom to encourage student participation in and enthusiasm for the class. At the same time, teachers need to focus more on the students seated on the sides and in the back row, and discourage them from using their mobile phones in class.

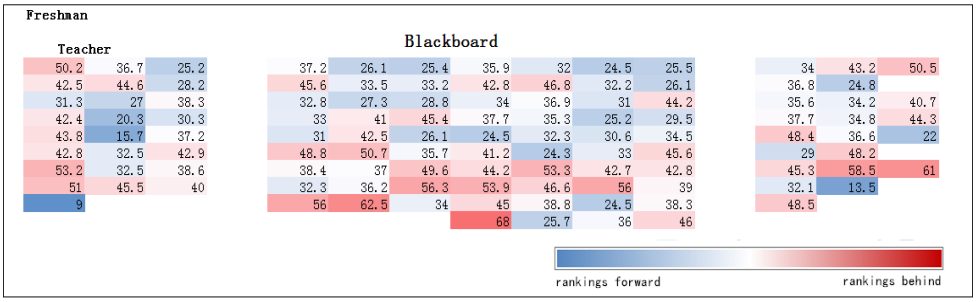

Figure 1.1 Color gradation figure distribution map of freshman seating choices

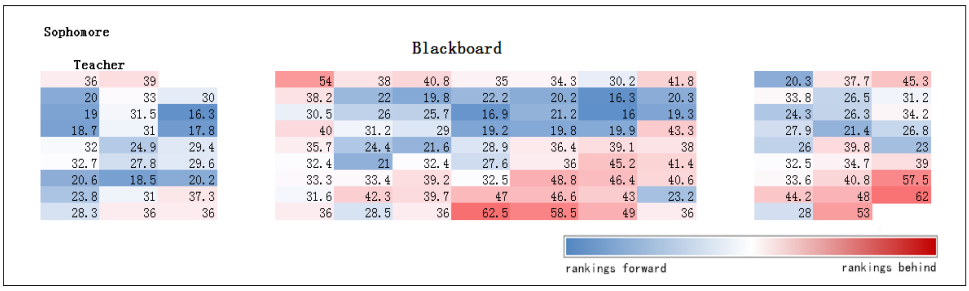

Figure 1.2 Color gradation figure distribution map of sophomores seating choices

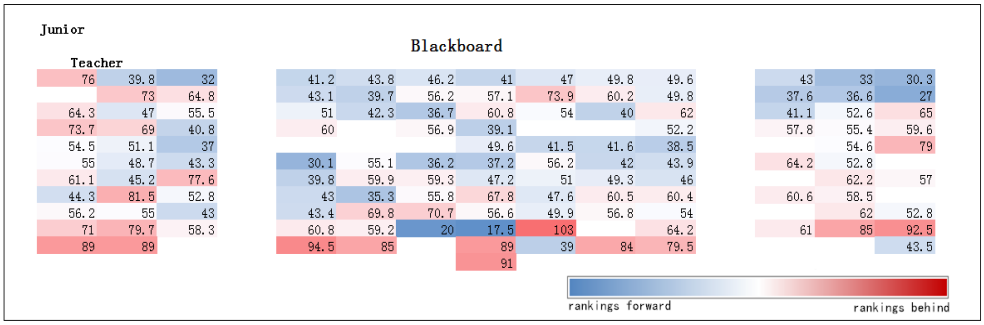

Figure 1.3 Color gradation figure distribution map of junior seating choices

Stage 2: We used the SPSS software to analyze the maximum, minimum, and average values for each seat row in the academic year. The level of attendance and occupancy rate of each row is shown in Tables 3.1-3.3. The first row in the table corresponds to the first row of the classroom, the second row corresponds to the second row of the classroom, and so on. Therefore, we only considered the rows where the total level of attendance exceeded 20.

Our analysis of Table 3.1 reveals that the average shows an upward trend of volatility as the seat distance from the classroom front increased. The interval difference became increasingly polarized in terms of sitting at the back. Also, the occupancy rate was slightly lower in the first two rows and began to decline in the third row. Except for 37.7% of the first row, the average value in Table 3.2 gradually increased in terms of sitting at the back of the classroom. Except for the first row, the interval difference shows an upward trend as a whole, and the performance trend of occupancy rate is close to 3.1. In Table 3.3, the overall average shows an upward trend in terms of sitting at the back, but the magnitude was slightly smaller than that in 3.1 and 3.2. There is no obvious regularity in the fluctuation of the interval difference, and the occupancy rate gradually decreased with sitting toward the back.

As a whole, the average of the freshman, sophomore, and junior years shows that the average seat ranking became increasingly large as students sat at the back. In other words, the closer students were to the front row, the better their academic performance. The law of occupancy rate was also consistent. The occupancy rates in the first and second rows were slightly lower than those of the latter two rows, and the occupancy rates show a downward trend starting from the third row. This indicates that students prefer to sit at the front of the classroom[15]. The increasing trend in the interval difference for freshman and sophomore years shows that the academic performance of students seated close to the front row was relatively stable. Conversely, the interval difference between the last two rows is more than 1.5 times the interval difference of the other rows, which indicates that the academic performance of the students in the last two rows is quite different. During the interviews, we investigated the reasons for these unusual phenomena.

When we conducted follow-up interviews, we learned that the lower occupancy rate in the first two rows was due to the proximity to the blackboard, which made students' eyes and spine more susceptible to discomfort over long periods of time. Therefore, we suggest that, if there are enough seats in the classroom, teachers could ask students to take their seats starting in the second row but encourage them to sit near the front. At the same time, we also learned that the interval between the last two rows was too large, mainly because students who were not particularly interested in courses and had previously taken online

courses chose to sit in the last two rows. Thus, we recommend that teachers strengthen their interaction with students in the back row to increase their interest and attention.

Table 3.1 Freshman seat ranking statistics

Row	Max	Min	Ave	Interval difference	Level of attendance	Occupancy rate
1	50.5	24.5	34.34	26	148	81.32%
2	46.8	24.8	36.43	22	144	79.12%
3	44.2	27	34.01	17.2	155	85.16%
4	45.4	20.3	35.15	25.1	140	76.92%
5	48.4	15.7	32.71	32.7	131	71.98%
6	50.7	24.3	39.56	26.4	114	62.64%
7	61	32.5	45.93	28.5	104	57.14%
8	56.3	13.5	41.87	42.8	72	39.56%
9	62.5	9	39.62	53.5	34	18.68%

Table 3.2 Sophomore seat ranking statistics

Row	Max	Min	Ave	Interval difference	Level of attendance	Occupancy rate
1	54	20.3	37.70	33.7	75	44.38%
2	38.2	16.3	25.65	21.9	87	51.48%
3	34.2	16	23.63	18.2	119	70.41%
4	43.3	17.8	26.62	25.5	122	72.19%
5	39.8	21.6	30.71	18.2	115	68.05%
6	45.2	21	33.25	24.2	112	66.27%
7	57.5	18.5	35.80	39	96	56.80%
8	62	23.2	39.98	38.8	60	35.50%
9	62.5	28	40.65	34.5	24	14.20%

Table 3.2 Junior seat ranking statistics

Row	Max	Min	Ave	Interval difference	Level of attendance	Occupancy rate
1	76.00	30.30	44.05	45.70	85	72.65%
2	73.90	27.00	51.58	46.90	101	86.32%
3	65.00	36.70	51.72	28.30	104	88.89%
4	73.70	39.10	56.45	34.60	113	96.58%
5	79.00	37.00	49.71	42.00	106	90.60%
6	64.20	30.10	47.06	34.10	100	85.47%
7	77.60	39.80	54.63	37.80	93	79.49%
8	81.50	35.30	55.68	46.20	88	75.21%
9	70.70	43.00	55.85	27.70	76	64.96%

To verify the notion that students who are seated close to the front of the classroom generally have better academic performance, we drew a seat ranking box-plot, as shown in Figures 4.1, 4.2, and 4.3. A-I in the box-plot represents rows 1-9. In the box-plot, the performance of freshmen and sophomores is represented more intuitively. The distances

between the median (Q2), upper quartile (Q1), and lower quartile (Q3) in the figure increases as students sat toward the back. In the junior year, the relationship between seat choice and academic performance was not very obvious. It was mainly affected by the nature of professional elective courses. Specifically, the requirements for elective courses were lower for students, and students' learning enthusiasm was thus lower.

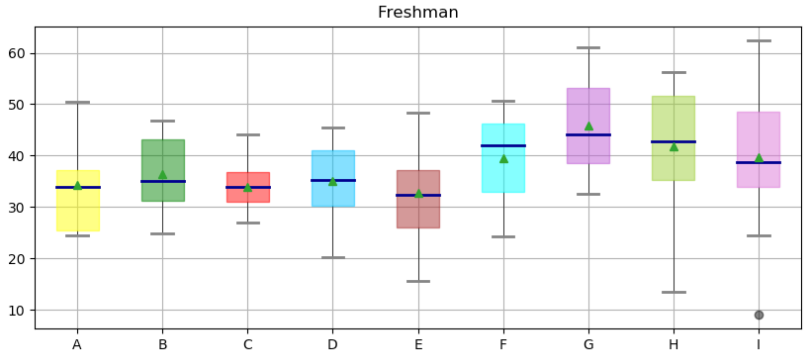

Figure 2.1 Box-plot of Freshman seat ranking

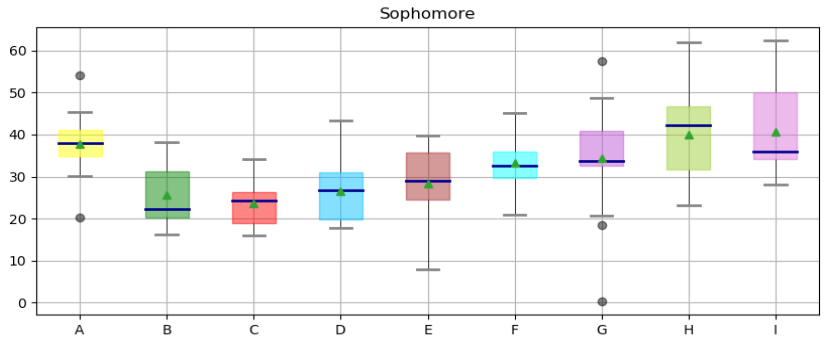

Figure 2.2 Box-plot of Sophomore seat ranking

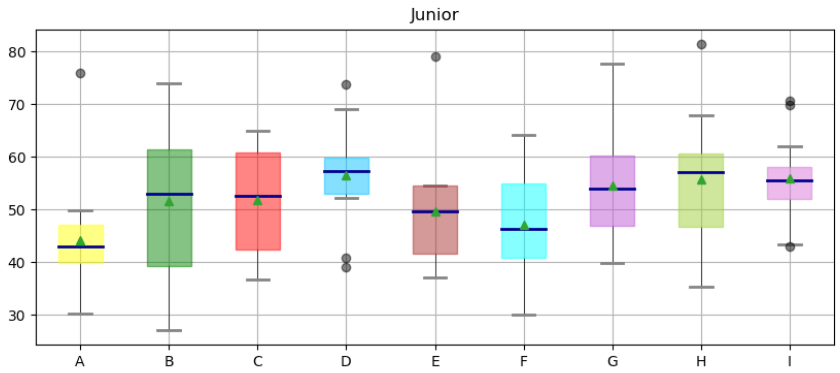

Figure 2.3 Box-plot of Junior seat ranking

We also analyzed the phenomenon from the point of view of academic performance correspondence seat, which refers to the classification of students based on academic performance. We analyzed the distribution of seats for each group of students. We divided the students in the three academic years – junior, freshman, sophomore - into four groups of A+, A-, B+ and B-. We used the SPSS software to count the front row occupancy rate of the

four groups, as shown in Table 4.

Table 4 Front row occupancy rate

Group	Freshman	Sophomore	Junior
A+	0.79	0.50	0.77
A-	0.53	0.44	0.50
B+	0.47	0.25	0.46
B-	0.44	0.40	0.44

As we can see in Table 4, the front row occupancy rate of the A+ group is 0.79, 0.50, and 0.77 for different grades, which represent the highest values of the four groups. The front row occupancy rate of the B- group is 0.44, 0.40, 0.44. Except for the sophomore year, the front row occupancy rates was the lowest. The occupancy rate of the freshman, sophomore, and junior students gradually decreased, but there was an outlier (0.25) in the sophomore B+ group. This indicates that students seated closer to the front of the classroom had superior academic performance.

4.2 What is the impact of seat changes on academic achievement?

To answer this question, we preprocessed the data to calculate the variance in seat change and the last average displacement, as described in Section 3.2. Variance can describe the volatility of students' seats, and the last average displacement can quantify the change in displacement. Therefore, variance and last average displacement, to study the correlation between the variance and average displacement and students' grades. Using SPSS to analyze the Pearson correlation between variance, last average displacement, and score. The results of our analysis are shown in Table 5.

Table 5 Pearson correlation analysis results

Grade	Number of students	Analysis	Variance	Last average displacement
Freshman	75	Pearson correlation	-.007	-.264*
		Significance(bilateral)	.949	022
Sophomore	63	Pearson correlation	-.161	-.260*
		Significance(bilateral)	.208	.039
Junior	103	Pearson correlation	.008	-.091
		Significance(bilateral)	.935	.042

Note: **. Significantly correlated at the .01 level (two-sided).

*. Significantly correlated at the 0.05 level (two-sided).

Table 5 shows the Pearson correlation and the Sig value between the variance, last average displacement, and score. According to the results, we found that the Pearson correlation coefficient values for the freshman, sophomore, and junior academic years were -0.264, -0.260, and -0.091, and the Sig values were 0.022, 0.039, and 0.042. The Sig values are all lower than 0.05. Therefore, the null hypothesis is rejected. In addition, the Pearson correlation coefficient values are all lower than 0, so the last average displacement has a significant negative correlation with the academic year.

In order to ensure the accuracy of the experimental conclusions, we use the last average displacement as the benchmark to verify the experimental results.

We sorted the last average displacement of the three years in ascending order, and selected the top 20% and bottom 20% of the results for further analysis. Among the selected students, we analyzed the student's average score, average variance, as well as the average grades and average variance of each academic year, which are plotted in Table 6.

Table 6 Student data based on Last average displacement ranking

Grade	Data sources	Average grade	Average grades for the academic year	Variance	Average variance for the academic year
Freshman	Top 20%	89.47	89.11	0.96	1.86
	Bottom 20%	85.60		2.56	
Sophomore	Top 20%	74.15	71.29	0.43	1.56
	Bottom 20%	69.53		2.56	
Junior	Top 20%	71.45	68.51	0.48	1.45
	Bottom20%	74.95		2.33	

In Table 6, we can see that the average grades of the top 20% of the students were higher than the grade average score. In addition, the variance scores were much lower than the academic year average variance, and all the variance scores were below 1. Among the bottom 20% of the students, the average grades for freshman and sophomore students were lower than the academic year average, and the variance was much larger than the academic year average, both exceeding 2. Therefore, we consider the SPSS analysis conclusion to be correct.

Based on these research results, we can conclude that seat changes have a certain impact on academic performance, and students with stable seat assignment perform relatively better academically. For students, this means they are likely to do better in class if they do not change seats often.

In addition, in Table 6, we found that the average grades of the bottom 20% of students in the junior year is higher than that of the top 20%. Checking at the original data, we found that two students in the top 20% scored only 18 and 19 points. These two extreme values accounted for 10% of the total number of samples, which seriously affected the experimental results. For reasons of experimental authenticity, we did not remove them.

4.3 What are the characteristics of the trajectory of student seat change?

To answer this question, we extracted the value of the student's seat change trajectory x (the row change trajectory), and then used Python to generate a single student's row change trajectory diagram, as shown in Figure 3.1, 3.2, 3.3. The number of trajectories for each student is based on the student's academic year.

Figure 3.1 Freshman row trajectories

Figure 3.2 Sophomore row trajectories

Figure 3.3 Junior row trajectories

The trajectory diagrams resulted in the following observations:

1) The students with the highest ranking tended to sit at the back of classroom in the later stages of the course.

For each academic year, we selected the top 20 students with the highest grades for further study. Through observation, we found that the proportion of students that were

"climbing" from freshman to junior were 0.55, 0.50, and 0.80. This shows that students with the highest grades are more inclined to sit at the back of the classroom in the latter part of the course, and especially during the last two classes.

The results of our interviews conducted with teachers and students verified this trend. The teacher said that the last two classes did not have new key content but mainly served to review past course material, which can explain students' lack of interest. Student interviewees said that, when they were in later stages of the course, they had developed a kind of self-confidence in knowing that they had been learned well, so they gradually relax. They also mentioned excitement that the holidays were approaching as another reason they became more relaxed.

We suggest that teachers make more efforts in counseling students in the later stages of the course in order to calm their emotions surrounding the holidays. It is also necessary to foster an environment where students can focus on course review and pay attention in class.

2) The companion effect of students with similar trajectories.

In Figure 3.1-3.3, we used red boxes to mark students with similar trajectories. Among these students, the rankings were very similar, and at least 70% of the students with similar trajectories were also roommates. Indeed, the campus activities on Chinese are mainly organized in the dormitory. This could explain why roommates have similar trajectories. Nevertheless, the rankings were extremely close, which warns us that we must pay attention to this companionship effect.

We suggest that teachers should pay attention to the dormitory culture and atmosphere. They should encourage students to be altruistic toward each other and to support one another.

5 CONCLUSIONS

This paper analyzes the characteristics of student seat selection, and the correlation between seat selection and academic performance, based on data such as the student seats sequence in the classroom. Using quantitative analysis methods and analyzing data with tools such as SPSS and Python, we found that there is a certain correlation between seat selection and academic performance. We have obtained some important conclusions from the research results. Students who chose to sit near the front row and who did not change seats had better academic performance. At the same time, we also found other seat distribution characteristics. There was a difference in learning ability between students seated in the first row and students seated on both sides of the wall. Through interviews with teachers and students, we analyzed the reasons for these observed differences. Based on the results of our study, we provided targeted suggestions to teachers that can help them improve the quality of their teaching as well as students' academic performance.

Future research should consider more factors affecting seat selection and academic performance, such as class size, teaching style [16], and seat arrangement patterns. Variables such as personal traits [17], body movements [18], perspective, elevation angle [19], etc. can improve data analysis methods and lead to more accurate conclusions.

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