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Abstract

Many studies on the effects of the traditional row-column classroom arrangement on academic performance have concluded that an action zone--whereby students who sit in the front and middle rows perform better than those seated at the sides and the back--exists. Therefore the traditional classroom arrangement does not provide learning parity for all students based on their seating positions, suggesting therefore, that some students are at a learning disadvantage due to seating position.

The present study investigated the single-row horseshoe design for its learning merits, with an attempt to discover if it offers a learning parity for all students or if it puts some students at a learning disadvantage similar to the row-column arrangement.

Comparative analyses of grades and attendance among the sides and sections of the horseshoe revealed no significant difference, suggesting that in the single-row horseshoe design, students are likely to enjoy learning parity. The single-row horseshoe arrangement is recommended as a classroom design due to its high potential for optimal learning. However, reduction to a one-size-fits-all formal principle is not warranted.

Introduction and Literature

Classrooms are complex places. The teaching and learning that occur in them are influenced by many variables, including teaching strategies, students' aptitudes, previous preparation, motivation, and classroom ecology. Classroom ecology and its effects on various aspects of students' achievement have been studied by several researcher's (e.g. Axelrod, Hall, and Tams 1979; Becker, Sommer, Bee, and Oxley 1973; Burda and Brooks 1996; Holliman and Anderson 1986; Koneya 1976; Schmidt, Stewart, and McLaughlin 1987). Some of the studies have examined the relationship between seating arrangements and a variety of dependent variables including student personality (Pedersen 1994; Totusek and Staton-Spicer 1982; Walberg 1969), teacher perception of students (Daly and Suite 1981), and achievement (Brooks and Rebeta 1989; Sommer 1967; Stires 1980; Wulf 1976, 1977). Most of these studies, however, focused on student participation and performance under the standard classroom arrangement of seating in rows and columns. They neglected the investigation of other classroom arrangements such as the horseshoe and circular types.

In ecological studies of the classroom, there appear to be commonly held beliefs concerning student achievement and classroom seating position. As students sit farther from the front of the room, grades decrease and number of absences increase (Brooks and Rebeta 1991; Holliman and Anderson 1986). Sommer (1967) found that, in classrooms with rows and columns, students who sat in the front rows and in the center of the room participated in class activities more than those seated on the side zones. He also found

that in the seminar-style arrangement, students who sat directly opposite the instructor participated more than those at the sides.

Becker, et. al. (1973) conducted three studies to assess the participation, interest, and performance of 282 college students who were free to choose their own seats in classrooms of different sizes and arrangements in the traditional row-column arrangement. They found no significant difference in class participation based on class size but they reported a significant difference in students' grades based on their seating positions. Grades decreased as students sat towards the rear and side areas. Students in the front also made more positive comments about the instructor than students in the rear. Their findings suggest that grades and perceptions of the instructor were related to proximity to the instructor. The greater the propinquity between students and the instructor, the better the students' grades and the more favorable the students rated the instructor.

Stires (1980) sought to determine the effects of the free choice versus no-choice hypothesis on student performance and attitude in a standard classroom row-column arrangement, also. His study was based on college students who were randomly assigned seats and those who were allowed to choose their own seats. His results concluded that students in the choice condition had higher test scores than those in the no-choice condition. Also, a significant main effect indicated that students who sat in the middle of the class had better test scores than those seated at the sides. However, the front-back difference was not found to be significant even though the values were in the expected direction.

Holliman and Anderson (1986) studied the relationship between students' grades and proximity, centrality, student density, and aisle seating. One hundred forty one college students who selected their own seats participated in the experiment. Results revealed that front row students demonstrated superior performance than students who sat farther back. No significant difference in grades was found related to centrality, student density, and aisle seating.

Overall, research on classroom ecology suggests that when students sit in front rows, especially in the center of the room, they participate more in class and obtain better grades than students who sit in the back of the room. This is due to greater visibility and proximity with the instructor (Becker et al. 1973; Holliman and Anderson 1986; Stires 1980). This phenomenon, which is often described as action zone or action T (Sommer 1967; Good and Brophy 1995), suggests that the physical arrangement of a classroom significantly contributes to differential learning opportunities for students.

Despite the amount of studies that have been conducted on classroom ecology, there appears to be a dearth of research focusing specifically on the horseshoe seating arrangement. Noted

for focusing on the horseshoe is Wulf (1976, 1977) who studied forty-four students who freely selected their own seats (free choice condition) and 37 who were assigned seats (no-choice condition) for differences in grades and participation. Her results indicated that student's who freely chose to sit in the middle center area had the highest rate of participation in class activities than other students. However, no significant differences were found in GPA or in class grades under both the free choice and no-choice conditions. However, Wulf had students seated in rows within the horseshoe condition, thereby tainting her findings with the effects of multiple seating rows of the traditional classroom seating arrangement. By so doing, the effects of a potential greater visibility of all students to the instructor, a potential characteristic advantage of the horseshoe arrangement over the traditional row-column seating arrangement, was compromised.

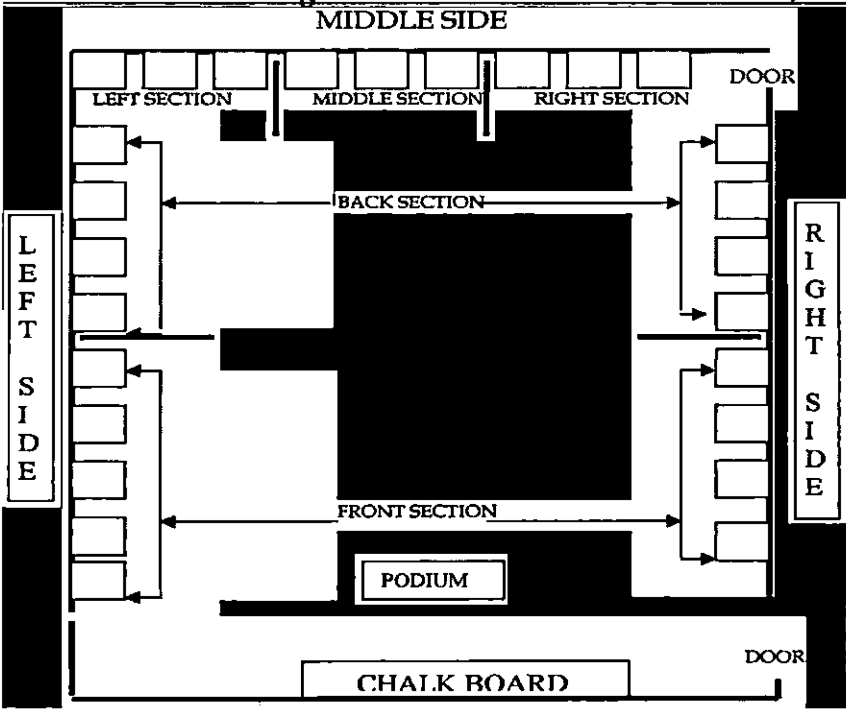
Based on the conclusions of the cited literature that the traditional classroom arrangement yields differential learning potentialities (especially as demonstrated by grades), the objective of this study is to explore the horseshoe classroom design for its own potential learning disparities. Specifically, this study analyzes what we term the "single-row horseshoe design" (see figure 1) to see if a learning disadvantage, such as that which has been linked to the side and back rows of the traditional row-column classroom design, exists among the various sides of the horseshoe. In the single-row design,

students sat side-by-side one another, in a single line (row), along each side of the wall, thereby ensuring that no student sat behind another, thus creating a condition in which every student technically occupies a "front row" seat.

If every student technically sits in the front row, it is assumed that they will equally benefit from the learning advantages of proximity and visibility that the occupants of front row seats in the row-column design enjoy. Hence, no differences in performance should be expected among the three sides of the horseshoe. However, the right and the left sides of the horseshoe (from the front podium) do have their front and back sections, with the front sections likely to enjoy greater visibility and proximity to the instructor than the back. Likewise, the center of the middle row is likely to enjoy much greater instructor eye contact and attention than the side sections. This means that the back sections of the side rows and the side sections of the middle row are at a potential learning disadvantage similar to the one associated with the back and side rows of the traditional row-column design as reported in the literature. In this sense, we expect to find differences in performance based on the sections of the sides of the horseshoe. The variations in our assumptions and expectations about the sides and sections of our horseshoe design led us to explore the learning potentials of the single-row horseshoe design by addressing the following questions:

1. Is there a significant difference in students' grades based on the side of the horseshoe where they sit?
2. Is there a significant difference in students' grades based on the section of the side of the horseshoe where they sit?
3. Is there a significant difference in students' class attendance based on the side of the horseshoe where they sit?
4. Is there a significant difference in students' class attendance based on the section of the side of the horseshoe where they sit?

Figure 1: Example of classroom layout of the single-row horseshoe classroom design showing the sides and sections of each side of the horseshoe.



Methodology

Five classes comprised of 119 students, taught by both researchers during the same semester while teaching in the same Midwestern university, were used in this study. Two of the classes were upper level education courses and three were lower level survey courses in sociology. The mixture of courses across the two departments and the variations in scheduling periods helped to ensure a good mix of students in the study. (The sociology classes were general education courses that enrolled students from practically every major in the university as well as every class standing from the first year students to graduating seniors). The education classes, while being less diverse in terms of majors (in this case primarily education majors) had a small enrolment (approximately 10%) of sophomore students in addition to students in the upper classes (juniors and seniors).

The seating arrangement used in each of the classes was the single-row horseshoe arrangement (which can also be termed the semi-circular arrangement or the "U" arrangement). This design is comprised of three main sides: the left, right and middle (back wall) sides from the instructor's view while facing the classroom from the podium (see figure 1). To control for the effect of seating bias in which students of similar abilities may sit on the same side of the classroom, two seating selection methods, random seat assignment and free choice (i.e. self-selection), were used. In the

random seating assignment, each seating position was randomly assigned by the professors from a pool of registered names for each class. For the free choice method, students were given one week to choose a comfortable location where they would prefer to sit for the entire semester. When the selections were made, the students were instructed to remain their selected locations for the entire semester similar to the classes where seating was randomly assigned by the researchers. For the entire semester, no one was allowed to change seating locations.

The five classes used in this study ranged in size from 21 to 28 students. Three were conducted in the afternoon and two were morning classes. With the assumption that students in the free choice seating condition were likely to outperform those in the random assignment, as suggested by the findings of Stires (1980), we decided to assign three different classes for free choice seating. This would provide a good range and diversity of students for analysis. To ensure this mix, one afternoon upper level education class that met on Mondays, Wednesdays and Fridays (MWF), one morning lower level sociology class (MWF) and one afternoon sociology class that met on Tuesdays and Thursdays (Tue and Thur) were designated for free choice seating method. The remaining two classes, one morning upper level education (Tue and Thur) and one afternoon lower level sociology classes (MWF) were used for random assignment seating method. This

combination of courses in two different departments at different levels with offerings on both the MWF and the Tue/Thur schedules at both the morning and afternoon starting periods gave us reasonable confidence for a good mix of students in our five classes for this research. Each of the MWF classes were scheduled for 50 minutes while the Tuesday/Thursday classes ran for 75 minutes.

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Two main sources of data--attendance and examination grades--were collected throughout the semester. To avoid possible instructor bias in grading essays, only multiple choice exams were given in each class. Each instructor administered three fifty-question multiple choice exams. Attendance was recorded during every lecture except for the infrequent occasions when class met at other locations, such as in the city for a field project. Overall, attendance was taken approximately 36 times in 12 weeks in all five classes. All observations on attendance were converted into percentages based on the number of times attendance was recorded. Similarly, a composite score, in percentage, for each student, on all three examinations administered during the semester, was recorded and used for analyses. Prior to conducting tests, outliers were removed from both the upper and lower limits of our data distribution, and alpha was set at .05.

Tests and Results

To answer our first question regarding differences in grades based on the side of the horseshoe (left, middle and right) where students sat, a separate ANOVA was conducted for each of the seating conditions and another for aggregate data for all five classes (i.e. combination of free choice and random assignment). Results for the free choice condition indicate F=.246 and p=.7827; random assignment, F=1.746 and p=.1867; and, for aggregate data, F=1.259 and p=.2880. This shows that in all conditions, no significant difference exists in grades by the side of the classroom where students sat. Details of these results are delineated in Table 1.

Table 1. One-Way ANOVA tests of significant difference in grades (in percentages) by side of the horseshoe in the Free Choice and Random Assignment Seating Arrangement classes and for aggregate data for all five classes.

	FREE CHOICE		RANDOM ASSIGNMENT		AGGREGATE (all five classes)	
SIDE	**N**	**Grade**	**N**	**Grade**	**N**	**Grade**
Left	25	81.76	15	81.67	40	81.73
Middle	22	81.55	16	83.81	38	82.50
Right	21	80.33	15	79.60	36	80.03
Lambda	.492		3.492		2.518	
F-value	.246		1.746		1.259	
P-value	.7827		.1867		.2880	

Aggregate data provided opportunities for further analyses of our data, hence a two-way ANOVA was conducted to see the

independent as well as the interactive effects of side and seating condition on grades. The coefficients reported in Table 2 show that side, seating condition, and their interactive effects have no significant influence on grades. That is, regardless of the seating condition, no significant difference was found in grade by side of the class where the students sat.

Table 2.Two-Way ANOVA coefficient table showing significant contributions of side and seating conditions and their interactive effects on grades using aggregate data from all *five classes.*

	GRADE				
	N	Coef.	St. Err.	t-test	P-value
Intercept		81.453	.659	123.548	<.0001
Side: Left (L)	40	.260	.926	.281	.7791
Middle (M)	38	1.226	.929	1.320	.1896
Right (R)	36	-1.486			
Seat Condition Rand Assign.(RA)	46	.240	.659	.364	.7165
Free Choice (FC)	68	-.240			
Side*Seat Condition Left, RA	15	-.287	.926	-.310	.7574
Left, FC	25	.287			
Middle, RA	16	.893	.929	.962	.3382
Middle, FC	22	-.893			
Right, RA	15	-.607			
Right, FC	21	.607			

Averaging across the rows, as done to answer question one, may mask any differences that could exist in certain portions of each side. This instigated the second question about differences in grades by the sections of the sides of the horseshoe. Each of the left and the right sides of the horseshoe was divided into two sections, front and back, using the formula 50-50 or 50% +1. That is, when an even number of seats were present in a side, each section was assigned 50% of the seats (50-50), but when the number of seats was odd, the front section was assigned 50% + 1 seat to ensure greater distance of the back-section from the podium (see figure 1). The middle side was divided into three sections, left middle, middle-middle and right middle because we suspected that the middle of the middle row was likely to enjoy greater eye contact than the sides of the row. The number of seats assigned to each of the three sections was derived by simply dividing the number of seats in the row by three, each third constituting each section when the number of seats was odd. When the number of seats was even (e.g. 10), each of the right and left sections received 1/3rd of the largest odd number (i.e. 1/3rd of 9 seats) while the middle-middle section was assigned 1/3rd +1. This formula helps to keep the number of seats at both ends of the row the same while simultaneously removing the dilemma of where to assign the extra seat when the number of seats was even.

To answer our second question, a one-way ANOVA was first conducted to seek significant difference in grades by the sections (front, back, left middle, middle-middle, right middle) of the sides of the horseshoe in both the free choice and the random assignment seating conditions and for aggregate data. Results, shown in table 3, indicate F=1.184 and p=.3266 in the free choice condition; F=1.252 and p=.3042 in the random assignment condition while aggregate data indicated F=.842 and p=.5014. No significant difference was found in grade by section of the sides of the horseshoe in both seating conditions and for aggregate data.

Table 3. One-Way ANOVA tests of significant difference in grades (in percentages) by section of side in the Free Choice and Random Assignment Seating Arrangement classes and for aggregate data for all five classes.

	FREE CHOICE		RANDOM ASSIGNMENT		AGGREGATE (all five classes)	
SECTION	N	Grade	N	Grade	N	Grade
Front	23	81.17	16	80.38	39	80.85
Back	22	81.00	14	80.93	36	80.97
Left Middle	6	81.83	5	86.40	11	83.91
Mid-Middle	9	85.00	6	80.83	15	83.33
Right Middle	8	77.50	5	84.80	13	80.31
Lambda	4.735		5.010		3.368	
F-value	1.184		1.252		.842	
P-value	.3266		.3042		.5014	

The two-way ANOVA was then used to further analyze aggregate data to seek independent and interactive impacts of section and seating condition on grades. The coefficients, shown in table 4, indicate that neither section, seating condition, nor their interactive effects have a significant influence on grades. That is, regardless of the seating condition, no significant difference was found in grade by section of the class where the students sat.

Table 4. Two-Way ANOVA coefficient table showing significant contributions of section and seating conditions and their interactive effects on grades using aggregate data from all five classes.

	GRADE				
	N	Coef.	St. Err.	t-test	P-value
Intercept		81.984	.746	109.838	<.0001
Section: Front (F)	39	-1.210	1.140	-1.061	.2910
Back (B)	36	-1.020	1.173	.870	.3866
Left Middle (LM)	11	2.132	1.768	1.206	.2306
Mid-Middle (MM)	15	.932	1.582	.589	.5571
Right Middle(RM)	13	.834			
Seat Condition (SC) Rand Assign.(RA)	46	.683	.746	.915	.3623
Free Choice (FC)	68	-.683			
Section* SC F, RA	16	-.1082	1.140	-.949	.3446
F, FC	23	.1082			
B, RA	14	-.719	1.173	-.613	.5415
B, FC	22	.719			
LM, RA	5	1.600	1.768	.905	.3676
LM, FC	6	-1.600			
MM, RA	6	-2.766	1.582	-1.748	.0834
MM, FC	9	-2.766			
RM, RA	5	2.967			
RM, FC	8	-2.967			

In question three, we explored the differences in attendance by the sides of the horseshoe using one-way ANOVAs for the two seating conditions and for aggregate data. Results, shown in table 5, indicate that in the free choice condition, F=.583 and p=.5610 and in the random assignment condition, F=.647 and p=.5282. For aggregate data, F=.010 and p=.9902. This indicated that no significant difference was found in attendance by the side of the horseshoe in each seating condition and for aggregate data.

Table 5. One-Way ANOVA tests of significant difference in attendance (in percentages) by side of the horseshoe in the Free Choice and Random Assignment Seating Arrangement classes and for aggregate data for all five classes.

	FREE CHOICE		RANDOM ASSIGNMENT		AGGREGATE (all five classes)	
Section	N	Attendance	N	Attendance	N	Attendance
Left	25	91.00	15	88.73	40	90.15
Middle	22	89.00	16	91.56	38	90.08
Right	21	87.38	15	93.20	36	89.81
Lambda	1.166		1.293		.020	
F-value	.583		.647		.010	
P-value	.5610		.5282		.9902	

The two-way ANOVA was again used to further investigate aggregate data by seeking independent and interactive effects of side and seating condition on attendance. As shown in the coefficients displayed in table 6, side and seating condition and their interactive effects have no significant influence on attendance.

That is, regardless of the seating condition, no significant difference was found in attendance by side of the class where the students sat.

Table 6. Two-Way ANOVA coefficient table showing significant contributions of side of the horseshoe and seating condition and their interactive effects on attendance using aggregate data from all five classes.

		ATTENDANCE			
		Coef.	St. Err.	t-test	P-value
Intercept		90.146	1.070	84.260	<.0001
Side: Left (L)	40	-.279	1.503	-.186	**.8528**
Middle (M)	38	.135	1.507	.090	**.9287**
Right (R)	36	.144			
Seat Condition Rand Assign.(RA)	46	1.019	1.070	.953	**.3429**
Free Choice (FC)	68	-1.019			
Side*Seat Condition Left, RA	15	-2.152	1.503	-1.432	**.1549**
Left, FC	25	2.152			
Middle, RA	16	.262	1.507	-.174	**.8623**
Middle, FC	22	- .262			
Right, RA	15	1.890			
Right, FC	21	-1.890			

Our fourth question was to seek differences in attendance by the sections of the sides of the horseshoe. The one-way ANOVA was, again, first used to test for difference in attendance in each of the seating conditions and for aggregate data. Our results show that in the free choice condition, F=.623 and p=.6477, in the random assignment condition, F=.055 and p=.9942 and for aggregate data,

F=.359 and p=.8370. These results, detailed in table 7, again, show that under each seating condition and for aggregate data, no significant difference was found in attendance by the side of the horseshoe.

Table 7. One-Way ANOVA tests of significant difference in attendance (in percentages) by section of the side of the horseshoe in the Free Choice and Random Assignment Seating Arrangement classes and for aggregate data for all five classes.

	FREE CHOICE		RANDOM ASSIGNMENT		AGGREGATE (all five classes)	
Section	N	Attendance	N	Attendance	N	Attendance
Front	23	88.65	16	91.19	39	89.67
Back	22	90.46	14	90.71	36	90.56
Left Middle	6	94.50	5	91.40	11	93.09
Mid-Middle	9	86.78	6	90.33	15	88.20
Right Middle	8	86.38	5	93.20	13	89.00
Lambda	2.493		.220		1.438	
F-value	.623		.055		.359	
P-value	.6477		.9942		.8370	

The aggregate data was also further analyzed to seek both the independent and interactive effects of section and seating condition on attendance. As shown in table 8, section and seating condition and their interactive effects have no significant influence on attendance. That is, regardless of the seating condition, no significant difference was found in attendance by section of the class where the students sat.

Table 8. Two-Way ANOVA coefficient table showing significant contributions of section of the side of the horseshoe and seating condition and their interactive effects on attendance using aggregate data from all five classes.

		ATTENDANCE			
		Coef.	St. Err.	t-test	P-value
Intercept		90.359	1.243	72.686	<.0001
Section:					
Front (F)	39	-.440	1.889	-.232	**.8174**
Back (B)	36	.225	1.954	.115	**.9086**
Left Middle (LM)	11	2.591	2.945	.880	**.3811**
Mid-Middle (MM)	15	-1.804	2.636	-.684	**.4952**
Right Middle(RM)	13	-.572			
Seat Condition (SC)					
Rand Assign.(RA)	46	1.008	1.243	.810	**.4195**
Free Choice (FC)	68	-1.008			
Section* SC					
F, RA	16	.260	1.899	.137	**.8913**
F, FC	23	-.260			
B, RA	14	-.878	1.954	-.449	**.6542**
B, FC	22	.878			
LM, RA	5	-2.558	2.945	-.868	**.3872**
LM, FC	6	2.558			
MM, RA	6	.770	2.636	.292	**.7707**
MM, FC	9	-.770			
RM, RA	5	2.405			
RM, FC	8	-2.405			

Further analysis was conducted using aggregate data to explore for the independent and interactive effects of side and condition on the combination of grade and attendance using the two-way MANOVA. Findings, shown in table 9, indicate once again that neither the side of the horseshoe nor the seating condition and their combined effect have any significant impact on the combination of grade and attendance. The two-way MANOVA was similarly conducted to seek individual and interactive effects of section and seating condition on the combination of grade and attendance. Again, findings, shown in table 10, indicate that neither the section of the horseshoe nor the seating condition and their combined effect significantly influenced the combination of grade and attendance.

Table 9. Two-way MANOVA result showing independent and interactive effects of side of the horseshoe and seating condition on grades and attendance.

Side	Value	F-value	Num. DF	Den. DF	P-Value
S	2.000				
M	-.500				
N	52.500				
Wilk's Lambda	.972	.779	4	219	**.5402**
Roy's Greatest Root	.029	1.566	2	108	**.2136**
Hotelling-Lawley Trace	.029	.779	4	212	**.5415**
Pillai Trace	.028	.780	4	216	**.5390**

Table 9 Cont:: Two-way MANOVA result showing independent and interactive effects of side of the horseshoe and seating condition on grades and attendance.

Side	Value	F-value	Num. DF	Den. DF	P-Value
Seat Condition					
S	1.000				
M	0.000				
N	52.500				
Wilk's Lambda	.992	.454	2	107	**.6361**
Roy's Greatest Root	.008	.454	2	107	**.6361**
Hotelling-Lawley Trace	.008	.454	2	107	**.6361**
Pillai Trace	.008	.454	2	107	**.6361**
Side*Seat condition					
S	2.000				
M	-.500				
N	52.500				
Wilk's Lambda	.967	.919	4	214	**.4537**
Roy's Greatest Root	.026	1.422	2	108	**.2457**
Hotelling-Lawley Trace	.034	.913	4	212	**.4575**
Pillai Trace	.034	.925	4	216	**.4500**

Table 10. Two-Way MANOVA result showing independent and interactive effects of section of the sides of the horseshoe and seating conditions on grades and attendance.

Section	**Value**	**F-value**	**Num. DF**	**Den. DF**	**P-Value**
S	2.000				
M	.500				
N	50.500				
Wilk's Lambda	.964	.477	8	206	**.8714**

Table 10 Cont: Two-Way MANOVA result showing independent and interactive effects of section of the sides of the horseshoe and seating conditions on grades and attendance.

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Section	Value	F-value	Num. DF	Den. DF	P-Value
Roy's Greatest Root	.028	.727	4	104	.5752
Hotelling-Lawley Trace	.037	.474	8	204	.8738
Pillai Trace	.036	.481	8	208	.8690
Seating Condition					
S	1.000				
M	0.000				
N	50.500				
Wilk's Lambda	.989	.578	2	103	.5631
Roy's Greatest Root	.011	.578	2	103	.5631
Hotelling-Lawley Trace	.011	.578	2	103	.5631
Pillai Trace	.011	.578	2	103	.5631
Section*Seat Condition					
S	2.000				
M	.500				
N	50.500				
Wilk's Lambda	.928	.979	8	206	.4535
Roy's Greatest Root	.063	1.647	4	104	.1680
Hotelling-Lawley Trace	.077	.977	8	204	.4549
Pillai Trace	.073	.981	8	208	.4522

Discussion and Conclusion

Literature indicates that students perform better when they have greater contact, visibility and physical proximity with the instructor. Becker et al. (1973), for example, claimed that proximity to the instructor led students to obtain better grades. Similarly, Holliman and Anderson (1986) indicated that in the row-column seating arrangement, students in front row seats outperformed their counterparts who sat at the back, both in terms of examination grades and contributions to class activities. And, according to Wulf (1976, 1977), the tendency of students with greater propinquity to the instructor, to participate more in class activities than those with lesser propinquity is true, regardless how the seating position was determined, free choice or random Assignment. Students with the greatest physical closeness to the instructor contributed more to class activities than those with lesser closeness to the instructor. These results indicate that the physical configuration of a classroom carries the potential to enhance or hinder students' performance whereby certain sections of a classroom are more apt to enjoy a learning advantage over others.

Based on the hypothesis that physical closeness to the instructor yields better academic performance, the single-row horseshoe design, in which all students could be considered to have sat in "front rows", was analyzed in this study for its learning potentials. The design of this study was not to directly compare the traditional row-column arrangement with the single-row horseshoe design, per se. Instead, it was an effort to analyze the horseshoe for its own merits and demerits in enhancing or hindering students' performance in similar ways as the traditional arrangement had been studied.

Our findings indicated that there was no significant difference in students performance (as measured by grades and class attendance) among the different sides and among the sections of the sides of the single-row horseshoe configuration. These results were true in the classes where the seating positions were selected by free choice as well as in classes where seats were randomly assigned. These results agree with the findings of Wulf (1976, 1977) on the relationship between seating condition and grade point average (GPA) in the horseshoe design.

The results of this study signify the single-row horseshoe seating arrangement as a classroom configuration that produces no significant learning disadvantage to any student regardless of his/her seat location on the horseshoe. Borrowing from the assumptions of the action-zone phenomenon, we assume that the lack of significant difference in students' performance by seat location on our horseshoe design was due either to the reception of equal attention (visibility, proximity and eye contact) from the instructor by students in each side of the horseshoe or by a lack of significant difference in the amount of attention each side received from the instructor during lecture. This invariably helps to create a classroom ecology in which no student was at a learning disadvantage simply due to a seating position.

Identifying optimal learning environments for students' academic achievement is potentially important for educators, hence, we recommend further studies on the horseshoe and other classroom configurations such as circular and the traditional row-column. This is especially important because of the likelihood of contradictory findings in this type of research. Montello (1988, 1992), for example, concluded that the relationship between seating arrangement and students' performance was a myth. He indicated, after a comprehensive analysis of available literature on the subject that existing evidence indicated an inconsistent effect of seating location on performance. He claimed that even when an effect was present, it was a weak one. Others such as Good and Brophy (1995) and Sommer (1967) concluded that there was no one best seating arrangement for all types of classroom tasks. Factors such as pedagogical methodology, task structure, eye contact, teacher expectation and even student's level of anxiety were likely to play a role in what sort of achievement is influenced by seating patterns.

Despite contradictory evidence in the literature, our findings led us to still recommend the single-row horseshoe design because of its potential to create an environment of learning parity, there-by enhancing opportunities for every student to achieve optimum learning. As found in this study, no student is more likely to be at a learning disadvantage than another. This factor may enhance a leveling effect in performance between high achieving and more competitive students who are more likely to occupy front row seats (Burda and Brooks 1996; Totusek and Stanton-Spicer 1982; Walberg 1969) and students with negative values for learning who are more likely to gravitate to the back of the class (Walberg 1969) in the row-column design. However, wisdom and common sense also led us to conclude, as did Weinstein and Mignano (1993), that the most effective classroom arrangements are still those that are congruent with the instructor's intended objectives and with the various factors earlier identified by Good and Brophy (1996) and Sommer (1967). Furthermore, classroom arrangements must also attend to the instructional needs of students and teaching styles of teachers (Wengel 1992). It is also worth noting here that the practicality of our single-row horseshoe design is contingent upon the relationship between classroom dimensions and student population. A large student population in a small classroom may hinder the practice of our design. Also, even when our design is practicable, it can be criticized for being space (and cost) inefficient due to the empty space in the middle of the class. Hence, the most effective classroom design may not be reduced to a one-size-fits-all formal principle.

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