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A Case Study in Architecture Studio: Seating versus Enthusiasm through Sketching Logbook

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Abstract

Previous studies have investigated how seating arrangement may affect students' performance. This paper presents alternative readings on the relationships between seating in architecture studio and learning enthusiasm within the context of journaling in sketching logbook. The study was conducted upon the students in year 2023/2024 2nd-Semester Undergraduate Architecture Studio, Department of Architecture, Universitas Gadjah Mada. Logbook activities were recorded and visualized against the seating arrangements to formulate hypotheses about potential relationships. Rank-Biserial and Spearman's ρ were used to test the strength of the correlations. The results show that (1) mobile adjacency among groups correlates positively with similarity in enthusiasm, (2) average visual proximity to all other groups correlates positively with enthusiasm, and (3) both mobile and visual proximity to the entrance correlates positively with enthusiasm. These aspects reveal possible patterns of contacts among students, leading to the conclusion that social interaction in studio is indeed significant for students' enthusiasm.

Keywords: *Architecture Studio; Correlations; Seating; Quantitative Analysis*

Introduction

Within the general topic of educational facilities, and more specifically on the relationship between the quality of physical environment and the quality of the educational process, one of the topics most frequently discussed is the seating arrangement. Studies generally both confirming (Gutierrez, 2022) and negating (Kurniawati, Karnalim, & Budi, 2021) such relationships have been and still are conducted, as well as studies on more specific aspects of the topic (Ke, 2023; Yang, Nie, Zheng, & Qiao, 2020). Seating arrangement is particularly interesting within the context of architecture studio due to its trait of peer-learning, wherein exist high potentials of seating arrangement to affect interactions among studio participants, thus influencing learning aspects. Researchers have studied relationship between seating arrangements and learning performance in architecture studio (Tafahomi, 2023; Rosyadi & Ilhamdiah, 2021). However, there remains a gap, wherein it is still possible and required to investigate the relationship between seating arrangement and learning enthusiasm, as well as to explore more specific aspects of seating arrangement in architecture studio.

This paper focuses on the problem of the gap in terms of the relation between seating arrangement and learning enthusiasm. The

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aim is to investigate the factors related to the seating arrangement in architecture studio which may potentially affect the learning enthusiasm of the participants. The objectives are conducting general observations and assessments of the quantitative parameters specified to measure learning enthusiasm, and taking the initial results as a base to make hypotheses about the possible relationship between certain factors and the degree of learning enthusiasm: 1) adjacency between groups, 2) average proximity to all the other groups, and 3) proximity to the entrance of the studio. Finally, statistical analyses were conducted to measure these hypothesized relationships.

This paper starts with the summarized literature review about seating arrangements within the general context of educational process from the elementary schools to the universities, continued by the discussions on seating arrangements within the more specific scene of educational process in architecture studio. Thereafter, an explanation about the methodology used in this paper is presented. The paper is then concluded with the quantitative results of the analysis, along with the interpretive discussions.

Lastly, some clarifications in regards to the scope and boundaries of this study. First, "studio" as discussed in this paper is defined as studio within the context of architecture education; this study excludes architecture studio within professional scene. Second, the milieu of educational architectural studio investigated in this paper is represented by the physical environment as well as activities of one particular design studio held by the undergraduate Architecture Study Program in the Department of Architecture and Planning Universitas Gadjah Mada, Yogyakarta, Indonesia; namely, the architecture design studio of the 2nd semester, also known as Architectural Composition Studio (Studio Komposisi Arsitektur). More detailed context of this Studio is described in the "Methodology" section, under the 1st sub-section of "Architectural Composition Studio at the undergraduate Architecture Study Program, Department of Architecture and Planning, Universitas Gadjah Mada".

Third, "seating arrangement" as explored in this study is defined as the seating arrangement of the students as 12 (twelve) groups, as opposed to the seating arrangement of the students as 81 (eighty-one) individuals. This decision is explained in the "Methodology" section, under the 2nd sub-section of "Seating Arrangement in the Architectural Composition Studio". Third, "learning enthusiasm" is restricted to enthusiasm in regards to the activity of journaling or sketching in a certain type of logbook with was specified and agreed from the beginning of the Studio, and is strictly defined as certain quantitatively measurable parameters, which are the magnitude and frequency of the journaling activities. As such, the descriptive quality of the logbook itself is beyond the scope of this study. More detailed accounts on the journaling activities can be found on the "Methodology" section, under the 3rd sub-section of "Sketching Logbook for the Architectural Composition Studio".

Finally, this study was conducted using the quantitative approach, in which learning enthusiasm was quantitatively measured, and the possible relationships between seating arrangement and learning enthusiasm were explored, proposed, and evaluated using statistical method, as presented in the "Methodology" section, under the 4th sub-section of "Learning Enthusiasm in Sketching Logbook: Quantification, Exploration, and its Correlations with Seating Arrangement". As such, beside the interpretations of the results, this study excludes other qualitative strategies, such as purposive interviews or observations on studio activities. Since the main focus is restricted to the spatial aspects of seating arrangements, this study also excludes other non-spatial factors possibly impacting learning enthusiasm, such as social dynamics of the students or teaching styles of the instructors. Such qualitative strategies and potential non-spatial factors may be considered for future works.

Literature Review

1. Seating Arrangement in General

Relationship between seating arrangements and students' performance as well as social behavior

is one of the classical topics in the field of education and its built environment. There are confirmations for such relationship in general (Ali, Sen, Li, Khan, Abdul Basit, & Ahmad, 2024; German, Villapando, Resilva, Quiambao, & Guevarra, 2020) as well as negations/conditions (Sarita, Riza, & Asty, 2022).

Other studies also propose more specifics findings. For example, it has been shown that flexible seating arrangements is preferable and considered better than conservative one (Hendershot, 2022; Cole, Schroeder, Bataineh & Al-Bataineh, 2021). Studies investigating what type of layout is better—whether it is rows, clusters, or horseshoe (Salma & Şahin, 2022)—reveal that horseshoe (or U-shaped, or crescent) is the most preferable (Hayashi, Mochizuki, & Yamauchi, 2023; Adolo, Akhmad, & Jannatussholihah, 2022; Rogers, 2020), although sometimes rows (Camacho, 2024) and even single desks (Tobia, Sacchi, Cerina, Manca, & Fornara, 2022) also produce similarly positive impact.

Finally, within the context of positions, a number of studies suggest that front position closer to the teacher produces highest academic performance (Byiringiro, 2023; Chan, Chin, Wong, Kam, Chan, Liu, Wong, Suen, Yang, Lam, Lai, & Zhu, 2022; Lyu, Jiang, & Wu, 2021; Will, Bischof, & Kingstone, 2020). On the other hand, in certain conditions, middle or center (Lu, Liu, Xie, Zhang, He, & Shi, 2023; Wasendorf, McCombs, & Boury, 2023) may impact positively in terms of engagement; it should also be noted that engagement level tend to be similar among students sitting closer to each other (Gao, Rahaman, Shao, Ji, & Salim, 2022).

2. Seating Arrangement in Architecture Studio

Due to the characterizing trait of architecture studio wherein students may work both in person and in groups, engage in discussion, and observe other students in work and in jury—or in short, *peer learning* (Tafahomi, 2021a), it is understandable that the quality of its physical environment is crucial (Wijaya & Dharmatanna, 2024; Arshard, Abdul Kadir, Tengku Aziz & Mokhtar, 2023). More specifically, seating arrangements is also considered among the significant factors affecting academic performance and engagement of the participants. Similar to classrooms in general, studies have shown a preference to U-shaped seating for architecture studio as well as positive impact of being closer to the instructor (Tafahomi, 2021b). It has also been suggested that visual access in studio correlates with the performance (Edgü, 2015); however, at the same time, privacy and protection against distraction may be reduced by more social layouts (Tafahomi, 2021c).

In general, those previous studies in the context of architecture studio focused on the importance of physical settings of the studio, students' preference in seatings, and relationships between seating arrangements and learning *performance* in studio. Nevertheless, there remains a gap: to investigate the relationship between seating arrangement and learning *enthusiasm* in studio, as well as to explore more specific aspects of the seating arrangements. Therefore, this study attempts to address this gap by examining the relationship between certain aspects of seating arrangement in architecture studio and learning enthusiasm of the participants. Further details regarding this objective are presented in the following "Methodology" section.

Methodology

1. Architectural Composition Studio at the Undergraduate Architecture Study Program, Department of Architecture and Planning, Universitas Gadjah Mada

For this study, the Architectural Composition Studio (Studio Komposisi Arsitektur) at the undergraduate Architecture Study Program, Department of Architecture, Universitas Gadjah Mada, has been selected. The Studio was conducted at the 2nd Semester, the second half of the Academic Year 2023/2024. The Studio involves 81 (eighty-one) students which were organized into 12 (twelve) groups designated from A to L, each consisting of 6 to 8 students. At the beginning of the Studio, twelve instructors were assigned to these groups, one instructor for each group. Approximately mid-semester, at a transition to the final task, the same twelve instructors were

rotated such that each group got different instructor. The Studio was held twice a week, each session lasting for approximately 4 hours. The process was conducted for 14 weeks, and during the whole semester, there were total three small tasks and one final task. At the end of each small task, an internal jury was held, while at the end of the final task, the jury was conducted using the cross-system wherein the groups were examined by other groups' instructors.

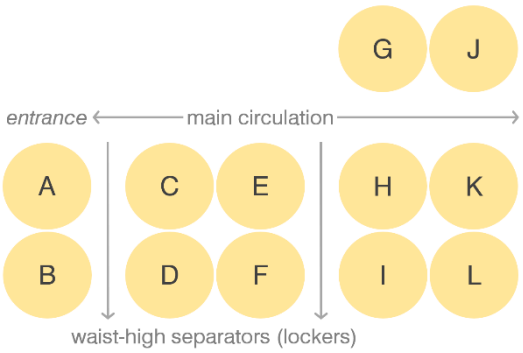
For each routine session, instructors were expected to monitor the groups and discuss with the students. During the discussions within one group, students from other groups may and sometimes were encouraged to observe and even participate. Students were also permitted and encouraged to interact one another during the time without the presence of the instructors. In conclusion, peer-learning was encouraged in the Studio, and the physical settings of the space, in particular the seating arrangements, were designed to further facilitate peer-learning, as described in the following sub-section.

2. Seating Arrangement in the Architectural Composition Studio

The Architectural Composition Studio was held at the ground floor, east section of the north wing of the Department of Architecture and Planning, Universitas Gadjah Mada. The main workroom of the Studio is solely accessed via a common space which is also connected to the Staff and Materials Room and to another studio at the west section.

The main workroom is a single open-plan space wherein the twelve groups are organized without partition in conventional sense. There are several non-wall separation strategies between adjacent groups, such as circulation lanes and waist-high (800 mm height) lockers, but these non-wall separators do not impede visual (and verbal) interactions among groups. The spatial territory of each group is mainly determined and perceived by the use of one common work desk for each of the groups. Thus, the main workroom is basically composed of twelve common work desks for twelve groups arranged according to the geometry of the space, with limited mobile contact yet permitted visual (and verbal) connections among groups. The schematic physical arrangement of the Studio is depicted in **Figure 1**.

Figure 1. Schematic physical arrangement of the Architectural Composition Studio, undergraduate Architecture Study Program, Department of Architecture and Planning, Universitas Gadjah Mada, 2023/2024 Academic Year
Source: Authors



Finally, the allocation of the group common desks throughout the Studio was constant and unchangeable during the whole semester. This constancy is not a design for this present study; rather, it is a common, already-set rule for all the Studio activities—not only this particular Studio, but also for all the other Studios in all academic years. However, the intra-group *individual* seatings, i.e. the allocation of the students within one group around their common desk, was *inconstant* and changeable, in order to further encourage and enrich interactions among students. Considering this characteristic, it may not suitable to investigate seating arrangement in terms of the ever-changing individual positions; thus, instead, this study focuses on seating arrangement in terms of the constant, dependable *group* positions. This decision to measure grouped rather than individual seating arrangement resulted in certain consequences in the quantification of enthusiasm and the strategy to measure relationships between seating and enthusiasm; these impacts are explained further in following sub-sections.

3. Sketching Logbook for the Architectural Composition Studio

The Architectural Composition Studio was focused on the architectonical aspect of design, i.e., spatial-formal compositions. Final presentation drawings were to be produced by hand, and from the beginning of the Studio,

students were given weekly task of journaling in the form of sketching logbook. Students were encouraged to record their observations and reflections, precedent studies, search for idea, and design transformations in this logbook, use it in discussions with instructors, and report it weekly.
Due to the crucial role of this sketching logbook as facilitator for the design process in the Studio, the logbook is taken as the representation of the students' *learning enthusiasm.* Since the measurand is *enthusiasm* instead of *performance*, the quality of the content is beyond the scope of this study. The logbook was measured strictly in quantitative terms: *magnitude* (number of pages reported) and *frequency* (number of reporting). However, since enthusiasm—similar to the seating arrangement—was measured in group rather than individually, the magnitude and frequency were processed further to obtain the quantification of enthusiasm. The quantification strategy is described in the following sub-section.

4. Learning Enthusiasm in Sketching Logbook: Quantification, Exploration, and its Correlations with Seating Arrangement

The *quantification* of learning enthusiasm is obtained from two measurands: magnitude and frequency, which were measured in groups instead of individually. *Magnitude* is defined as the number of total pages of the logbook produced and reported by all members of the group. *Frequency* is defined as the ratio of the number of members producing and reporting the logbook to the number of all members of the group. The quantified value of enthusiasm is the product of magnitude and frequency. For example, if in a week a group reports a total of 30 pages coming from 5 out of 6 members, the value of enthusiasm is 30 × (5/6) or 25. Thus, the lower limit of enthusiasm is 0, while there is no upper limit. The enthusiasm was calculated for every week during the Studio, and the mean values were taken as final quantification.

The *exploration* of possible patterns and relationships inferable from the spatial distribution of the quantification was then conducted by first converting the numerical values into a map or plan in which the values were represented by range of colors. This procedure of assigning certain color to certain value is known as *interpolation.* The result was then used to formulate hypotheses about relationships between spatial aspects of seating arrangement and enthusiasm.

Finally, *correlations* were used to test the hypotheses. As described in following "Results and Discussions" section, the formulated hypotheses involve variables with values classifiable into two scales: *nominal-dichotomous* (wherein there are only two contrasting values) and *ordinal* (wherein real values are converted into rank). Accordingly, two types of bivariate correlations were used in this study. The first is Rank-Biserial correlation to investigate relationship between one nominal-dichotomous variable and one ordinal variable, calculated using Equation 1:

$$r(\mathrm{rb}) = \frac{2(Y_1 - Y_0)}{n} \quad \text{.......................................(1)}$$

wherein:

r(rb)	Rank-Biserial correlation coefficient
n	number of data pairs
Y_1	Y score means for data pairs with an *x* of one of the two binary values, with Y scores in rank
Y_0	Y score means for data pairs with an *x* of the other of the two binary values, with Y scores in rank

The second is Spearman's ρ to investigate relationship between two ordinal variables, calculated using Equation 2:

$$\text{rho } (\rho) = 1 - \frac{6\sum d^2}{n(n^2-1)} \quad \text{.............................(2)}$$

wherein:

rho (ρ)	Spearman's correlation coefficient, also denoted as r_s
n	number of paired ranks
n^2	squared value of the number of paired ranks
d	difference between paired ranks
d^2	squared value of the difference between paired ranks
$\sum d^2$	sum of the squared value of the difference between paired ranks

These two types of correlation produce coefficient with similar format, wherein the maximum result of +1 indicates maximum positive relationship, the minimum result of −1 indicates maximum negative relationship, and 0 indicates no relationship. The descriptive interpretations of correlation coefficients are presented in **Table 1**.

Table 1. Descriptive Interpretations of Correlation Coefficients

Coefficient	Descriptive Interpretation
≥0.70	Very strong relationship
0.40–0.69	Strong relationship
0.30–0.39	Moderate relationship
0.20–0.29	Weak relationship
0.01–0.19	No/negligible relationship

Source: Leclezio, Jansen, Whittemore & de Vries, adapted from Dance & Reidy 2004

Table 2. Summary of the Quantified Learning Enthusiasm

Group	Week 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Mean
A	19.00	61.00	21.67	6.00	8.00	12.00	0.00	0.00	0.00	30.00	1.50	1.17	3.33	0.00	0.00	**10.91**
B	41.00	75.00	0.00	21.43	0.00	14.86	0.00	1.86	0.00	0.00	27.43	0.00	2.86	0.00	0.00	**12.30**
C	17.14	51.00	24.00	0.00	19.29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	81.43	0.00	0.00	**12.86**
D	27.00	57.00	39.00	9.50	10.00	19.33	0.00	0.00	0.00	2.00	0.00	36.00	3.67	0.00	0.00	**13.57**
E	34.00	60.00	4.57	0.00	0.43	45.00	0.00	0.00	0.00	1.43	58.86	3.14	2.86	0.00	0.00	**14.02**
F	37.86	86.00	10.29	12.86	18.86	26.43	0.00	0.00	0.00	0.00	0.00	0.00	95.14	0.00	0.00	**19.16**
G	38.00	57.00	20.57	1.14	3.43	26.57	0.00	0.00	0.00	77.00	0.00	40.00	60.00	0.00	0.00	**21.58**
H	6.00	51.00	18.00	0.00	0.14	0.86	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**5.07**
I	25.00	45.43	12.00	13.29	17.14	2.29	0.00	0.00	0.00	17.71	0.00	5.71	4.86	0.00	0.00	**9.56**
J	26.57	56.57	13.14	2.57	20.00	19.43	6.57	0.00	0.00	1.00	3.43	0.00	0.00	0.00	0.00	**9.95**
K	26.00	39.17	2.67	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**4.99**
L	31.00	33.43	23.57	1.00	22.29	0.29	0.00	0.00	0.00	0.00	0.00	2.43	33.14	0.00	0.00	**9.81**
Mean	27.38	56.05	15.79	5.65	10.55	13.92	0.55	0.15	0.00	10.76	7.60	7.37	23.94	0.00	0.00	**11.98**

Source: Authors

Results and Discussions

1. Quantification of Enthusiasm

Table 2 depicts the summarized results of the quantified learning enthusiasm of the students participating in the Studio in terms of the journaling activity using the sketching logbook. The values of enthusiasm, which is the product of magnitude and frequency, were calculated in terms of groups. The values are first presented chronologically for 15 weeks during the semester and then summarized by the average/mean values for all 12 groups.

2. Interpolation of the Numerical Results

Figure 2 presents the comparison between two types of interpolation which may be used to visually present how the mean values of enthusiasm of the all 12 groups are distributed spatially according to the seating arrangement in the Studio.

Figure 2. Comparison between linear- and ordinal-scaled interpolations of the values of enthusiasm
Source: Authors

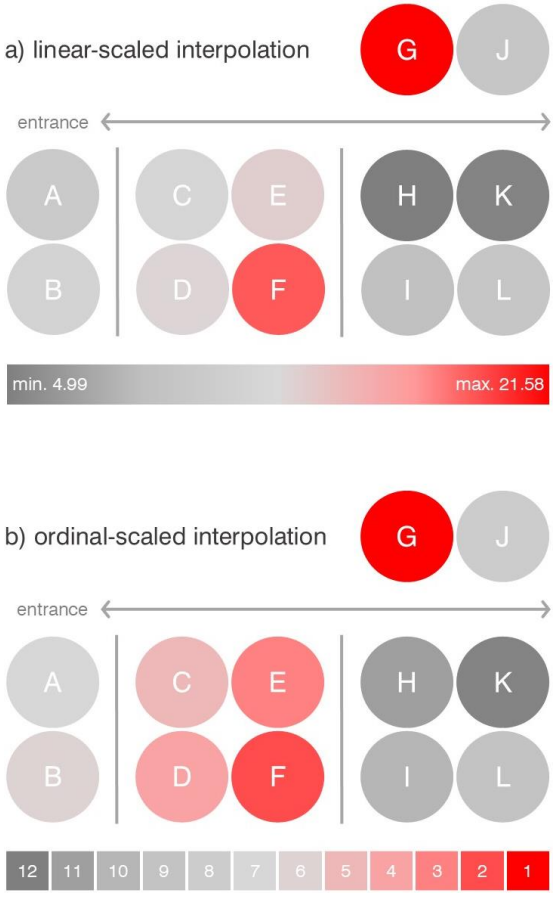


Figure 2-a depicts interpolation based on *linear scale.* In this type, colors are assigned directly according to the numerical value, and from one extreme end color to the other, changes in color are distributed in a constant manner between the minimum and maximum numerical values (in this case, 4.99 and 21.58, respectively). Therefore, linear-scaled interpolation is the most intuitive and straightforward. However, in the case of very minor differences between values, this interpolation may fail to depict enough contrast so that the pattern of values distribution may not be prominent enough. Such is the case here: The differences between Group F and Group D, F and E, and among G, H, and I, are clear enough, yet it is much harder to identify the difference and order among A, B, C, D, E, I, L, and J. In short, the low variations in the majority numerical values, combined with small numbers of exceptionally high and low values, result in a relatively monotonous color scheme. Since the objective here is not to depict the exact values but instead to bring up the spatial pattern of lower-to-higher values through a more diversified color scheme, another type of interpolation is required: one based on *ordinal scale.*

Figure 2-b depicts interpolation based on *ordinal scale.* In this type, colors are assigned not to value but instead to *rank* or *order.* This interpolation sets exact values asides and arrange all 12 groups into a rank from 1 (the highest) to 12 (the lowest value), without considering the difference between values. In a similar fashion, the range of colors is divided into 12 segments identical in size, and these segments of color are then assigned to the data according to the rank. Thus, ordinal-scaled interpolation may not be the most intuitive and numerically straightforward, but it does possess an advantage: regardless of the variations in the numerical values, it ensures that all the color ranges/segments are utilized evenly. With such diversified color scheme, it is much easier to observe how the higher and lower values are distributed spatially according to the seating arrangement. Therefore, in exploring these initial results to hypothesize the possible patterns or relationships, ordinal-scaled interpolation was selected.

3. Formulation of the Hypotheses

Using the ordinal scale to interpolate the numerical results as described previously, it is possible to observe certain patterns regarding the spatial distribution of the values, leading to the formulation of the hypotheses. These patterns are presented in **Figure 3.**

Figure 3. Three hypotheses formulated according to the patterns observed from the ordinal-scaled interpolation of the values
Source: Authors

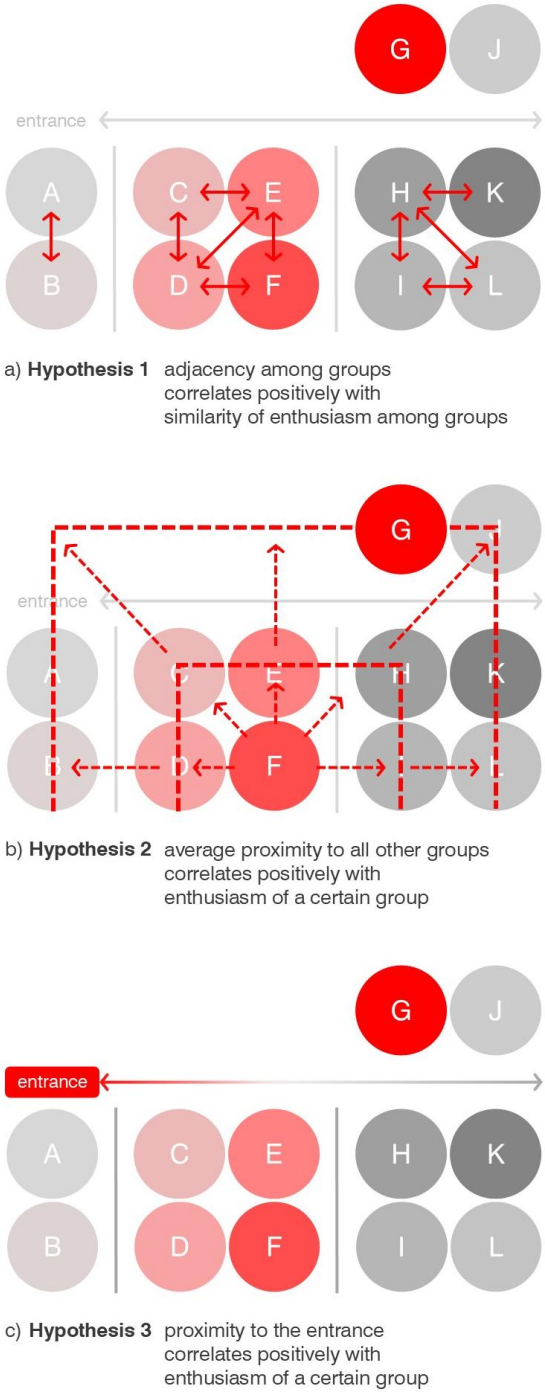


Figure 3-a depicts the first observable pattern: *some of the adjacent groups tend to be similar in enthusiasm.* This pattern is noticeable between A and B, among C, D, E, F, and among H, I, K, and L. Thus **Hypothesis 1** was formulated as such: *Adjacency among groups correlates positively with similarity in enthusiasm among groups.*

Figure 3-b depicts the second observable pattern: *the more centered a group is, the higher its level of enthusiasm.* This pattern is shown by the facts that 1) Group F, the second highest in enthusiasm, is located at the somewhat 'center' of the Studio; 2) the adjacent 'inner layer' (Groups C, D, E) are consecutively lower in enthusiasm than Group F, and 3) almost all the rest (the 'outer layer') are even lower. By defining 'centrality' as 'the proximity to all other groups', **Hypothesis 2** was formulated: *Average proximity to all other groups correlates positively with enthusiasm of a certain group.*

Figure 3-c depicts the third observable pattern: *the closer to the entrance a group is, the higher its level of enthusiasm*: 1) 5 out of 6 groups closer to the entrance is within the higher half in terms of enthusiasm (B, C, D, E, F), and 2) 5 out of 6 groups farther from the entrance is within the lower half in terms of enthusiasm (H, I, J, K, L). Thus, **Hypothesis 3** was formulated as such: *Proximity to the entrance correlates positively with enthusiasm of a certain group.*

Hence, the key aspects of the seating arrangement are adjacency among groups and proximity to other groups and to the entrance. However, the presence of the non-wall separators between groups in the form of waist-high lockers poses an additional complexity; these separators maintain visual contacts yet limit mobile ones. It is then possible to consider these aspects in both *visual* and *mobile* terms, as illustrated in **Figure 4.**

Figure 4. Visual versus mobile adjacency and proximity
Source: Authors

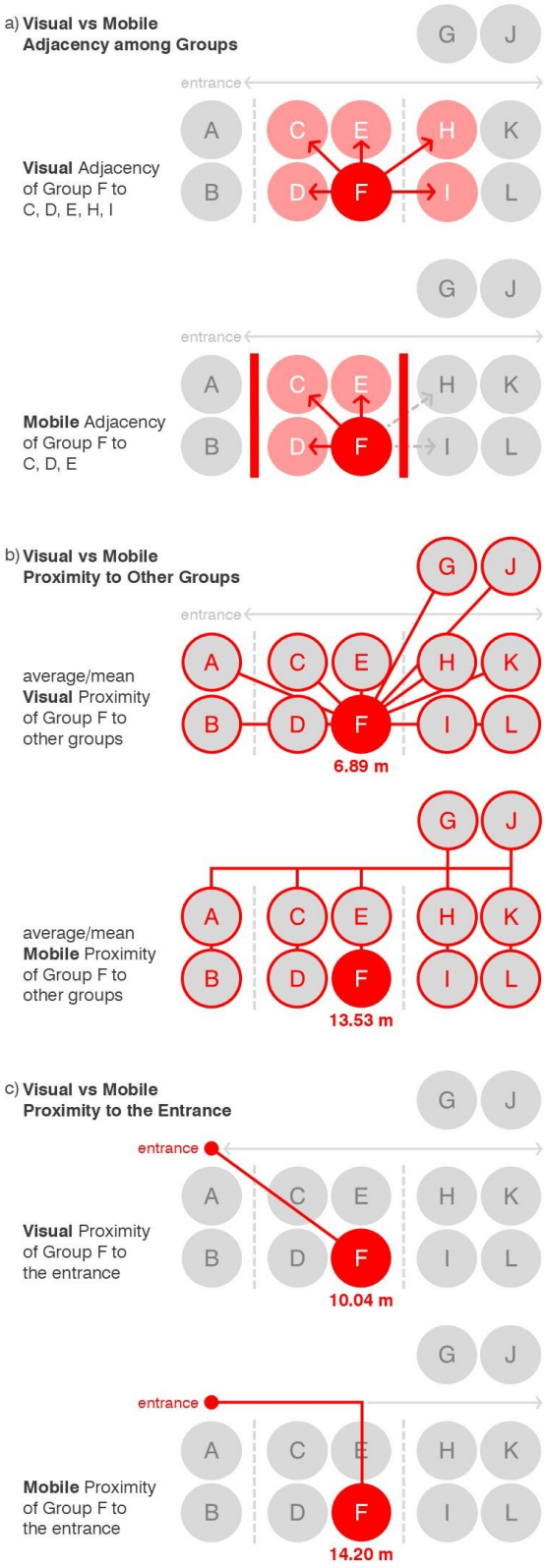


Figure 4-a depicts the comparison between visual and mobile *adjacency among groups*. Despite being separated by the lockers, H and I can be considered *visually adjacent* to F, since the lockers do not impede visual contact. However, H and I posses *no mobile adjacency* to F, because the direct or *adjacent* mobile contact is prohibited; students from F have to walk around the lockers to reach H and I. Only C, D, and E can be considered adjacent to F in mobile terms.

Figure 4-b depicts the comparison between visual and mobile *proximity to other groups*. In other words, it is the difference between the distance required by a certain group to *observe* other groups versus the distance that must be *traveled* to reach other groups. It is shown that the average *visual distance* from Group F to all other groups is 6.89 m, while the average *mobile distance* is 13.53 m. Hence, Group F's *visual* proximity to other groups is higher than its *mobile* proximity.

Figure 4-c depicts the comparison between visual and mobile *proximity to the entrance of the Studio*. Similar to the previous point, it is the difference between the distance required by a certain group to *observe* the entrance versus the distance that must be *traveled* to reach it. It is shown that the *visual distance* from Group F to the entrance is 10.04 m, while the *mobile distance* is 14.20 m. Again, Group F's *visual* proximity to the entrance is higher than its *mobile* proximity.

Thus, the previous hypotheses were detailed into 6 relationships: visual and mobile adjacency vs similarity in enthusiasm, visual and mobile proximity to others vs enthusiasm, and visual and mobile proximity to the entrance vs enthusiasm.

Finally, it should be noted that, in observing the patterns and formulating the hypotheses, Group G may be regarded as the *outlier* with which the patterns and hypotheses do not concur. Despite earlier statement that this study does not take into account the non-spatial factors possibly affecting enthusiasm such as group dynamics and teaching styles of the instructors, it is important to mention that Group G did indeed experience particular dynamic differing from other groups due to the instructor. At the second half of the semester, Group G worked directly under the guidance of the Coordinator of the Architectural Composition Studio, who initiated the program of journaling using the sketching logbook. Within this context, compared to the other groups, Group G received from this instructor relatively stricter reminders and encouragements to continue and report the journaling activity. The impact was that Group G became the most successful in maintaining the journaling activity during the second half of the semester compared to the other groups in general, thus obtaining the highest mean value of enthusiasm.

Therefore, unlike the other groups, the development of learning enthusiasm of Group G was, so to speak, enhanced and unnatural. It is reasonable to suspect that, in the case of Group G, the contribution of spatial factors in determining enthusiasm may be insignificant compared to that of this particular dynamic and instructor's influence; it is reasonable to regard Group G as an *outlier*. For this reason, the previously proposed 6 relationships were examined using two strategies: 1) by including, and 2) by excluding Group G. At last, in total, 12 correlations were calculated.

4. Testing the Hypotheses: Correlations using Rank-Biserial and Spearman's ρ

The process of quantification, exploration through interpolation, and formulation as described previously resulted in a set of hypotheses about possible relationships, which were then tested using correlations. The framework of formulation of these correlations is depicted in **Figure 5.**

As mentioned previously, variables investigated in this study possess values in two types of scale. The variable of *adjacency among groups* (be it visual or mobile) was measured by only two binary non-quantitative values: *adjacent* and *not adjacent.* This scale is known as *nominal-dichotomous.* However, the variable with which adjacency is paired is *similarity in enthusiasm,* which was measured by using the *difference* between enthusiasm values. For the set of 12 groups (Group G included), a total of 66 values of difference were obtained; while for the set of 11 groups (Group G excluded), there were 55 values of difference. Thus, since the number of data is

relatively modest (*n* = 66 and *n* = 55), the real numerical values of difference were converted into *rank* or *order,* resulting in *ordinal scale.* Hence, the 1st hypothesis (which covers the first 4 correlations)—*adjacency among groups versus similarity in enthusiasm*—was tested by using Rank-Biserial Correlation, which measures relationship between one variable valued in nominal-dichotomous scale and another variable valued in ordinal scale (Calkins, 2005).

Both the variable of *proximity to all other groups* and *proximity to the entrance* (be it visual or mobile), as well as the variable of *enthusiasm* with which the former two were paired, were measured by real numerical values. However, since the number of data is exceptionally modest (*n* = 12 when Group G is included and *n* = 11 when Group G is excluded), the real values were converted into *rank* or *order* as well, resulting in *ordinal scale.* Hence, the 2nd hypothesis (covering the second 4 correlations)—*proximity to all other groups versus enthusiasm*—and the 3rd hypothesis (covering the third and last 4 correlations)—*proximity to the entrance versus enthusiasm*—were tested by using Spearman's ρ, which measures relationship between two variables both valued in ordinal scale (van den Heuvel & Zhan, 2022).

In conclusion, a total of 12 correlations coefficient were obtained and presented in two digits (Cole, 2015). The numerical coefficients were then interpreted descriptively using the guidance as presented in Table 1 (see the previous "Methodology" section). The summary of the final results is depicted in **Table 3**.

The first noticeable finding from Table 3 is that, when Group G (the suspected outlier) was included in the calculations, only Hypothesis 3 was proven satisfyingly (+0.49 and +0.43); the other two hypotheses were disproven (all coefficients under +0.2, indicating no or negligible relationships). On the contrary, when Group G was excluded, all the three hypotheses were provable (albeit with various strength). This finding indicates that Group G is indeed an outlier; accordingly, only the results excluding Group G will be discussed.

Figure 5. Formulation of the correlations
Source: Authors

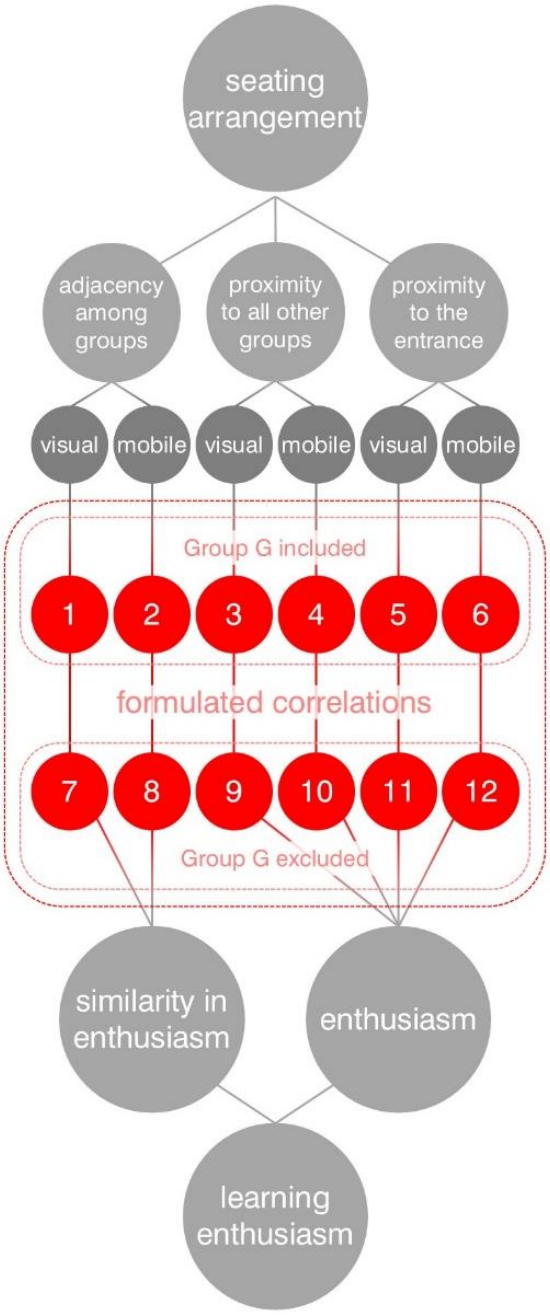


Table 3. Resulted correlation coefficients

Hypotheses	Learning Enthusiasm	Aspects of Seating Arrangement	Group G included	Group G excluded
adjacency among groups correlates positively with similarity in enthusiasm among groups	similarity in enthusiasm	visual adjacency among groups	+0.13	+0.17
		mobile adjacency among groups	+0.13	+0.20
average proximity to all other groups correlates positively with enthusiasm of a certain group	enthusiasm	visual proximity to other groups	+0.07	+0.35
		mobile proximity to other groups	+0.15	+0.01
proximity to the entrance correlates positively with enthusiasm of a certain group	enthusiasm	visual proximity to the entrance	+0.49	+0.57
		mobile proximity to the entrance	+0.43	+0.49

Source: Authors

Hypothesis 1: Adjacency among groups correlates positively with similarity in enthusiasm among groups

The results for Hypothesis 1 show that there is indeed a significant—albeit weak (r_{rb} = +0.20)—relationship between *mobile* adjacency and similarity in enthusiasm, yet there is no such relationship (r_{rb} = +0.17) when the adjacency is merely visual. Within the context of *social contacts requiring mobility*—i.e., inter-groups discussions and conversations—enthusiasm of a group might be significantly affected only by other groups adjacent without separators impeding direct mobility, possibly because the act of 'visiting' (mobility) is the form of contact requiring the most initiative, consciousness, and effort. Hence, a group initiated this type of contact only with groups which were closest (adjacent) and easiest to reach (unimpeded by separators); groups which were adjacent yet separated might even be considered too far and too difficult to reach.

Furthermore, this form of contact might still be felt too exhaustive, since the students might prefer to use virtual/non-physical mode to interact (online chats, browsing etc.); thus, inter-groups contact of this type might be the least frequent to happen. This may explain why the correlation coefficient is low. Nevertheless, the number is still considered significant enough, and this finding concurs with that by Gao et al. (2022) which states that students sitting close to each other tend to be similar in terms of learning engagement.

Hypothesis 2: Average proximity to all other groups correlates positively with enthusiasm of a certain group

Contrary to Hypothesis 1, the results for Hypothesis 2 show that there is a significant relationship with moderate strength (ρ = +0.35) between average *visual* proximity to other groups and enthusiasm, yet there is no such relationship (ρ = +0.01) when this proximity is regarded as mobile. Within the context of *social contacts with all groups in the Studio*—as opposed to the contacts with *some groups* as in the case of Hypothesis 1— enthusiasm of a group might be significantly affected only if the contact was visual; i.e., visual observation to all other group without the need for discussion or other activities requiring

mobility. Therefore, the more 'spatially centered' a group within the Studio—i.e., the higher its proximity to all other groups—the more and the clearer visual observations about what happened in other groups were obtained, increasing the motivation and enthusiasm of the group.

This type of contact might require less effort compared to that of Hypothesis 1. However, it still demanded initiative and consciousness, and thus the frequency might be not too high albeit also not too low. This may explain why the correlation coefficient is moderate. Nevertheless, it is stronger than that of Hypothesis 1, and this finding concurs with previous studies stating that the less distance between students, the better (Hayashi, Mochizuki, & Yamauchi, 2023); that the more visual access, the better (Edgü, 2015); and that distance to the center correlated inversely to the engagement (Lu et al., 2023).

Hypothesis 3: Proximity to the entrance correlates positively with enthusiasm of a certain group

Lastly, the results for Hypothesis 3 show that there is indeed a significant, strong relationships between *both visual and mobile* proximity to the entrance and enthusiasm (ρ = +0.57 and +0.49, respectively). The closer a group to the entrance, the more other groups—in their trip to and from the entrance—ought to *see and pass or visit* that group; in other words, making *visual and mobile* contacts which might increase the motivation and enthusiasm of the group close to the entrance.

The mobility between work desk and the entrance of the Studio is inherently natural; any student having needs outside the Studio (cafeteria, toilets) must pass the entrance. Therefore, social contact initiated by this type of mobility ought to happen *most frequently.* This may explain why the correlation coefficients are high. In other words, it is probably not (the proximity to) the entrance *per se* that affect the enthusiasm, but rather the frequency of contact which were presumably encouraged by the (proximate) position of a group relative to the entrance. In this sense, this finding concurs with previous work stating the positive significance of interaction and collaboration for learning process (German et al., 2020).

Conclusion

This study has been conducted by quantifying the learning enthusiasm, exploring the possible spatial pattern, formulating hypotheses regarding the relationships between spatial aspects of seating arrangement and enthusiasm, and testing the hypotheses using correlations. The results reveal that the hypotheses have been proven: (1) *mobile adjacency* among groups correlates positively with the *similarity* in enthusiasm, (2) *average visual proximity* to all the other groups correlates positively with enthusiasm, and (3) *both mobile and visual proximity* to the entrance correlates positively with enthusiasm.

The main idea encompassing these findings is, in essence, the significance of social contact with learning/working colleagues for the enthusiasm in learning/working process. Although the variables investigated in this study were spatial aspects of seating arrangement, the impact on enthusiasm presumably originated not from the spatial aspects *per se,* but instead from the social contacts enabled and/or instigated by those spatial aspects. Therefore, the main implication of this study is that social contact still has a positive impact on enthusiasm within the context of learning process, particularly in carrying out creative activities that are exploratory in nature; the activity of journaling during the design process using the sketching logbook in the Architectural Composition Studio was a part of the Studio which was exploratory. At the same time, it should be noted that the strength of the impact presumably depends on the *characteristic* of the social contact. The more natural the contact—i.e., the less initiative, effort, and consciousness required—the more frequent the contact ought to happen, and presumably the stronger the impact.

This study only measured the relationships between seating arrangements and enthusiasm; as such, other possible non-spatial affecting factors are beyond the scope of this study. Likewise, enthusiasm was measured only by the journaling activity using sketching logbook; there might be other forms excluded from this study such as study models, digital product etc. What might also be considered for the potential further

studies is conducting questionnaires and/or interviews with the Studio participants; as such, the numerical results may be triangulated with more nuanced data and findings. This approach also offers the possibilities to conduct future collaborations with other scientific disciplines such as social study in general and pedagogical study in particular.

Lastly, this study focused only on enthusiasm (as defined formerly) and not on quality of works. Therefore, there are interesting possibility to investigate the relationship between quantification of logbook activity and the quality of the logbook, between enthusiasm and the final results of the Studio, or between the quality of the logbook and the final results of the Studio. Such possibilities may be explored in the future works.

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