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The Effect of Classroom Size, Shape and Crowdedness on User Perceptual Assessments

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Abstract: This study explored the effect of the different sizes, floor-plan geometries (square or rectangular) and crowdedness of two classrooms on users' perceptual assessments of the spaces. Two classrooms of the Ankara In-service Training Institute were employed as a research environment and a Likert-style semantic-differential scale consisting of 15 polar adjective pairs elicited users' assessments of each space. The two classrooms were found to be perceived differently by the users, despite having otherwise similar characteristics, A classroom having greater area, a square shape and proportionately less furniture was more positively perceived than a classroom having smaller area, a rectangular shape and proportionately more furniture.

Key words: Architectural form · Architectural size · Perceptual Performance · Crowdedness

INTRODUCTION

Many studies regarding user perceptions of architectural places have been conducted. Only a small portion of those studies, however, have focused on the effects of geometric forms (square, rectangle, circle etc.) and the dimensions of indoor spaces on perceptions of users [1-7]. Pennartz [4] determined that there was a significant relationship between dimensions and forms of architectural places and the regulation of environmental conditions. Krier [5] showed that architectural places with different geometric forms (square, rectangular, elliptical, triangular, octagonal and combined forms) have, in broad strokes, different effects on user perceptual assessments. As for Alp [6], in a study comparing the differences between physical and qualitative features of offices having different architectural forms, he propounded that the places had different aesthetics and that triangular and circular plans, especially, were preferable to the customary right-angle space organization.

İmamoğlu [2] constructed three 1/10 scale room models, a square room and two rectangular rooms proportioned as follows: A$\sqrt{2}$ (1x1.414) and $\sqrt{3}$ (1x1.732). Compared to the square room, the room with the $\sqrt{2}$ plan was perceived more negatively with regard to freedom and planning factors, but more positively in terms of attractiveness. However, only the differences in terms of the freedom factor were statistically significant. Sadalla and Oxley [3] confirmed that geometric form affects user perceptions of an architectural space, specifically that a rectangular space having the same physical size as a square space is perceived as being larger. In a study regarding the effects of hospital waiting halls on users' perceptual assessments, Akalin-Baskaya and Yildirim [7] demonstrated that a rectangular waiting area enabling circulation via its long side was appraised more positively by real users of the place than a square one. Yildirim *et al.* [8] reviewed users' perceptual assessments of a café/pastry shop (square and rectangular) with similar characteristics but different shapes. In that study, users perceived the rectangular café/pastry shop more positively than the square space. All in all, the studies mentioned above make it clear that user perceptual assessment of spaces of similar physical size but different floor-plan geometries (square, rectangular etc.) may differ.

Researching the spatial factors that influence perceived crowding, Sinha and Prakashvati [9] have found that people perceive less crowding with an open plan organization and side furniture arrangement. Floor height is another spatial factor that has been studied by Kaya and Erkip [10], who have proposed a relationship between height from the ground and perceived crowding (at higher floors crowding is perceived more).

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Harrell *et al.* [11] have reported a correlation coefficient of 0.58 between physical density and crowding. Akalin-Baskaya and Yildirim [12] have studied the relationship between circulation axes and seating areas of a waiting hall, suggesting that the disturbance is much higher even where there are less-defined boundaries (where people pass through from different directions) and the space is more likely to be negatively perceived. Yildirim and Akalin-Baskaya [13] have reported a customer seem to have a more positive perception of moderate density of seating elements than a high density of seating elements. Consequently, if the differences in seating element densities in cafe ´/restaurants are taken into account, this can positively affect customers' choice and use of a particular cafe ´/ restaurant.

Research Hypothesis: A limited number of studies have examined how spaces having different sizes and shapes are perceived by users. The results of these studies, for the most part, are not sufficiently solid to support one another. In the present study, real environments properly experienced by users were employed and we attempted to provide an opportunity for real assessment in the usage process. In order to test the supposition that the size, floor-plan geometry and crowdedness of a space affect user perceptual assessments of it, the following research hypotheses emerge:

H: A classroom having greater area, a square shape and proportionately less furniture will be more positively perceived than a classroom having smaller area, a rectangular shape and proportionately more furniture.

Research Method

Respondents: Participants in this study consisted of 145 trainees aged 20-55, pursuing English education at the Ministry of Education Ankara In-Service Training Institute. Of these, 61.4% were female and 89.7% were in the 20-45 age group (Table 1).

Table 1: General information about respondents

		Example A		Example B		Total	
General Information		F	%	F	%	F	%
Sex	Female	42	29	47	32.4	89	61.4
	Male	28	19.3	28	19.3	56	38.6
Age	25-45	61	42.1	69	47.6	130	89.7
	45 and over	9	6.2	6	4.1	15	10.3
Education	License	47	32.4	64	44.1	111	76.6
	Master	23	15.9	11	7.6	34	23.4

F: Frequency, %: Percentage Value

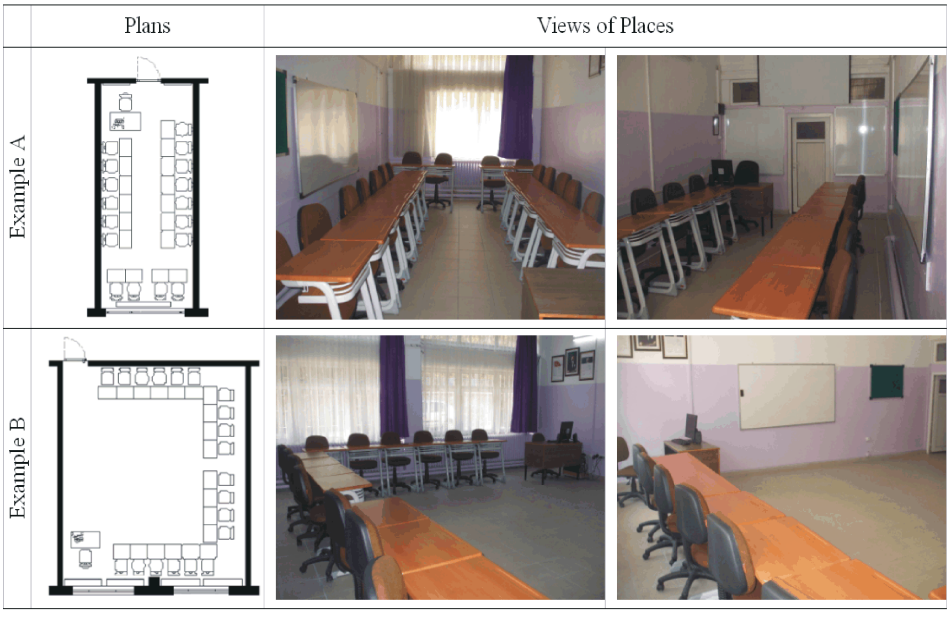

Fig. 1: Plans and views of the classrooms used in the research

Environment Settings: This study was carried out in two classrooms of different size, shape-square (50m^2) and rectangular (25 m^2), and crowdedness-average chair/ desk units per m^2 Exp. A: 0.42 and Exp. B: 0.72-in the Ankara In-Service Institute. A Likert-style semantic differential scale was used to measure the effects of the physical and environmental conditions of the classrooms on user perceptual assessments (Figure 1). In similar previous studies, Miwa and Hanyu [14], Maslow and Mintz [15], Mintz [16] and Yildirim *et al.* [13] have asserted that elements such as lighting, colour, materials, accessories and so on substantially affect user perceptions of a space and occasion differences in user assessments. Additionally, Whiton [17] suggested that each piece of furniture or equipment used in a space is not merely stuff occupying the space; it is part of a group of elements that define and balance spatial forms. Moreover, Norberg-Schulz [18] specified that the way equipment is deployed in a space sends messages about the creation of a space and channels user behaviors in the space. A space's limitations influence user descriptions of it and its qualities, with such polar adjective pairs as small / big, refreshing / boring, bright / dark or simple / complex applying differently according to a room's materials and arrangements. Therefore, in order to limit differences between the two rooms studied as much as possible all equipment, quantity of light, accessories and furniture in the classrooms used as test environments were controlled so as to be nearly identical.

Questionnaire Design and Procedure: Scales found to be valid and useful in studies by Berlyne [19], İmamoğlu [2], Ertürk [20], Fiedler [21], Green [22], İmamoğlu [23], Kaya and Weber [24], Baskaya *et al.* [25] and Yildirim *et al.* [13] were utilized in the design of the present survey, which consisted of two parts. The first part elicited general information concerning the respondents and the second part elicited respondents' perceptual assessments of the classrooms by means of their responses to 15 polar adjective pairs, positive and negative, on a five-point Likert-style semantic differential scale. The adjective pairs employed in this assessment were as follows: *free / limited, simple / complex, organized / disorganized, sparse/dense, roomy / cramped, attractive / unattractive, bright / dark, big / small, planned / unplanned, high / low, calm / restless, active / stationary, peaceful / unpeaceful, warm / cold, I prefer / I do not prefer*.

The experiment commenced immediately after the selected user groups were taken into the classrooms. The purpose of the study and points to which participants should pay attention while completing the questionnaire and might have difficulty understanding were explained. Participants were asked to answer the survey questions after thoroughly perceiving the space. The survey sessions were held at various times on weekdays. Users took almost 20 minutes to complete the survey on average. Survey data were collected over a 4-week period in 2010.

Statistical Analysis: Respondents' perceptual assessments were the dependent variable. The combined difference in size, shape and amount of furniture per classroom area was considered the independent variable. Averages and standard deviations of responses for each adjective-pair dependent variable were derived. Then, to test the different effects of each classroom on user perceptual assessments, a one-way variance analysis (ANOVA) was applied. Moreover, in order to compare the averages of the variables, a single variance analysis was conducted and the data were demonstrated graphically.

RESULTS

The reliability of the data derived as a consequence of the above-described statistical analysis was examined via Cronbach's Alpha; the reliability coefficient generated by the questionnaire scale was 0.87. In previous studies by Bagozzi and Yi [26], Grewal *et al.* [27], Bosma *et al.* [28], McKinley *et al.* [29] and Kim and Jin [30], it has been suggested that when alpha reliability coefficients rise to 0.70 for all elements, a measurement instrument can be accepted as reliable. The data yielded by this study may thusly be considered reliable.

Differences between users' perceptual assessments of the two classrooms were tested using a single variance analysis (ANOVA). Categorical averages and standard deviations for the data were derived as well (Table 2).

The categorical averages and standard deviation values given in Table 2 clearly show that the classrooms in the scope of the research had different effects on users' perceptual assessments. The ANOVA results demonstrate that the differences between the dependent variables as measured for the classroom with rectangular form having 25 m^2 space (0.42 chair-desk units per m^2 in room) and for the classroom with square form having

Table 2: Averages and standard deviations for dependent variables and ANOVA results

	Classrooms				
	Example A		Example B		
Dependent Variable	$\overline{X}^a$	SD	$\overline{X}^a$	SD	ANOVA
Free / limited	3.60	1.28	2.20	1.24	0.000*
Simple / complex	2.46	1.18	1.64	0.88	0.000*
Organized / disorganized	2.49	1.25	1.84	0.89	0.000*
Sparse / dense	3.96	1.22	2.09	1.03	0.000*
Roomy / cramped	3.36	1.20	1.79	1.02	0.000*
Attractive / unattractive	3.64	1.27	3.28	1.26	0.087^{ns}
Bright / dark	2.53	1.21	1.91	1.10	0.000*
Big / small	4.33	1.05	2.04	1.03	0.000*
Planned / unplanned	2.83	1.34	2.05	1.04	0.000*
High / low	2.30	1.38	1.97	1.16	0.120^{ns}
Calm / restless	2.91	1.34	1.86	0.91	0.000*
Active / stationary	3.39	1.12	2.97	1.25	0.040**
Peaceful / unpeaceful	3.10	1.17	2.28	1.06	0.000*
Warm / cold	2.51	1.24	2.08	1.10	0.030**
I prefer / I do not prefer	3.23	1.51	1.97	1.08	0.000*

Note: $\overline{X}$: Average value, SD= Standard deviation. *: $P < 0.001$ and **: significant at $P < 0.05$, ns: insignificant at $P < 0.05$.

a: Variable means ranged from 1 to 5, with higher numbers representing more negative responses.

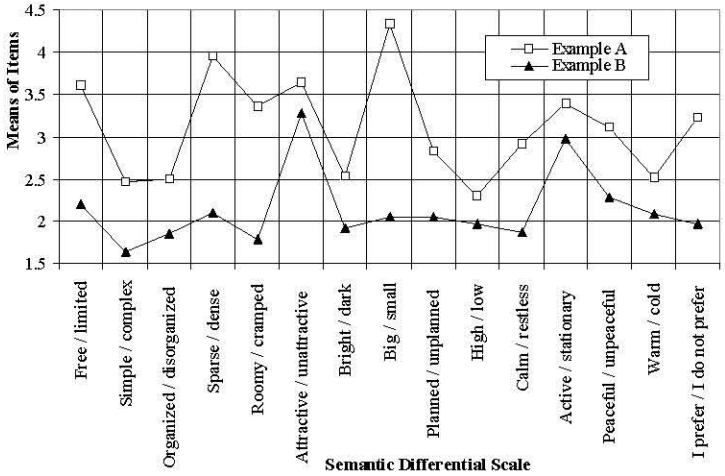

Fig. 2: User perceptual assessments of English classrooms
Note: Variable means ranged from 1 to 5, with higher numbers representing more negative responses.

50m^2 (0.72 chair-desk units per m^2 in room) were statistically significant at $p < .001$, at $p < .05$ levels for the adjective-pairs free/limited (F=44.74, df= 1, P = .000), simple/complex (F=22.65, df= 1, P = .000), organized/disorganized (F=13.04, df= 1, P = .000), sparse/dense (F=99.25, df= 1, P = .000), roomy / cramped (F=72.29, df= 1, P = .000), bright/dark (F=10.44, df= 1, P = .000), big/ small (F=175.72, df= 1, P = .000), planned/ unplanned (F=15.11, df= 1, P = .000), calm / restless (F=30.55, df= 1, P = .000), active / stationary (F=4.35, df= 1, P = .040), peaceful / unpeaceful (F=19.62, df= 1, P = .000), warm / cold (F=5.01, df= 1, P = .030) I prefer / I do not prefer (F=33.67, df= 1, P = .000). According to this, it can be said that differences in the design of interiors with respect to different sizes and floor-plan shape are quite remarkable. The square classroom (Example B) having larger area and lower crowdedness was perceived more positively compared to the rectangular classroom (Example A) with smaller area and higher crowdedness. This result supports the hypotheses.

However, no significant difference emerged for the adjective-pair variables attractive / unattractive (F=2.97, df= 1, P = .087) and high / low (F=2.40, df= 1, P = .120). This situation implies that the classrooms were perceived similarly with regard to these two adjective pairs and that no distinctive difference in user perceptions existed. With a view to comparing the averages of these variables, a variance analysis was conducted and the data displayed graphically (Figure 2).

As seen in Figure 2, Example A was perceived more negatively for all adjective pairs as compared to Example B. Thus, the size and shape of a classroom has a clear effect on user perceptual assessments. Given its larger area and square form, Example B appears to have been perceived more positively on account of its having greater circulation space and more amenable arrangements. Both classrooms, on the other hand, were generally found "ordinary" and "passive," perhaps due to the furniture used in both spaces.

CONCLUSION AND DISCUSSION

The results of this study clearly show that the combination of size, shape and crowdedness of a classroom had a significant effect on user perceptual assessments. The fact that differences in the size [1, 3-4], shape [2, 5-6, 8, 20, 22] and crowdedness [7, 9-12, 24] of a place have significant effects in terms of users' perception of a space has been observed in many previous studies.

Sadalla and Oxley [3] and Yildirim *et al.* [12] have asserted that a rectangular space is perceived more positively compared to a square one of similar size. The results of this study, however, showed that a 50m^2 classroom with a square floor-plan was perceived more positively than a 25m^2 classroom with a rectangular floor-plan. The comfort arising from the greater circulation area, equipment flexibility and usage space of the square classroom are thought to explain the apparent contradiction of the findings of this study with existing literature.

In the study in which Imamoglu [2] constructed 1/10 scale models of a square room and two rectangular spaces, the square space was found to be perceived as less attractive regardless of its being perceived more positively as compared to the rectangular spaces. In this study, correspondingly, the square place was perceived more positively than the rectangular in terms of planning and freedom. The size of the spaces is considered to explain that difference.

Arlitsch [31], in a study comparing computer labs of different sizes used at different times, the layout and location of furniture and equipment elements used in the space were found to affect student users' perceptual assessments. The results of this study demonstrate that a 50m^2 square space was perceived more positively in general, suggesting that the larger space offers a clearer communication environment, greater flexibility, a more comfortable arrangement and better moving space for users.

The results of this study show that the combination of size, shape and crowdedness of an educational space significantly affects the positive/negative perceptions of users. Moreover, it seems quite reasonable to conclude that designing spaces with a size and shape amenable to spatial arrangements that will increase learning levels and support positive communication among users plays an important role in user satisfaction and expectations. Especially in designing classrooms used in educational institutions, user perceptual assessments should be taken into serious consideration.

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