PRINT: ISSN 0970-9274 ONLINE: ISSN 2456-6608
J Hum Ecol, 43(2): 189-194 (2013)
DOI: 10.31901/24566608.2013/43.2.10

An Analytic Study into Indoor Climate of the Girls' Colleges

Purva Jaggi[1], Rupa Bakhshi[2] and Pushpinder Sandhu[3]

Department of Family Resource Management, College of Home Science,
Punjab Agricultural University Ludhiana
Mobile : 09816369505[1], 09855030946[2] 09855556034[3]
E-mail:[1] <purva1978@gmail.com> [2]<bakhshia@pau.edu> [3]<spushi@pau.edu>

KEYWORDS Classroom. Ergonomics. Female Students. Humidity. Noise Level.Physical Environment. Subjective Assessment. Temperature. Ventilation

ABSTRACT The physical environment of the classroom is an important determinant of learner's comfort possibly affecting his work performance and mental efficiency. The present study was conducted with the objective to study the indoor climate of selected Indian classrooms and their subjective assessment by the female student population. A total sample of 10 colleges was selected for this study. Two classrooms from each college, making a total of 20 classrooms were selected. Five users from each classroom were taken making a total of 100 users for the subjective assessment of various comfort parameters and subjective assessment was also made by self observation of these parameters. The study was conducted with the help of an interview schedule. An environmental kit was used to measure various environmental parameters of the selected classrooms.The indoor comfort level in the selected classrooms was not appropriate as desirable for effective learning. The classrooms were either too warm or too cold. The temperature was not conducive for studies. The lighting was also not sufficient in intensity in the classrooms to facilitate easy reading and writing without eye pain and strain. Classrooms were not completely isolated from each other. The mean scores for subjective assessment of wind speed, temperature in summers and winters, humidity, lighting and noise level were 1.55, 1.41, 1.47, 1.89, 2.14, 1.49 and 2.16 respectively.

INTRODUCTION

Classroom is a place where students spend most of their time. As they have to spend considerable amount of time on studies, provision for good study facilities becomes essential. The physical environment of the class-room is an important determinant of learner's comfort possibly affecting his work performance and mental efficiency. Educational buildings are one of the building types necessarily of great interest when we consider the potential links between building performance and thermal comfort. Students spend long periods of time in classrooms, and a good indoor climate can help to optimize conditions for students' performance. The relationship between indoor environmental conditions (for example, temperature, relative humidity and wind speed) in general and student performance is well established. Besides, a classroom has to facilitate learning and increase the work efficiency of the students through providing a comfortable and stress-free working environment suitable for intellectual activities. During the past decade, research in ergonomics has led to an improvement in the technology of work and workplace design.

However, the largest workplace of all, that is, the classroom is still being ignored. Especially in case of female students, no research has been conducted to meet the design requirements of the workplace. Girls' colleges are increasing in number in India now. At present, there are 1800 girls' colleges in India (Chronicle Year Book 2009). Workplace designing and ensuring comfort for female student populationis significant because they have special requirements which are slightly different from those of the male students' population. Thus, there is a need to focus attention on classroom environment for female students.

In India, so far this field has not been explored fully and to facilitate learning, schools must also encourage a good physical class-room environment. Classroom ergonomics is an important aspect of preserving not only the health and well being but also ensuring academic success and achievement. Therefore, there is an urgent need for development and maintenance of better ergonomically designed classrooms with the basic ergonomically designed classroom environment and timely and appropriate maintenance that would make them a rich learning environment for students. The present investigation was conducted with the following specific objectives:

1. To study the indoor climate of selected classrooms

2. To examine subjective assessment of indoor climate by selected female students.

MATERIAL AND METHODS

The study was conducted in Ludhiana city. The local selection of the sample was purposive. A total sample of 10 colleges was selected for this study. Two classrooms from each college, making a total of 20 classrooms were selected. Five users from each classroom were taken making a total of 100 users for the subjective assessment of various comfort parameters and subjective assessment was also made by self observation of these parameters.

For the classroom survey, an interview schedule was constructed which included the information regarding location and layout of the classrooms and the information regarding various aspects of the physical environment like temperature, humidity, lighting, ventilation and noise level. An environmental kit was used to measure various environmental parameters of the selected classrooms. It included lux meter to measure the light intensity (in lux), sound level meter to measure the noise level (in decibels) , room thermometer to measure the room temperature (in Celsius) and hygrometer to measure the relative humidity in percentage. The results were statistically evaluated in terms of average, percentage, standard deviation and mean scores.

RESULTS AND DISCUSSION

Environmental Parameters of the Selected Classrooms

The environmental parameters of the selected classrooms which were studied included temperature, relative humidity, lighting, ventilation and noise level. Table 1 shows the data regarding environmental parameters of the selected classrooms. The various environmental parameters that constitute the indoor climate of the selected classrooms are described below in detail:

Temperature (°C): As shown in Table 1 the average temperature inside the classrooms that were surveyed was 34.75±3.69 °C. Sixty percent of the classrooms surveyed were having indoor temperature between 35°C 40°C.Another 25 per cent of the classrooms had temperature in the range of 30-35°C while 15 per cent of the classrooms were having temperature in the range of 25-30°C. This shows that majority of the classrooms were having temperature above the stan-

Table1: Environmental parameters of the selected classrooms (n=20)

Indoor climate	*Number*	*Percentage*	*Mean*	*SD*	*Recommended levels*
Temperature (°C)					
25-30	3	15			
30-35	5	25	34.75	3.69	(20-28)°C**
35-40	12	60			
Relative Humidity (%)					
38-40	2	10			
40-42	4	20	42.20	1.36	45 per cent*
42-44	14	70			
Lighting (Daylight in lux)					
100-150	15	75			
150-200	4	20	140.00	28.56	150-200 lux **
200-250	1	5			
Noise Level (Decibels)					
Inside					
35-40	1	5			
40-45	3	15	46.25	2.75	40-45 dB *
45-50	16	80			
Outside					
30-45	1	5			
45-60	3	15	63.75	8.25	45 dB*
60-75	16	80			

Figures in parenthesis indicate percentages.
Source: *Central Building Research Institute, Roorkee (1990)
**Grandjean (1988)

dard recommended levels of (20-28) °C which has been recommended for the learning activity by Grandjean (1988). This indicates that the selected classrooms were too hot and were not conducive for learning activity. According to Berkovic and Bitan (2012) the architects and researches have concentrated on finding different sources of energy and energy consumption using passive systems by interacting with the environment such as dynamic shading which affect air temperatures and therefore indoor climate. Moreover, the correct orientation of indoor spaces improves the indoor climate of the space, while orienting them toward solar angles and wind direction may create thermal discomfort in these spaces.

Relative Humidity (Percentage): Table 1 further reveals that the average relative humidity level was 42.20±1.36 per cent inside the classrooms surveyed in Ludhiana city. This humidity was at an average temperature of 34.75±3.69 °C which was present inside the selected classrooms and is not considered as comfortable at this temperature for the learning activity. The recommended relative humidity level is in the range of 22-29 per cent at the recommended temperature of 20 -28 °C for the learning activity as recommended by the Canadian Centre for Occupational Health and Safety (2008). Majority of the classrooms (70 per cent) had relative humidity in the range of 42-44 per cent. 10 per cent of the classrooms had relative humidity in the range of 38-40 per cent and only 20 per cent of the classrooms had relative humidity in the range of 40-42 per cent. Thus it can be concluded that the selected classrooms were not within comfortable humidity levels.

Lighting (Daylight in Lux): It is evident from Table 1 that the average lighting inside the classrooms was 140.00±28.56 lux. About 75 per cent of the classrooms were having daylight in the range of 100-150 lux and 20per cent of the classrooms were having lighting levels in the range of 150-200 lux. Only 5 per cent of the classrooms were having daylight level in the range of 200-250 lux. The recommended lighting level for the classrooms is a minimum of 150-200 lux as given by Mathur (1990) which shows that only 25 per cent of the classrooms were having enough lighting conditions according to the standards

Noise Level (dB)

Inside the Classrooms: The average noise level inside the classrooms was found to be 46.25±2.75 decibels. The Table 1 showed that 80 per cent of the classrooms had noise levels between 45-50 decibels which exceeds the critical limit of 45 decibels given by Grandjean (1988) while 15 per cent of the classrooms had noise level in the range of 40-45 dB. Rest 5 per cent of the classrooms had noise level in the range of 35-40 decibels. The rest 80 per cent of the classrooms the noise level in the range of 60-75 decibels. This shows that in case of 20 per cent of the classrooms the noise level was within the acceptable range according to the standards given by Grandjean (1988). The high level of noise present inside the classrooms can lead to hindrance in the learning process. A person can perform tasks that call for high level thought, concentration and skill in noisy surroundings, but this necessitates unnecessary expenditure of nervous energy and mental strain to isolate oneself from the noise and to prevent it reaching consciousness. Broadbent (1957) found that a noisy situation made breaks in concentration more frequent.

Outside the Classrooms: The mean noise level outside the classrooms was 63.75±8.25 dB. According to Table 1, 15 per cent classrooms were having noise level outside them in the range of 45-60 decibels while 5 per cent classrooms had noise level in the range of 30-45 decibels which is up to the standards, that is, below 45 decibels. The data indicates that 95 per cent of the classrooms had outside noise level between above 45 decibels which is not recommended and may not be conducive to learning due to disturbance and leads to loss of efficiency. Thus, it can be concluded that the inside and outside noise levels were deviated from the standards. This could lead to fatigue, nervousness, irritability as well as general lowering of vitality, together with a variety of feelings of dislike. The external noise in classrooms can be controlled by the use of entry vestibule.

According to Attia et al. (2012), and Ali and Ahmed (2012) the different design techniques of educational buildings could improve thermal comfort significantly. Passive design systems have a noticeable impact on improving the thermal performance of buildings particularly in hot arid regions.

Subjective Assessment of Environmental Parameters of the Selected Classrooms

Subjective responses regarding environmental parameters of the selected classrooms were

taken and mean scores were worked out. The data in this regard has been given in the Table 2, which indicates that the subjects were not satisfied with the various environmental parameters of the selected classrooms. Table 2 also reveals self (observed) assessment about all these parameters while collecting the data.

Ventilation: Majority of the respondents were not satisfied with the ventilation as 55 per cent of them perceived the classrooms as suffocating and 35 per cent perceived them as windy. Only 10 per cent perceived them as comfortable. The 'self assessment' also indicated that 80 per cent of the classrooms were uncomfortable. The mean score for self assessment as calculated was 1.60 while the mean score for subjective assessment of ventilation by the subjects was 1.55. The results are similar to a study conducted by Deryck and Pattron (2009) in which 60 per cent of the students were not pleased with the condition of the air condition vents. The vents were dirty and were partially closed. This created the conditions of stuffiness and uneasiness in the classroom.

Table 2: Subjective assessment of environmental parameters of the selected classrooms

Parameter	*Self (observed) (n=20)*	*Respondents (n=100)**
Ventilation		
Suffocating	12 (60)	55 (55)
Windy	4 (20)	35 (35)
Comfortable	4 (20)	10 (10)
Mean Score	1.60	1.55
Temperature		
Summer		
Uncomfortable	12 (60)	70 (70)
Comfortable	5 (25)	19 (19)
Very comfortable	3 (15)	11 (11)
Mean Score	1.55	1.41
Winter		
Uncomfortable	-	68 (68)
Comfortable	-	17 (17)
Very comfortable	-	15 (15)
Mean Score	-	1.47
Humidity		
Humid	4 (20)	27 (27)
Dry	14 (70)	57 (57)
Comfortable	2 (10)	16 (16)
Mean Score	1.40	1.89
Wind Speed		
Windy	3 (15)	5 (5)
Tolerable	15 (75)	76 (76)
Comfortable	2 (10)	19 (19)
Mean Score	1.95	2.14
Lighting		
Poorly lit	13 (65)	63 (63)
Moderately lit	5 (25)	25 (25)
Well lit	2 (10)	12 (12)
Mean Score	1.45	1.49
Noise Level		
Extremely noisy	2 (10)	7 (7)
Noisy	15 (75)	75 (75)
Calm	2 (10)	13 (13)
Very calm	1 (5)	5 (5)
Mean Score	2.10	2.16

Figures in parentheses indicate percentages.*Multiple Responses

Temperature (Summer): Majority of the respondents felt uncomfortable during summer. Seventy per cent of them felt like that while according to self observation also found that 60per cent of the classrooms were uncomfortable during summers. Only 19 per cent of the respondents perceived the classrooms as comfortable. The mean score for the assessment by self was 1.55 while the mean score for the subjective assessment by respondents was 1.41.The score below three indicates that the comfort level of the classrooms was less than 50 per cent. These results are in line with a study conducted by Deryck and Pattron (2009) where all students (100 %) found that classroom temperature was the most unbearable. The classrooms were either too warm or extremely cold. These extremes in temperature create an unfavourable classroom conditions which makes the students often uncomfortable and unable to concentrate.

Temperature (Winter): Table 2 further reveals that 68 per cent of the respondents reported the classroom environment as uncomfortable during winter as against only 17 per cent who reported it to be as comfortable. The mean score for subjective assessment by the respondents was 1.47 out of a maximum of three which indicates that the classrooms were not comfortable during winter.

Humidity: Table 2 also reveals that only 16 per cent of the respondents reported that the classrooms' humidity level in classrooms was comfortable. Another 27 per cent reported them as humid and rest 57 per cent reported them as dry. Self observation also indicates that only 10 per cent of the classrooms were comfortable as far as humidity level was concerned, 70 per cent were dry and 20 per cent were humid. The mean scores then calculated were 1.89 and 1.40 (as the perception of respondents and by self respec-

tively). These low scores indicate that the classrooms were not having a comfortable humidity level.

Wind Speed: Only 19 per cent of the respondents reported the classrooms to be comfortable with the wind speed while 76 per cent felt it as tolerable and 5 per cent as windy (Table 2). The self observation revealed that only 10 per cent of the classrooms were comfortable as far as wind speed was concerned and 75 per cent were tolerable while rest 15 per cent were windy. The mean score for the wind speed as calculated for the respondents was 2.14 and the score given on the basis of self observation was 1.95. These scores indicate that the wind speed was not satisfying in the classrooms.

Lighting: According to Table 2, only 12 per cent respondents felt that the classrooms were well lit while 25 per cent of them felt that they were moderately lit. Sixty three per cent labelled the classrooms as poorly lit. The 'self observation' also revealed that only 10 per cent of the classrooms were well lit. 25 per cent of them were moderately lit and 65 per cent of them were poorly lit. The mean score calculated on the basis of 'self observation' was 1.45 and that for the respondents was 1.49. This condition of the classrooms can be a cause of eye pain and strain. The lighting was not sufficient in intensity in the classrooms to facilitate easy reading and writing without eye pain and strain. A similar condition was reported in a study conducted by Deryck and Pattron (2009) where the majority of the students (80 %) found that the lighting in most classrooms was not appropriate and a major cause of eye strain.

Noise Level: The Table 2 reveals that 75 per cent of the respondents labelled the classrooms as noisy and 7 per cent of them found them to extremely noisy. Thirteen percent of the respondents perceived that the classrooms were calm and only 5 per cent perceived that they were very calm. Self observation also indicated that 75 per cent of the classrooms were noisy, 10 per cent of them were extremely noisy, another 10 per cent of them were calm and only 5 per cent were very calm. The mean score for the noise level in the classrooms as given by respondents was 2.16 and it was 2.10 according to the self observation. The noisy classrooms can affect the learning process and can lead to interference in speech and lack of ability to concentrate. A study by Connolly (2011) of the Institute of education concluded that the poor acoustics were very bad for learning. In a lot of tasks, higher noise levels take the older age group back to the same level as the younger age group. Though there will always be a certain amount of noise in a classroom, but if you put students in an acoustically poor room it will amplify that.

CONCLUSION

The indoor comfort level in the selected classrooms was not appropriate as desirable for effective learning. The classrooms were not comfortable during summer as well as winter season. Humidity and lighting levels were also not appropriate, although these were close to the recommended levels. The noise level for inside the classrooms was close to recommended, but outside the classrooms it was exceeding the critical limit. This may be due to the fact that classrooms were not completely isolated from each other which resulted in unnecessary noise entering the classrooms, thereby creating a hindrance in the learning process. The subjective scores for various environmental parameters indicate that the classroom environment was perceived as not being conducive for the learning activity. Immediate action should be taken to improve conditions within the classroom making them more students centred and ergonomically friendly for increasing health, well being and academic performance. This study provides a clearer understanding of the relationship between existing indoor and will assist in the development of an indoor climate based on student's subjective thermal sensation and preference in the classrooms.

RECOMMENDATIONS

Based on the results presented here, classroom environment requires special consideration with regards to occupant indoor climate. However, more information is needed on student's subjective assessment of the indoor climatic factors, over a wider range of conditions Further, more research is needed in order to verify the observations of this study and to obtain a better understanding of the student's assessment of the indoor climate.

REFERENCES

Attia S, Evrard A, Gratia E 2012. Development of benchmark models for the Egyptian residential buildings sector. *Applied Energy,* 94: 270–284.

Berkovic S, Yezioro A, Bitan A 2012. Study of thermal comfort in courtyards in a hot arid climate. *Solar Energy,* 86: 1173–1186.

Broadbent 2001. Children Suffer Academically in Noisy Classrooms. *The Tribune,* P. 12.

Connolly D 2011. Children Suffer Academically in Noisy Classrooms. *The Tribune*, P. 12.

Deryck D, Pattron D 2009. Classroom Ergonomics Implications for Health, Safety and Academic Performance. From <www.thefreelibrary.com>

Grandjean E 1988. *Fitting the Task to the Man.* 4th Edition. London: Taylor and Francis Ltd.

Mathur V K 1990. *Design Data and Space Norms for Primary Schools*. Roorkee: Central Building Research Institute.