

## Evaluation of Combination of Natural and Artificial Lighting Condition in Primary Schools (Case Study: Baneh City of Kurdistan Province, Iran)

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### A-R-T-I-C-L-E-I-N-F-O

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### A-B-S-T-R-A-C-T

**Background & Aims of the Study:** Promoting the health and safety is an important part of the fundamental mission of schools and one factor in designing and operating schools that always has been important is lighting. As students spend considerable hours in the classroom and school, lighting should be designed appropriately and in accordance with the standards, to protect them from injuries. Therefore, this study aimed to determine the combination of natural and artificial lighting condition in primary schools of Baneh city, Kurdistan, Iran.

**Materials & Methods:** This is a cross-sectional study. Its population consisted of primary schools in the city of Baneh and 12 schools were randomly selected as samples. Measurement has been done, using observation method in those schools by completing the assessment form. Then collected data were analyzed by SPSS 19, using descriptive statistics, one-way ANOVA and Kruskal Wallis Test.

**Results:** Results showed that the windows to the floor area in the most of schools classes were in standard range and just in 7 classes, the windows to the floor area ratio were less than standard. ANOVA showed the mean of luminance in those schools in  $p \leq 0.05$  was significant and most of classes were in range of standard luminance. Comparison of luminance in schools corridors with standard showed that corridors luminance of 3schools were less than standard range.

**Conclusions:** The amount of luminance in all schools was not appropriate especially in old schools. Therefore, to reduce the effect of inappropriate lightning on health in some classes, it is necessary to redesign the system. Furthermore, for parsimony, the lightning system modification is required to achieve standard luminance which is important.

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## Background

The environment can be defined in terms of physical and social dimensions. The social environment includes the groups which we belong (1). Evidence showed that physical and mental health which are related to the built environment, including human-modified places such as homes, schools, industrial areas, workplaces, parks, farms, roads (2,3). One challenge for modern generation is to better

understand of broad impact of our built environment on health (4,5). First social institution for children in their life is primary schools (6). Promoting the health and safety is an important part of the fundamental mission of schools (7). Schools inappropriate conditions of environmental health can have many effects on people in it (6). The most obvious and accepted link between the environment and learning is the need for basic level of physical comfort, external physical conditions such as sound,

light and temperature (8) which are require careful consideration at design stage (9). Classroom lighting and decor can promote discomfort and impair task performance through glare (10). Natural light provides a suitable conditions in working place that carry out visual tasks comfortably during the day and creates a more attractive environmental quality (11); so natural lighting is necessary in every building, especially in schools. A successful school design depends to a great deal on the quality of the visual environment (12). Light have a vital role in our daily lives (13). Light not only for seeing and doing things, but as a factor for creating a pleasant working environment is used. Therefore, the amount of light given the nature and type of work, so the capacity and accuracy of requirements must be provided to the extent that people can easily do their tasks (14). The lack of lighting in the workplace create nervous exhaustion, injuries to the individuals health and vision. Even people with healthy eyes are observed due to the incorrect and inappropriate lighting system have been suffered from the adverse effects of physiological, neurological and psychiatric (15,16). So, providing suitable lighting both natural and electric for the tasks and activities of a school is important and the lighting of a building should enhance (17). Therefore, international and national organizations (health and education) have control and reduce the adverse effects of exposure to unsanitary to define standards in different places depending on the type and conditions (15). Some recommended design luminance range are 300 lux to 500 lux for different types of classroom (18,19). The percentage of window area to the floor are suggested 10 to 12.5% in Neufert (2000) architecture's data (20). According to Iran standard, the luminance should be at least 200 lux and maximum 500 lux in classrooms and at least 100-150 lux in corridors and standard percentage of window to the floor is 0.125 to 0.2% (21). So it is essential to examine the type of lighting and the amount of light that

the occupants of the space can carry out their special activities without visual difficulties in a comfort visual environment (12). Dargahi and colleague investigated the situation of environmental health and safety in Parsabad schools in the academic year 2012-2013. They reported the environmental health status was in average and 95% of school classes had a maximum use of natural light (22). Kalhor, emphasizes to the point that the window area at least one-fifth of the size of the room should be designed to provide minimum lighting for study (23). But Kermani investigated the environmental health and safety status among primary schools and reported that from the study of 80 schools, just 45 schools had a suitable window (24). Considering that promoting the health and safety is an important part of the fundamental mission of schools (8). Students spend considerable hours in the classroom and school so lighting should be designed appropriately and in accordance with the standards to protect them from injuries both psychologically and biologically (such as fatigue, reduced physical and mental perception, glare, refractive errors, mental health problems, headaches and impaired vision, etc) (25).

#### **Aims of the study:**

This study has been conducted to investigate the combination of natural and artificial lighting condition in primary schools in Baneh city for necessary modification.

#### **Materials & Methods**

This is a cross-sectional study. The total primary schools in this city are 34, which 12 schools that 4 of them were operating two shifts randomly selected as samples. It has been done, using measurement and observation methods in those schools by completing the assessment form. General lighting, luminance in classrooms and corridors of schools, the ratio of window area to the floor, the status of artificial light and normal light conditions (sun) were evaluated in the classroom. Network method

was used to measure the luminance and in this method first class floor was measured, a simple map was traced in a regular checkerboard network and cell division of 1\*1m. After calibration of luxymeter, it was placed on the desired station. After that, the measured values in the station entered to the checkerboard network cells and luminance of classrooms and corridors were calculated. To measure the luminance, the luxymeter machine (model DX-200), made in Germany, was used and in order to calibrate the Luxmeter, zero point calibration method was used. To avoid any interference with the climate at the time of measurement, sunny days from 10 A.m to 12 P.m for the study in network method were considered. Then collected data were analyzed by SPSS 19, using descriptive statistics and one-way ANOVA, Kruskal Wallis Test. The level of significant was considered  $P < 0.05$ .

## Results

According to Kruskal Wallis Test, the mean of window to the floor area in the classes of schools in  $p \leq 0.05$  which was significant, so the windows to the floor area in the most of classes were in standard range and just in 7 classes, the

windows to the floor ratio were less than standard. ANOVA analysis showed the mean of luminance in studied schools in  $p \leq 0.05$  was significant and most of classes were in range of standard luminance. Comparison of luminance in schools corridors with standard showed that, corridors luminance of 3 schools were less than standard range. According to Table 1, class 5 and 6 in Shahed school, class 8 and 9 in Shahid Motahari school, class 3 and 5 in Shahid Namaki school, class 7 in Bentolhoda schools had the windows to the floor area ratio less than standard. According to table 2, in assessment of 102 classes, luminance of 54.9% classes were in 200-500 lux range and 44.1% were in  $>500$  lux range of luminance and 1% in  $<200$  range. According to Table 3, one-way ANOVA analysis showed the mean of luminance in  $P \leq 0.05$  was significant and classes were in range of standard luminance but mean of luminance was different in classes. According to figure 1, comparison of luminance in schools corridors with standard showed that, corridors luminance of Shahid Namaki school, Shahid Beheshti and Shahid Namaki2 (2) schools were less than standard.

**Table 1) Ratio of window area to floor in schools classes**

Schools name	window area to floor area ratio														
	Class name														
	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	Class 7	Class 8	Class 9	Class 10	Class 11	Class 12	Class 13	Class 14	Class 15
Shahed	0.26	0.26	0.26	0.26	0.09	0.12	0.19	0.26	0.25	0.26	0.26	*	*	*	*
Shahid Motahari	0.26	0.26	0.26	0.26	0.26	0.26	0.2	0.02	0.05	0.25	0.26	*	*	*	*
Shahid Namaki	0.25	0.24	0.12	0.25	0.08	0.33	*	*	*	*	*	*	*	*	*
Bentolhoda	0.33	0.33	0.33	0.33	0.26	0.33	0.02	0.43	*	*	*	*	*	*	*
Pirmorad	0.18	0.28	0.22	0.13	0.26	0.31	0.35	0.22	0.22	*	*	*	*	*	*
Seyyed jamalodin	0.3	0.3	0.3	0.3	0.3	0.3	*	*	*	*	*	*	*	*	*
Shahid Beheshti	0.18	0.18	0.15	0.24	0.18	0.15	0.24	0.3	0.24	0.24	0.24	0.2	*	*	*
Shahide Azime Khaki	0.35	0.35	0.35	0.22	0.22	0.26	0.22	0.22	0.22	0.22	0.3	0.15	0.25	0.22	0.2
Shahid Lotfi	0.2	0.2	0.2	0.2	0.2	0.2	0.2	*	*	*	*	*	*	*	*
*Etesami	0.27	0.27	0.27	0.27	0.27	0.27	*	*	*	*	*	*	*	*	*
22 Bahman	0.2	0.2	0.2	0.37	0.37	0.2	*	*	*	*	*	*	*	*	*
Shahid Namaki2	0.33	0.33	0.33	0.2	0.33	*	*	*	*	*	*	*	*	*	*

**Table 2) Descriptive analysis of illuminance in classes**

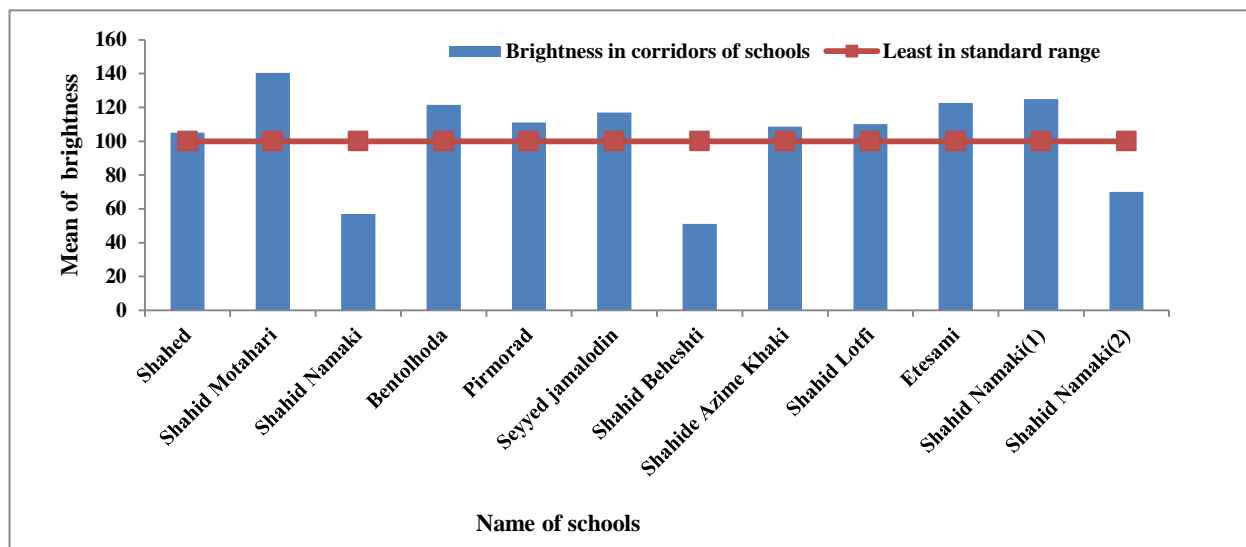
Standard range of illuminance(lux)	Luminance(lux)	Frequency	Percent	Cumulative percentage
200-500	<200	1	1	1
	200-500	56	54.9	55.9
	>500	45	44.1	100
	total	102	100	

**Table 3) Mean of illuminance in schools using One -Way ANOVA analysis**

		Sum of squares	Df	Mean squares	F	Sig
Average of illuminance	Between group	375535.377	11	34139.580	2.696	0.005
	Within group	1139556.685	90	12661.741		
	Total	1515092.062	101			

**Table 4) The mean of window area to floor area ratio using a Kruskal Wallis Test**

window area to floor area ratio	Kruskal Wallis Test		
	Chi-Square	Df	Asymp. Sig
	31.206	11	.001



**Figure 1) The mean value of luminance (lux) in schools corridors**

## Discussion

There are various classroom lighting which may be important for pupils' learning, teachers and they can have clear preferences about classroom lighting (18). This study aimed to determine the combination of natural and artificial lighting condition in primary schools. According to the results, the windows to the floor area in the most of schools classes were in standard range and in 7 classes, the windows to floor area ratio were less than standard.

Although this rate is not high but it is important to provide natural light in classrooms. Also, it is necessary to compliance of conditions with existing standards as Dargahi in their study found that, the 95% of classes had a maximum use of natural light (22). Another results showed that, most of classes (54.9%) were in range of standard luminance and 1% were in <200 range but 44.1% were in more than standard range. Winterbottom examined the lighting and discomfort in the classroom. He found that, in 88% of classrooms, the mean

illuminance (from excessive day- and artificial lighting) was in excess of recommended design (18). As an excessive illuminance causes discomfort and inhibit task performance, this subject should be considered in different aspect and also be controlled. one –way ANOVA showed the mean of luminance were different in classes and Kruskal Wallis test showed the mean of the windows to the floor area ratio were different in classes. So it is necessary to consider that, although the mean of luminance and the window to the floor area ratio were in standard range in those schools but some classes were less than standard range and as schools are important places in accordance with standards, the light of all classes in any cases is necessary. The studies assessing environmental health conditions, including lighting situation showed, most studied schools had medium levels of standards according to the health instruction guide for schools' environment, so more attention of authorities is necessary (24,26,27). Other results of compare the luminance in schools corridors with standard showed that, corridors luminance in 3 schools was less than standard range and as low-light creates lots of problems, this subject can reduce damages that related to these places. Maitra studies showed the importance of this subject. their studies showed that, school injuries in public places occur with similar frequency to injuries, where the environment is generally unsupervised and very varied. This should be the target of the accidental prevention measures (28). So according to this study, providing the appropriate illuminance increase safety and lead to less injuries.

### Conclusion

Regarding to the importance of lighting, both natural and artificial in every places special in educational places, this study aimed to determine the combination of natural and artificial lighting condition in primary schools in Baneh city, Kurdistan, Iran at academic year

2012-2013. Results showed the mean of illuminance and the windows to the floor area ratio were in standard range but illuminance and the windows to the floor area ratio of some classes were not in standard range. Also, corridors iluminance of some schools were less than standard range. As there is need to an appropriate amount of luminance, means not very more or less than standard that can creates many problems. It is recommended at first, when create schools, paying attention to the implementation of the standards and non-standard luminance of classes be modified.

### Footnotes

#### Conflict of Interest:

The authors declared no conflict of interest.

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