International Journal of Advanced Biotechnology and Research (IJBR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-7, Special Issue4-May, 2016, pp144-152
http://www.bipublication.com

Research Article

Determination of Effective Factors on Reduction of Sick Building Syndrome in Designing Educational Environments

[1]Seyede Elham Ashrafi and [2]Hasan Sadeghi Naeini
[1]Architecture, Masters Graduate.
Islamic Azad university-Tehran North Branch
[2]Assist. Prof., Industrial Design Dept., School of Architecture,
Iran Univ. of Science & Tech.(iust),Tehran, Iran

ABSTRACT
Sick Building Syndrome (SBS) is a common problem in most office and residential buildings and it happens when more than twenty percent of the residents complain of symptoms such as headache, fatigue, runny nose, mucous irritation, difficulty in concentrating and the like. It seems there is a relationship between the level and intensity of discomforts and the time the residents spend in the building. One of the most important environments which can be affected by this problem are the educational environments and since paying attention to residents' health besides productivity and efficiency in closed environments especially the classrooms is of a great importance, it is expected the architects and designers try to reduce and obviate intensity of this syndrome. The current study is concerned with investigating the results of a case-study and descriptive-analytical research on SBS. An educational-academic center was chosen as the sample and the involved factors in outbreak of the syndrome such as ambient lighting, ventilation, noise pollution, colors, and space geometry were measured and investigated. Data collection was done through measurement besides inquiry and close observation of the environment. In terms of inquiry, two groups of students and the university employees collaborated as the volunteer samples. The results indicated that by controlling the desirable conditions of the classroom and reducing the maximum noise of 63dB to 55dB besides the sufficient ventilation of 15 cubic feet per minute entrance of fresh air into the building per person, and by the aid of geometry and considering the psychological impact of internal layout and arrangement of the benches and controlling the lighting between 300 to 500lux and suitablepaint color, the SBS can be reduced for residents of the educational environments.

Keywords: sick building syndrome, educational environment, ventilation, lighting, noise, space geometry

1- INTRODUCTION
Human, in his lifetime, is always receiving messages containing information from his surroundings and is learning from them be it natural or artificial and in the meantime, the effect of architecture, the human surrounding art, is of a great importance since the behavioral and psychological effects in human due to exposure to different environments leads to change in desire for learning, his sensitivity to environmental stimuli, concentration, and learning motivation in environments especially designed or educational purposes. These effects should be especially considered by the designers and the effective environmental details and features on their senses should be designed. Correct use of these details among which some are the parameters of internal layout such as color, size of the classrooms, ambient lighting and also using modern technologies, lead in people mental, emotional, and social growth and increase the educational productivity. Due to direct relationship between these factors and physical and mental health of the

residents, the necessity of paying attention to these factors is increasingly noticeable. Obviously, improper environmental design and ignoring the modification of environmental conditions according to people needs lead in several problems, one of which is SBS. The current study aimed at investigating the involving factors in discomforts resulted from SBS in an academic environment as the sample. These factors included the quality of inside air, lighting, noise, space geometry, and environment colors can cause Complications such as subjective symptoms (headache, fatigue, lack of concentration ...), signs of irritation (irritation, runny nose, eye irritation ...), respiratory symptoms (cough, shortness of breath, wheezing ..) dermal symptoms (skin itching, dryness, redness ...). Undoubtedly, controlling these factors is among the most important responsibilities of architects and internal designers, since protecting the health of buildings and several places residents among the key points in architecture.

Sick Building Syndrome:

The term Sick Building Syndrome (SBS) is used for describing a situation in which the residents of a building face serious health symptoms and in spite of no specific disease or causes, it seems the outbreak of these serious symptoms is related to the time they are in the building. The person may complain about a specific area in the building or the whole building (United States Environmental Protection Agency, 2009).

Considering the investigated environment in the current study which is an educational environment, identification and controlling these complications which undoubtedly affect the physical health and educational productivity, is essential from architecture perspective. Identifying the effective factors in controlling SBS is among the objectives of the current study and we seek to reach it by determining applicable criteria for architects of stable educational environments with regards to reducing the complications of SBS. Moreover, obviating the SBS is an effective step in promotion of buildings stability level, which is among the higher goals of the architects.

Brasche et al (2007) study in a European country indicated that SBS symptoms are more prevalent among employed women than men. The rate of prevalence was estimated as 44.3% for women and 26.2% for men. A. Norhidayaha,Lee Chia-Kuanga ,M.K. Azharb&S. Nurulwahidab (2013) in a study on three buildings, investigated the status of SBS. Their study aimed at determination of the relationship between the indoor air quality and SBS symptoms. The choosing criterion for the buildings was their age and oldness. An organized questionnaire was prepared and distributed between the residents and also the parameters of indoor air quality were technically measured. Their study indicated that the most important factors in predicting SBS were ventilation and preventing the accumulation of pollution.

Yuexia Sun a, Yufeng Zhang a, LijinBao a, Zhenguo Fan a, Desheng Wang a, Jan Sundell in a study (2006) titled “Effects of gender and dormitory environment on sick building syndrome symptoms among college students in Tianjin, China” researched the dormitory environment and the health conditions of the students which was published in Building and Environment Journal. In this study, 3716 persons from 1569 dormitory rooms reported the symptoms of SBS. One in three reported the general symptoms and one in four reported mucous and dermal problems. The female students reported more symptoms compared to male students. The smell of mold and dry air was confirmed by 31 and 76% of the residents, respectively. Dry air and dermal problems were generally the most important dangers. In winter, the higher speed of ventilation led in reduction of dermal problems and syndromes, while in higher indoor temperature and relative humidity, lower effects were observed.

Bloom, defines the educational environment as a set of conditions, forces, and external stimuli that challenge the person. These forces can be mental, intellectual, social, and physical forces. So, it can

be said that educational environment is a network of forces in learning and educational environments which are related to each other and affect students' learning outcome (Bloom, 1964).

The results of Wargocki, P., Wyon, D.P., Baik, Y.K., Clausen, G. and Fanger, P.O. (1999) study titled "Perceived air quality, Sick Building Syndrome (SBS) symptoms and productivity in an office with two different pollution loads" indicated that reduction of pollution load indoor is an effective way for increasing the perceived air quality by the residents besides reduction of the SBS symptoms and productivity increase.

As the study titled "Ventilation for Buildings: Design Criteria for the Indoor Environment, Brussels, European Committee for Standardization" also confirms this matter. In this office, a common source of pollution was omitted while the ventilation speed and other environmental factors were fixed.

2- Ventilation, indoor air quality, and the environmental comfort standards

Regarding that a wide range of our country's population is young and they are under education, the importance of paying attention to educational centers in different stages is undeniable. On the other hand, due to budget constraints, the growing energy costs, and other barriers, precise, optimum and yet efficient designing of air conditioning systems in these centers is of a great importance.

Air conditioning is one of the issues affecting most of other aspects of the complex. The dissemination of sound waves in environments such as libraries, classrooms, and other educational environments is usually related with the rate of sounds produced by air flow within channel networks and air distributers.

The productivity of ventilation system is directly related to indoor air quality. The residents of buildings in which the air is poorly distributed in different areas, or fresh air blow into the system is ignored, are more complaining about the conditions of indoor air.

Considering the input of fresh air is also of a great importance. Currently, the minimum recommended fresh air input for the building is 15cfm per each person in an inert and smoke-free environment, though following this standard necessarily doesn't guarantee the suitable air quality, since the needed ventilation is determined by several factors such as the number of people occupying a given space, the Climate variations and concentrations of chemicals and also other pollutants in the air (Ashrae).

Air temperature is measured using a conventional thermometer. Normally, most people feel comfortable between 70-76 Fahrenheit, though it should be noted that the mentioned scope increase in summer and decrease in winter. The relative scope of humidity in which the man feels comfortable is between 20-60%. The moisture amount can be expressed using wet temperature, relative humidity, or dew point temperature.

3- Noise

Noise level was intended for investigation of noise pollution amount in educational environments, since it's one of the most important factors in well-being of educational environments and is directly related to the rate of concentration and learning besides the feeling of mental fatigue.

Fuss and noise are integral parts of today's modern and quasi-modern life. Our ancestors used to live in a calmer environment and were exposed to softer noises. The concentration of rural areas and population growth besides ever-growing boost of industry has made the human environment to face a problem that caused loss of calmness and sometimes disrupted the daily life. This problem is called noise pollution. Road traffics, the noise produced by TV's, building noises, the noise from mobile phones in the closed areas, the earsplitting noise of the planes, subways and inter-city trains, ventilation systems, exhaust, horn, the cars' alarms, and motorcycles are examples of such problem.

4- Lighting

Another variable of the current study for identifying the factors of SBS creation is sufficient and suitable light. Lack of sufficient light, especially in educational environments,

leads to low vision, reduction in concentration, and also headaches.

The researches have indicated that suitable lighting increase vision and visual acuity besides facilitating distinguishing the objects movements and details. On the other hand, human better distinguishes the colors in a well-lighted environment. These factors facilitate deeper and more precise understanding of the subject.

Light has a direct effect on human's spirit and soul. In fact, light is said to be the human's spiritual food. The researchers believe that we should consider preparing sufficient and suitable light for our soul, the same way we consider healthy food for our body. So, we create a barrier on most of undesirable effects on our soul and spirit.

Most of the times, working in poorly lighted closed areas cause the individual's fatigue and irritation. Besides preventing the fatigue, light reduce the errors and increase the spirit and productivity. Omission of natural light in the house and working environment and using only artificial light for lighting lead to isolation, introversion and a sense of numbness and ignorance.

5- Environment Colors

Color and SBS relationship can be investigated in two manners. Firstly, the psychological effect of color on the viewer spirits and soul and his understanding of its concepts and secondly, the chemical aspect, the color's type, and vapor and particles given off by the paint in the space.

Oil paints of the walls and other indoor surfaces are the source of pollutants in the buildings. The older buildings may be painted by lead-based paints. Peeling paint cause diffusion of color as dust. Lead-containing dust can bear dangers on the residents' health.

The psychological effects of the colors are undeniable, especially in educational environments. In colors architecture, specific and new definitions of space are introduced. Failure in recognition of this matter leads in irreparable effects, so the colors used in a library is different from a prison or a kindergarten due to different definitions of space.

Color in educational environments should provide an environment free of fear, so it can improve visual processes, reduce stress, and involve mental growth process through visual stimulation. In fact, this visual stimulation rewinds mind and strengthens the connections during visual thinking training, problem-solving and innovation.

6- Space and Geometry of Designing Educational Environments

The context of education is a decisive factor in motivating learning since better learning behavior strengthens educational improvement (Holdford&Reinders, 2003).

The matter of effectiveness of educational environments on the rate of learning and other students' achievements has been the center of focus in several areas such as environmental psychology in educational environments for several decades. It is believed the current educational environments should have the needed stimuli to facilitate the possibility of non-static activities, since the most basic needs of modern education systems are "mental and physical movements" and "growth of social morality". In other words, the new method of learning is involved in this subject (Greeno, 1998).

According to Bruce Jilk, learning due to its nature and essence, is not a packaged process, but it is an indigenous process expressed by continuous discovering (Jilk, 2002).

On the other hand, with a quick look at the universe and its laws, what is more manifested is the close tie between the nature and flow and changes, so adapting with these changes has become a decisive factor for survival of human being. The intellectual way for coping with these extensive changes is achieving to a well-worked framework for complete exploitation of the laws of changes and evolutions in the universe. Therefore, the modern world educational environment should lead students to "discovering the new territories of their surrounding world" and adapt them with "the pace of changes and

improvements in educational technologies" (Young, 1990).

Therefore, this human need for physical-mental dynamicity should not be prevented by passive static standards, but the dynamic and useful solution slogan should be followed.

7- Methodology

In this sectional case-study which was started in 1393, data collection was done by field method besides observation, inquiry, interview, measuring, and also desk studies (investigating the documents and evidences). The instruments were a questionnaire and light and noise measuring instruments. These measurements were done in the former building of Islamic Azad University, Tehran Shomal Branch (Africa Blvd., Mirdamad Bridge) in four classrooms with openings to four main geographical directions.

The noise level pressure measurement was done by calibrated CEL231 digital audiometer according to the factory's standard manual. This audiometer includes a display and a setting tab and all the signals received by the device can be seen as some numbers on the display. All the measurements can be read in dB and recorded on specific sheets.

These measurements were done in selected environments after classifying the classrooms.

The environmental lights were measured by an all-digital HAGNER photometer, read in lux.

For avoiding the effects of intervening factors (changing the behaviors of the residents), this assessment was done without them being informed.

The questionnaire sample is provided in indices. This questionnaire was filled up by 30 people. The results and data were analyzed by SPSS, Chi^2, one way ANOVA, and t-test.

8- RESULTS

8-1- classrooms Light

According to the standards, the sufficient and suitable light for educational environments is 300-500 lux.

Comparing the obtained measurements in the classrooms with the standards, for the northern classroom the condition was critical and light was dim in 22% of the area (lower than 300lux), 11% of the area was shiny (higher than 500lux), and the rest of the area had suitable light (67%).

In the western classroom, the critical area with dim light was 87% and the area with suitable light was 13%.

In the eastern classroom, 13% of the area had dim light, 26% was shiny, and 61% of the area had suitable light.

In the southern classroom, 38% of the area had dim light, 11% was shiny, and 51% of the area had suitable light.

Regarding the results obtained from questionnaires, 79% of people are opposed to the claim that the environmental lighting is suitable. Also, assessing the environmental health factors and lighting factor, what can be obtained from Spearman Correlation Coefficient test in western and southern classrooms is that the environmental lighting has affected the environmental health (the negative coefficient in the equation).

8-2- classrooms Colors

Observing the paint color of the classrooms it was cream-colored, but due to obsolescence and lack of cleanliness, it had gone opaque and had darkened. According to the table, the favorable percentage of the surface reflects in a classroom are respectively 35-50 and 25-40 for the students desk, according to the regulation 1848 of the Standard Institute and UNESCO Asian Standard. In terms of the board this rate is the same for both standards as 20 and for the side walls they are 40-60 and 50-60 respectively. For the ceiling, these rates are 60-70 and 80.

Considering the darkened cream color of the classrooms walls and the table of color reflections which is set as 30% for cream color, it is lower than required standard for reflection from the side walls in educational environments. The ceiling color was untidy white with the maximum reflection percent of 65, which is again lower than standard. 93% of the volunteers were again

opposed to the claim that the classrooms paint color is suitable.

8-3- Breathing Air and Classrooms Ventilation

The main purpose of the cooling, heating, and ventilation is creation of man's thermal comfort. A comprehensive agreed definition defines it as a state of mental satisfaction with the environment's temperature (ASHRAE, 2001).

These conditions depend on factors such as air temperature, humidity, the air flow speed, and the average thermal radiation.

The air temperature is measured by a normal thermometer. The temperature in which most people feel comfortable is from 70 to 76 Fahrenheit, though the mentioned scope id increased in summers and reduced in winters. The relative humidity scope in which human feels comfortable is from 20 to 60%. The needed air flow for the building can be provided by ceiling fans, the air circulation fans, doors, and windows. By the air flowing inside the building, the indoor air scope for preserving the thermal comfort can be increased by 2°F.

According to the national regulations for buildings, all the working and educational environments should be ventilated either naturally or mechanically. The minimum amount of input air for the educational areas is 15fpc per each person.

In the mentioned university building, except for the cooling and heating which are mechanically provided by evaporative coolers and heating radiators respectively, in most periods of the year, the ventilation needs are met by natural ventilation.

83% of the volunteers were opposed to the claim that breathing air and ventilation is suitable. Regarding the results obtained from the questionnaires and assessing the environmental health factors and breathing air and ventilation factors in southern and western classrooms, the Spearman correlation coefficient test indicates that breathing air and ventilation affects the environmental health (the negative coefficient in the equation) and endangers the residents' health.

The relationship between the hours spent in the classroom and the breathing air and ventilation is significant and the value of coefficient shows an average relationship. It means that by increase in hours spent in the environment, this dissatisfaction is also increased.

The correlation test also indicated that there is a negative relationship between the variable cough and wheezing and suitable air and ventilation.

8-4- classrooms Noise Level

The binominal test on the environment noise level indicated that 86% of the volunteers are opposed to the claim that environmental noise is suitable. Regarding the results obtained from the questionnaires and assessing the environmental health factors and environmental noise factor in eastern and northern classrooms, the Spearman correlation coefficient test indicates that physical factor environmental noise affects the environmental health (the negative coefficient in the equation) and endangers the residents' health. Also, the relationship between the hours spent in the classroom and dissatisfaction with environmental noise is significant and the coefficient value shows an average relationship. It means that with more hours spent in the environment, environmental noise is more felt by the residents. Correlation test also indicated that there is a significant relationship between fatigue and classroom's noise.

With the assessments done in the classrooms and the majority being dissatisfied by the suitable environmental noise, and the critical zone higher than 55dB, there are 27%, 40%, 22%, and 25% higher than allowed noise for the northern, eastern, southern, and western classrooms, respectively. These results are in lines with the more dissatisfaction in northern and eastern classrooms according to the obtained data.

9- CONCLUSION

9-1- knowing the psychological effects of internal layout and benches arrangement in educational environments, and considering the criticisms on of the students on sitting behind each other in a row

which cuts the visual connection of the students and prevents the classrooms from being discussion-like and makes the lecturer a single speaker, we decided to propose other forms of group arrangements in which the students were interconnected and learn from both each other and the lecturer, cooperating with each other. Convergent sitting helps better connection between students and the lecturer and also strengthens friendship and connections between the students. The classroom as the stem cell of educational environment is the basis of this cooperation. For better defining and formation of this stem cell, we need to define a space as the pre-space, which is place for students to change cloths and get prepared before directly entering the classrooms. Another place set beside the classroom and helping its quintessential core, is a library containing the books needed for the related especial classrooms and an archive of movies, CDs, or slides alongside a computer for each especial classrooms. The introduction of especial classrooms numerously helps the space attractions, since it prevents fatigue resulted from a repetitious space. Therefore, the students not only move between different classrooms in various times, but also by different visuals of these classrooms, their especial definition can be helped and space attractions can be created.

9-2- according to the standards of the book "occupational exposure limits" published by Ministry of Health and Medical Educations, the sufficient and suitable light for educational environments is from 300 to 500 lux (a minimum of 300lux for reading and up to 500lux for more subtle activities) and more than this amount cause dazzlement. Also, according to the national regulations of building, each working or educational environment which needs natural light, should have at least one or several doors and glass windows which should be directly facing an open space, or street, to be in compliance with urbanization terms. These regulations also determine the minimum surface of the glass as 12.5% of these environments floor.

Improper lighting indicates the health risks and undesirability of the conditions will lead to unhealthy factors. Considering the 38 and 87% critical zones of dim light in southern and western classrooms, the results were predictable. For the lighting of the classrooms, first priority is to design the building as a way the light is natural, provided by facing openings without creating any shadows. For the second stage, using lighting systems by fluorescent lamps or the lamps with high lighting are suggested. Designing this lighting system provides all the intended areas with the suitable light lux.

9-3- according to the regulation 1848 of Standard Institution and UNESCO Asian standard, the suitable reflection percentage from the surfaces of a classroom.

Table 1: suitable reflection percentage from the surfaces of the classroom

b	a	surface
25-40	35-50	Student desk
20	20	Board
50-60	40-60	Side walls
20-30	30-50	Class room's floor
80	60-70	Classroom's ceiling

Table 2: the reflection rates of several colors

dark-medium-bright			color	dark-medium-bright			color
-	45	60	Brown yellow	0	75	90	White
8	25	50	Brown	0	70	80	Light yellow
10	25	50	Blue	45	55	70	Yellow
20	35	60	Gray	30	50	70	Crème
12	30	60	Green	25	45	65	Beige

10	30	35	Red	25	45	65	Pink
0.5	4	-	Black	-	50	60	purple ،pink

The correlation test indicated that there is a significant relationship between the variable inability in concentration and suitable colors in classrooms. The negative coefficient indicates that increase in inability to concentrate is related to reduction of suitable colors.

In terms of the factors of environmental health and color factor in northern and western classrooms, the Spearman correlation coefficient test assessment indicate that the paint color of the classroom affects the environmental health (negative coefficient in the equation). Also, the improper color of the classroom leads to health risks, resulting in improper physical conditions and unhealthy factors.

Besides following the above mentioned, the psychological effects of the colors should not be ignored.

9-4- the buildings ventilation using outdoor air, should be done based on ASHRAE standard criteria. This standard is also basis of 24th provision of building code of California, US.

In case the air replacement is done through natural ventilation, all the areas inside the building should have a distance of 20 feet with a door or a window or other building entrance and the total area of the air vents should constitute more than 5% of the room's floor area. Take a classroom with an area of 960feet as an example. For such a classrooms, the minimum needed surface for air vents should be 48feet. For following the 20feet principle, air vents should be designed on both ends of the room, otherwise the distance between some points of the classroom and the window will be more than 20feet.

In the four studied classrooms, the openings area was more than 5% of the classrooms' floor area, since the area of northern classroom is 70m, the western classroom 60m, and the southern and eastern classrooms, are 60 and 72m respectively. The minimum are of the classrooms openings is 3.8m which is higher than standard. However, for following the 20feet principle which is 6.1m, windows should be designed for the both ends of the classrooms, which was not followed in none of the four classrooms. The weather conditions even in temperate regions may be as such no natural ventilation method can be applied. Noise and outdoor air quality are also important factors in this manner.

In areas with much polluted outdoor air, using unfiltered outdoor air for building ventilation can be harmful for the residents' health. Unpleasant smells and more than usual outdoor noises are other troublesome factors. With the university location placed in a crowded area with urban congestion, the matter of air pollution as well as noise pollution with natural ventilation and opened openings gets more important.

Regarding inefficiency and insufficiency of natural ventilation (at least in warm and cool seasons), a mechanical system which besides ventilation accomplishes heating and cooling is needed. According to ASHRAE standard, a minimum of 15cfm of fresh input air per person is needed for buildings in a static and smoke-free environment.

In some periods of the year in which the natural ventilation is accepted, with regards to the requirements of the site, openings on the both ends of the classroom are needed.

9-5- in the classroom environment, the teacher's noise level is 75dB and 7 meters far from him, it is 68dB. In such a condition, the undesirable noise levels in the classrooms should be controlled in a way it never exceed 63dB. Also, the suitable distance of the educational environment from the cars passageway with the noise level 90dB should be at least 60 meters and from the playground with noise level of 80dB, it should be at least 25 meters.

Also, according to the national regulations of buildings, the maximum noise level allowed in the interior areas of educational environments should be 35dB for theoretical classes and 40dB for laboratories and workshops.

It seems in controlling the noise and noise and its effects, reduction of the maximum noise in an educational environment from 63dB to 55dB can help with decrease in students' dissatisfaction with environmental noises. In order to reach this objective, distance from noise pollution sources besides using acoustic materials and setting the rules for controlling the noises can be helpful.

Anyways, SBS is a process that must be controlled and monitored and by architecture and interior design considerations it can be considerably controlled.

REFERENCE

1. Young, J. (1990), Justice and the Politics of Difference, Princeton University Press
2. Procedia Engineering 53, 2009**.** 19- "Sick Building Syndrome". Environmental Protection Agency, United States
3. ASHRAE .1989. Standard 62–89: Ventilation for Acceptable IndoorAir Quality, Atlanta, GA, American . Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc
4. Holdford D, Reinders T P. Development of aninstrument to assess student perceptions of thequality
5. Greeno, J.G. (1998), TheSituativity of Knowing, Learning, and Research, American Psychological AssociationInc, Vol.53, No.1
6. Jilk, Bruce (2002), Freedom and Creativity, Vol. 52, No.7, Available at: \www.designshare.com
7. Lippman, P. (2002), The L-Shaped Classroom: A Pattern for Promoting Learning, AIA, Available at: \www.edfacilities.org
8. PAWEL WARGOCKI*, DAVID P. WYON, JAN SUNDELL, GEO CLAUSEN AND P. OLE FANGER. Indoor Air 2000 .102013 . A. Norhidayahaو Lee Chia-Kuangaو M.K. Azharb18 و- S. Nurulwahidab .93-98
9. Yuexia Sun a,*, Yufeng Zhang a, LijinBao a, Zhenguo Fan a, Desheng Wang a, Jan Sundell .2006 . Effects of gender and dormitory environment on sick building syndrome symptoms among college students in Tianjin, China Building and Environment 68 (2013) 134-139
10. Bloom BS. John Wiley & Sons.1964.Stability and change in human characteristics.New York.
11. Wargocki, P. Wyon, D.P. Baik, Y.K. Clausen, G. and Fanger, P.O. 1999 .Perceived air quality, Sick Building Syndrome (SBS) symptoms and productivity in an office with two different pollution loads. Indoor Air. 9.165–179
12. CEN .1998. Technical Report CR 1752: Ventilation for Buildings:Design Criteria for the Indoor Environment, Brussels, EuropeanCommittee for Standardization
13. Sylwester, R. (2003), Skulls and School Boxes: Student Brains That Want Out, University of Oregon, NCEF, Available at: \www.edfacilities.org