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Designing a High Performance Indoor Environment for a Productive Generation

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Abstract

In the last few years, educationalist, researchers and ministries have increased the concerns in effect of the indoor environment on students' performance in schools, and several research have already shown that the Indoor Environment Quality (IEQ) acts as a fundamental issue that cannot be abandoned when aiming to achieve a sustainable school. Consequence of indoor environments attain both the level of productivity and the performance of students while sickness and illness that increases absents. Indoor air quality, natural and mechanical lighting, thermal comfort, ventilation and noise may result in either a healthy and comfortable environment or a noxious uncomfortable domain for students. Considering all aspects of IEQ, it is essential during the early stages of design to achieve a successful workable project, where all IEQ will interact together and affect the building operation. Organization of seating in the classroom and design of the openings will affect efficiency of natural lighting and acoustics; building mass will affect temperature, humidity and air quality; materials whether applied on interior or exterior will affect the IEQ. All these aspects should be considered when designing, monitoring and maintaining during operations to establish a healthy indoor environment for students, which will effect directly their health and performance in the school. The focus of this desktop study is to review literature to find answers to some of the relevant questions and to illustrate factors that can affect the educational process and productivity of students through the physical teaching environment.

Keywords - indoor environment; high performance buildings; productivity; sustainable schools; IEQ

1. Introduction

In the last few years educationalist, researchers and ministries increased the concerns in effect of indoor environment on students' performance at school and academic results, Indoor Environment Quality (IEQ) acts as a

fundamental issue that cannot be abandoning when aiming to achieve a sustainable school. Consequence of indoor environments attains level of productivity and performance of students, sickness and illness that increases absents. Air quality, natural and mechanical lighting, thermal comfort, ventilation and noise, results in either a healthy and comfortable environment or a noxious uncomfortable domain for students.

Considering all aspects of IEQ is essential during the early stages of the design in order to achieve a successful workable project, where all IEQ will interact together and affect building operation. Organization on seating in class room and openings design will affect efficiency of natural lighting and acoustics, building mass will affect temperature, humidity and air quality, materials whether applied in interior or exterior will affects the IEQ. All these aspects should be considered when designing, monitoring and maintaining during operation to establish a healthy environment for students, which will have effects directly on their health and performance at school.

2. Methodology

The aim of this study is to review and demonstrate the indoor environment factors that have effects on the productivity and performance of students and teachers in primary schools, while students' needs a special environment to be provided in order to live healthy and to become a productive generation. In the aim of designing sustainable healthy schools for a healthy students and society, major aspects of IEQ is characterised and discussed, as all the factors are related to each other and cannot be segregated from the complete system. The following questions are investigated:

What makes a school a productive factory for new generations?

How does the physical design of the school effect and impact on user's mood, achievements, productivity, personality and comfort?

What are the constituent that have mostly effects on students health, performance and achievement and how?

A selective number of research papers and articles were reviewed, experiments, observation studies and surveys have been selected and analysed in order to find answers, facts and results related to the selected topics as shown in the next section. The selected and reviewed papers are collected from difference confidential sources that have different methods of reviews, different layout designs and weather conditions, but they all have one objective of improving and providing a high quality performing indoor environment to achieve health, performance, productivity and comfort.

3. Indoor Air Quality (IAQ)

Certain circumstances including air temperature, radiation, poor ventilation, humidity and moist conditions may lead to a poor IAQ that can cause discomfort for school occupants. Controlling humidity in classrooms is

important in order to provide a welfare and a suitable environment. Low humidity causes eye irritation, dry skin and dehydration, whereas high humidity and moist conditions promote bacteria and germs that cause allergies to the occupants and may also cause severe damage in the structure and envelope of the building by forming mold. Accordingly, sufficient improvement in the scientific subject was observed on students aged from 6-12 particularly in mathematics and reading with an average of 4% when the rate of ventilation in classrooms was increased by 1 l/s using fresh air from outdoor [5, 30].

4. Chemical Pollutions

Children's body metabolism is higher than adults, hence they require a higher rate on oxygen for breathing and growing, and they are highly reactive to the increase of CO₂ levels in the air. A child who absorbs high rates of CO₂ will be affected with an unhealthy breathing habit that effects on his/her intelligence quotient (IQ) level, speech, behaviour and performance in the school [5, 28, 30]. There are several chemical pollutants that are found in the inside environment. Chemical pollutants are important topic of interest because there are a few major factors that affect not only the environment, but also human health as well, such as compounds like carbon monoxide and dioxide, total volatile organic compound, formaldehyde and ozone.

Carbon Monoxide (CO)

CO is a dangerous chemical compound that is found indoors. CO is a compound, which attaches itself to hemoglobin and much stronger than oxygen. The binding capabilities are extraordinary. CO attaches tightly to hemoglobin and great carboxyhemoglobin (COHb) [9]. The concentration of COHb should be less than 2.5%, which is considered to be a safe level [21]. However, when this concentration limit exceeded, it may have a negative impact on the basic organs of the body and cause oxygen deficiency. When this happens, this is called hypoxia as this causes the major organs and tissues not to have enough oxygen to function. Eventually, when there is enough CO generated, the respiratory and cardiovascular fails and causes death or illness [35]. Depending on the age of a person, the metabolic rate can vary. For example, children have a higher metabolic rate because they are young, and therefore, they use more oxygen than adults. If a child is exposed to high levels of CO, that may cause health problems for the growing child [20]. It can affect a child's nervous system and other neurological problems, such as memory failure and a lower IQ level. In addition, this poisonous gas can cause speech and behaviour issues, while a child may be prone to depression [x]. Although CO concentrations are lower than the US's Environmental Protection Agency (EPA) and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards, which is 9 ppm for 8-hour duration is considered not

to be such a threat. However, a prolonged exposure can be considered damaging. It is just as bad as the short-term exposure [26]. In fact, the amount of CO acts as a predictor of daily attendance rate in schools. A study had observed a daily rise in absence by 3.79% for every 1 ppm for elementary students. Students where the locations of schools are in high traffic density streets have a tendency of low academic achievement compared to those schools located in semi-busy areas (Egan and Reilly, 1981).

Ozone (O₃)

O₃ is just like any other molecule and can be entered from outdoors to indoors through ventilation means. For example, air-conditioning systems, windows, and doors. Sources for O₃ can be air purifiers, photocopy machines, and printers. Too much O₃ exposure can cause cough and chest pain on deep inhalation. It can also cause shortness of breath, eye, throat and nose irritation, which later causes increase in sensitivity to airborne allergens that cause respiratory infections and asthma at the very least [4]. O₃ has the tendency to react very quickly with other compounds, such as hydrocarbons and terpenes in the room because of their high oxidizing properties. The products of O₃ initiated indoors can result all kinds of harmful pollutants that is harmful to human health thanks to its combining properties [44].

Carbon Dioxide (CO₂)

In many research, scientific data is usually comprised of using adults as children are avoided since they are very sensitive. The exposure to CO₂ studies has some limits to them because of the government. Children studying in schools with carbon dioxide concentrations of 1,000 ppm or more are at serious risk of dry cough. In one study, in a Dutch school within 14 classrooms, high levels of carbon dioxide were recorded due to the bad odour complains, which was reported [33]. The complaints were symptoms of dizziness, tiredness, concentration issues, unpleasant odours, headaches and high carbon dioxide concentrations between 1,500 - 4,000 ppm in 22 classrooms in five Norwegian schools. As a result, there were high amounts of carbon dioxide found where there were symptoms of inflammation and irritation in the nose of children in the classrooms of the study undertaken [15]. As a result, the children's performance and academic achievement were greatly affected. The intensity of CO₂ inside schools and other indoor spaces depends on how the ventilation is. In addition, the number of students, the length of stay, and volumetric size of the space. In addition, CO₂ outdoor concentration and other elements of combustion, such as cigarettes, cars, heating systems, which cause carbon dioxide, was also important in the study [32].

Volatile Organic Compounds (VOCs)

VOCs are defined as organic compounds that are released from specific fluid or solid materials. There are outdoor and indoor components. VOCs can come from natural biogenic sources, such as human activity with power plants, chemicals, and vehicle exhausts [16]. The amount of VOCs can exceed beyond the outdoor levels because of restricted indoor capacity size, poor heating and ventilation systems of the indoors. HVAC systems and several indoor building contaminant sources, such as cleaning products, air fresheners, perfumes, and printer inks are all sources of VOCs, and usually come with an unpleasant odour [25]. VOCs can cause serious harm to human health, but this depends on the toxicity of the levels. VOCs are carcinogenic and a temporary exposure can leave one vulnerable to it. A continuous exposure can cause cancer to human health. In addition, they may cause mutagenic problems [40, 41]. VOCs are directly linked with the sick building syndrome (SBS) issues. Some of the health problems that are associated to VOCs are inflammation of the upper respiratory tract, eyes, headaches, nausea, faintness, a blurred vision, ataxia, loss of memory, and shortness of breath. It cannot only cause tiredness and irritation, but also damage the organ system, such as the kidney and liver. The harm and the nervous system can leave the victim with serious long-term health problems [40]. The term TVOCs in most scientific publications is used to cut through long list of terms of symptoms and pollutants, and classified under one name.

Total Volatile Organic Compounds (TVOCs)

TVOCs do not measure the amount of compounds there is. There is enough evidence that there is a strong correlation between the inhabitant's health and TVOCs concentration levels. The health problems can grow further depending on the amount [1]. The guideline for TVOCs is set by a toxicological background and has not been an easy task because of the ever-changing composition of the VOCs and the activity that is related to the indoor environment [24]. TVOCs guidelines limit the comfort range by 200 mg/m³ (53 ppb). Accordingly, the exposure to TVOCs concentration can cause eye, skin nose, throat, and mouth irritation if the concentrations reach greater than 666 mg/m³ (177 ppb) and result to a 50 - 90 % damage to those body parts.

Formaldehyde (CH₂O)

Formaldehyde is another organic compound, which is organic. It is also found indoors. Many manufactured goods contain formaldehyde and release it into the environment. It has no colour but can be flammable. The smell can be choking and not expensive, and is out to use by construction companies and manufacturing industries. The toxic nature of this compound can cause

cancer and measured separately than the TVOCs since it is a major health hazard [5].

Particulate Matters (PM)

An indoor level of PM in classrooms comes from the indoor environment. The indoor level of PM is related to the number of occupants and the activity, HVAC, general maintenance, cleaning, age of structures, the location of the building and furnishings. The cleaning walking and the shoes that people wear indoors can make a difference in the amount of PM [13]. The occupants of the buildings can bring in contaminants from the outside world. It is hard to point the exact source, but it is caused by mobility. Usually, it is the source that comes from the outside environment and it can cause an unpleasant odour. The particle size determines where it will settle in the respiratory tract [44]. The exposure will be a form of toxic element, which is of chemical and biological means deposited on the PM.

5. HVAC System and Poor IAQ

Using HVAC system in the buildings is appropriate to control heating, cooling and ventilation, but may also be critical due to its role of introducing fresh air into the filter and filtration of exhausted air since any breakdown in the system or reflectance in maintaining and monitoring can act as problem and may lead to a poor IAQ by allowing contaminants to pass to the indoor and the growth of mold as a result [34]. Time spend in a poor IAQ causes severe sickness and illness for occupants formed in breathing problems, sneezing, influenza, headache, fatigue and other diseases, also known as 'Sick Building Syndrome' (SBS) [34].

Measuring CO₂ concentrations in a particular space indicated the ventilation rates in that area, spaces that have high levels of CO₂ is improper for breathing and living. Numerous schools around the world, in different research, measured CO₂ levels have indicated that they are not properly ventilated (Fig. 1). In most cases, ventilation was the solution for improving IAQ in many schools, however method of ventilation have to be wisely selected in order to reach the main aim of it [13, 31].

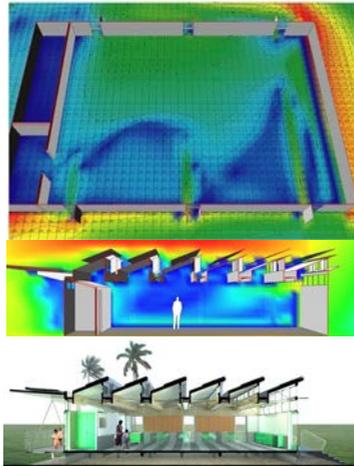


Fig 1 Natural ventilation air flow through classroom plan [2]

Beside mechanical ventilation, natural ventilation is required and is usually the role of the teacher as explained by Geelen et al. (2008) and they believe that pupils have to be involved in introducing better ventilation for their classroom through a themed game or program that is thought by the teacher to make them aware with the importance of ventilation for improving the quality of air inside the classroom, reducing moisture in the air and reducing amount of dust in classroom [13].

Monitoring IAQ

Indoor pollution can be monitored by simple passive diffusion samplers (Fig. 2) that indicates the amount of chemical pollution in the room during the measuring period. These devices are affordable and do not require electrical energy for operating.

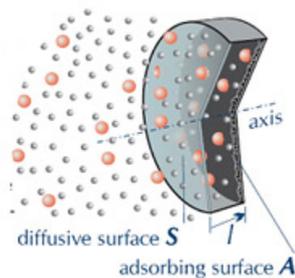


Fig 2 Description of diffusion sampler's structure [39]

The Best Duration and Period of Measuring

The best duration recommended for taking air samples is 5 days, during the hours that the school is operating and the users are practicing in their daily activities, where the air pollution will be different between the day time and the evening time as the school is closed. Moreover, other factors effect the results of sampling between day and night like the ventilation and the activities that are taking place at school [19].

Measuring the air pollution within 24 hours, for 7 days will lead to unreliable results due to the difference in factors and conditions between morning and evening times at school where windows and HVAC system is not in use. Moreover, variation in weather seasons will have effect on the results too where the temperatures and the rate of ventilation changes between summer and winter seasons. It can lead to an investigation for levels of pollution between different seasons in a year, however it's advisable to relay on the sampling that are undertaken during hot seasons, where levels of pollution are relatively higher [19].

Allocating Diffusion Samplers in Classrooms

For the best results and measurements, samplers are located in three different classrooms in the school that are mostly busy and in use (one sampler per classroom), the criteria for selecting the classroom that will be selected for sampling depends on the importance of these classrooms that they have a prototype system in terms of usage and function, these classrooms are common in the school building and are distributed on deferent levels of the school building.

Air sampling diffusers are placed in specific place from the ceiling that is near to the human level but do not interrupt the movement of students in class, at the same time, it should be placed in areas, which have low air movement and flow, it is not recommended to place it near windows and openings where high air flow is not required and it effects the results of the sampling. Evidences and observation shows that placing the samplers 1 m away from the wall and 1.5 m below the ceiling, for example on top of a cabinet is ideal [19].

Monitoring Outdoor Air Quality

It is essential to monitor the outdoor air pollution that is surrounding the school in the same ways of monitoring the indoors. The outdoor air transmits to the indoors through building openings and HVAC system, probably the outdoor pollution will transmit to the indoor and students will become vulnerable to contaminants and hazarded that is delivered by the outdoor air. In addition, traffic impact and surroundings shall be considered, a school

near to a busy street or industrial area is definitely exposed to more pollution than schools in different neighbourhoods [19].

There is substantial amount of research that reviewed and discussed the type and amount of light required in a classroom, the negotiation is whether it is possible to depend on the artificial lighting only. Generally, it is agreed that daylighting affects the mood and performance of the students and their grading level, as daylighting effects biologically on human beings in a positive way. However, depending on one source of light is not practical and convenient, using a hybrid system is more practical and appropriate in classrooms, where natural lighting levels are measured by sensors and artificial lighting is dimmed and controlled according the amount of light needed and amount of natural light available in the space [6]. In a research paper that was published by Knez (2001), the effect on light colours on students was studied, and Knez determined that males and females responded and acted differently against the colours of light; females reacted more emotionally and toward the warm white lighting, on the other hand, males acted positively on the cool light colours [22].

Daylighting

Many studies revealed the advantages of natural daylighting and its effect on improving students and teachers performance whether they were studying or working. Natural day lighting encourages students to be more active, prevents many diseases, reduces absents and cost saving. Many researchers and designers argued that daylighting should be considered and maintained from the very begging concept of the design, and should be an element that plays a numerous role in terms of school design [7].

Considering daylighting and introducing light into classrooms is the first step, however controlling day lighting in order to achieve comfort and avoid glare or other uncomfortable factors caused by day lighting is the critical point. Over doze of daylighting will increase the heat gain of the building, and this leads to intensive usage of cooling system to achieve thermal comfort. Building envelope and glazing have to be protected from direct exposure to sun light in active or passive methods. Studies proved that protecting the building from sun exposure and radiation externally is more effective than internally, insulation, light shelves, louvers; all these are some of the various innovative technologies that are effective in reducing the negative effect of day lighting. On the other hand, using artificial light is essential in some cases, where natural light is not available or efficient enough, but engineers should consider the amount and type of lighting used and to use less number of lighting fixtures, using high load of light can cause heat that reduces cooling efficiency in the room. Using a hybrid lighting system to control the lighting amount and the need for artificial lighting is

the smartest method can be applied, and the ideal method to control the lighting system in the school [7, 8].

Visual comfort is connected directly to lighting levels in classroom that allow students for a clearer vision and comfort. Moreover, daylighting minimises the user of artificial lighting and reduces the cost and energy required for lighting 30-70%. Natural day lighting enhances student's health by protecting them from diseases and is essential to for the growth of students. However, students studying in well-designed classrooms with good rate of daylighting showed 21% improvement in their performance than other students [34]. Innovative daylighting techniques increases the budget of the building, for that reason, it is essential to intensively study the location of implementing daylight strategies where they work the most for the comfort of the occupants and users (Fig. 3).

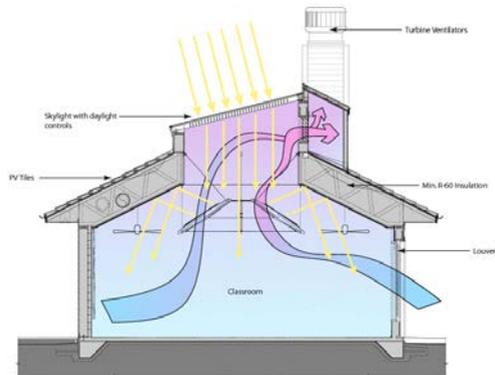


Fig 3 A customized by CPI daylighting skylight allow to control amount of light that enters to the classroom and filters it [45]

Classroom Openings and Connection to the Outdoor

Nowadays, physiological and biological researchers stated that window role is not limited to providing daylight; it also creates a connection to the outdoor views that demonstrates the value of learning, spans of vision toward the outdoor gives the eyes an opportunity to relax and relieve stress caused by reading and using computers for long durations, especially for children whose potential for vision is still developing and growing. Although, 1960's schools were designed with the minimum number of openings for the concept of avoiding distraction during class. Number of windows and openings does not mean providing good amount of daylight, direct solar radiation can cause discomfort and glare, diffused light contributes to comfort and clear vision. Efficient day lighting starts from a well-studied building orientation, a specified size and location for the windows provided, moreover using computer simulation software is beneficial for studying and

evaluating different options [34]. Skylights is the worst selection for introducing daylight into the school building, especially in hot climates where it allows for double and triple amount of radiation that passes through windows to enter into classrooms.

6. Thermal Comfort

One of the major issues that has effects on the thermal comfort is the radiant temperature of materials and surfaces in the classroom. It affects the thermal comfort of students and teachers in the classroom, as it was noticed that you will find students dressed in different clothes that varies from normal T-shirts to long sleeves and some wears jacket in the same classroom this behaviour in clothing expresses discomfort, you will find that students who are sitting near to the window and directed to the sun radiation is wearing short sleeves and feels hot, on the other side of the class students who might be directed to the AC feels cold and wears long sleeves and even jackets, this expresses a certain condition of unbalance in the class thermal condition and absence of comfort.

Interior materials used in the indoor effects the radiation and heat transfer in the classrooms where some materials have high radiant emitting while others not; also used colours in interior space effects the amount of absorption and reflection of heat. Generally, HVAC system is used in indoor spaces to control the indoor temperatures, however other factors effects the controlling of indoor temperature using HVAC system including exposure to sun, humidity, outdoor temperatures, wind velocity, thermal massing and building envelope, and mostly important the activities that is taking place in the indoor spaces of the school [17].

Relative Humidity (RH)

Relative humidity has a direct impact on the comfort of occupants, for that reason, it is essential to control relative humidity inside classrooms to achieve appropriate indoor air quality and thermal comfort. Dry air with low relative humidity causes skin and eyes dryness, meanwhile humid air and high temperatures may lead to growing of bacteria that causes skin allergy. High humidity levels forms moist that affects the buildings structure and elements causing damages in the skin envelope by forming bacteria and molds on the moist surfaces; these contaminants expands and grows effecting not only the paint face, it can reach to the main structure of the building in some cases. When mold occupies the space it creates a bad smell, in addition to a poor indoor air quality that affects the health of student sand causes many diseases [3, 5].

7. Acoustic Comfort

Researchers found out that listening ability of children is primitive comparing to adults and they need quieter environment for concentration and understanding, and their mentality is limited in recognizing sounds especially in noise. Students aged under 13 requires background noise which is less than the signals that they need to hear like the voice of the tutor, and when students have a temporary ear illness or attention issues they even require a quieter environment in order to hear and understand the voices clearly [8]. One on the major factors that has effects in the levels of noises is the transmitted noise from the surrounding area through building openings and poor insulated walls. A school which is located in a busy neighbourhood or near to an airport or a highway will definitely require a different remediation to reduce the noise emitting to the building [17].

Outdoor is not the only source of noise in school building, to reduce the amount of noise in the indoor spaces many factors shall be considered including the indoor factors and the outdoor factors. Using certain material that have low absorption coefficient may reduce the amount of noise like acoustic tiles, carpets and insulation materials. Considering a well-maintained and monitored HVAC system is essential to reduce the noise caused by machines that causes uncomforted and distraction in the classrooms [14].

8. Physical Environment of the School

The physical design of the school and classroom has a major contribution on the psychological feeling of students. Recently, designers are moving toward the open plan school for its social and physical contribution on students' education and reaction, the organization of the studying desks also is considered and whether they were arranged in a single order or double rows. Classrooms that have higher ceiling have acoustical problems, although it provides better amount of natural lighting [10, 16]. It was obvious that classrooms with lower ceilings effected psychologically on the behaviour of students and made them show more collaboration among other students in higher ceilings [36, 43]. Classrooms are considered the basic element of school design, and the space that is mostly busy where students spend most of their learning time, for that reason considering a pleasing design for the classroom is essential, using attractive and comfortable colours, soft materials, and innovative designs increases their ability of learning and interest in the school. Level of participating and asking questions in class increased comparing to students staying in normal classrooms [12, 16].

Classroom Seating and Physical Layout

One of the major factors that may affect students comfort and productivity in classroom is the arrangement of their seating's and classroom layout weathers it is a single, double row system or clusters (group desks). The location and type of desks effects students' vision, hearing and comfort. Many educational specialists studied the effect of different types of seating on students' achievements and ability to learn, they found out that row system is appropriate for individual tasks were less interaction is formed and concentration is increased, hence enhanced thermal condition in classes can be noticed due to the limited interaction between students and teachers [14]. Clustered seating layout is most common in primary schools, this form of seating allows for interaction between students and enhances their productivity level and encourages teamwork. Moreover, it is noticed that students participating in class and asking questions increases. New school designs recommends using ergonomics design and equipment which is flexible type of furniture and learning facilities that adapts to human body and needs to ensure the comfort of occupants in the school, different students have different bodies and heights, ergonomics chairs and tables are flexible where the legs height and backseat can be fixed and adjusted according to the students body, adapting the new strategy will promote extra comfort and adjustment for the users [27].

Shelves and Cupboards in Classrooms

Providing a lot of shelves and storing spaces in the classrooms may conflict with the concept of achieving good indoor air quality, because of the dust that will be collected on the top of these shelves that have displays and books on top, regular cleaning is required to prevent the diseases that is caused dust leading to an poor air quality [29]. Cleaning classrooms can be schedulable and students may participate in this. It is important to locate the shelves away from windows openings and in front of HVAC system, these areas collects more dust on fixtures surfaces. Black boards is one of the main sources of dust produced by chalks, many students and specially teachers suffer from breathing problems and sensitivity that is caused by the chalks, using white board instead of blackboards is a good solution, or blackboards have to be cleaned daily with a wet wipe to collect the dust.

9. Conclusions

Researchers and educationalists distinguished many factors in learning environment that have effect on school users, these elements includes air temperatures, lighting levels, air quality and noise, cause illness, distraction, comfort, absentees and at the end poor productivity. Unlike adults, physical conditions of pupils can simply be affected by the unhealthy indoor

conditions, because of their weak bodies and immune system that is in the stage of growing.

Students in primary and elementary schools are at risk of getting infections due to their young ages, promoting high level of indoor environment quality is essential, to protect students from illnesses and subjection to pollution, contaminants and hazards by applying the best strategies of promoting indoor environment quality.

The research indicates that air quality, air temperatures, and thermal comfort (heating and cooling) are the main factors effect on pupils' achievement. Persistent noise weakens performance in addition to causing reading abilities and communication skills. According to researches colours in indoor environment effects the mood and behaviour of students, however they act differently in different coloured spaces according to age and gender. Selection of interior colours depends in the function of the interior space, student's age and gender. Visual comfort in all its aspects that is discussed in the research is highly important and cannot be ignored, connection to the outdoors increases students' creativity and abilities to explore, day lighting increases their educational achievements and grading, many researches, studies and experiments proved this fact. Excellent indoor environment can be obtained by increasing air exchange rates with considering the thermal conditions of the classrooms to prevent negative effect on the air temperatures in the space, ventilation methods and equipment's should be with a high quality and performance. The prospective plan for schools should include applying smart systems and intelligent building systems achieve an eco-sustainable school that insure comfort for occupants, moreover building facilities and services should be designed to be easily cleaned and maintained on a regular basis to prevent sick building symptoms.

Finally, new trends and the awareness of the importance of providing high indoor environment encourages the idea of involving the end user in the process of designing the school, where a connection between the architect and the end user creates a complete design that is served in terms of design, services and architecture, at the same time provides the need of the message of education and designing a high performance indoor environment for a productive generation.

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