

Problems Associated with Indoor Air Quality (IAQ) in Classroom and Recommended Approaches

M.A. Suhaimi
Universiti Tun Hussein Onn Malaysia
GN150007@siswa.uthm.edu.my

M.A.A. Rahman, M. Awang, Z.A.Akakah
Universiti Tun Hussein Onn Malaysia

N. Hashim
Universiti Teknologi Malaysia

Abstract

School has become a major center of education and development of children in many countries around the world. During the school day, majority of the students spend most of their time in school in the classroom. Therefore, it is very important for the school to ensure that every classroom has good indoor air quality. Imbalance IAQ can contribute to Sick Building Syndrome (SBS) as well as Building-Related Illness (BRI) and thereby affect the health and productivity of students in the classroom. This situation certainly does not reflect the national education goals which aim to produce a good and perfect human capital with good features through a series of effective education. Therefore, this study aims to discuss problems related to IAQ and measures that can enhance the quality of indoor environment of a classroom at school. As a result, the study found that the most common problems associated with IAQ adversely affect the health of students and their performance. Meanwhile, a good quality of indoor environment in the classroom can be achieved through an emphasis on good design, construction and renovation of buildings as well as continuous maintenance practices. In conclusion, a good classroom environment will have a beneficial effect on health and thus can increase the productivity of students.

Keywords: Air contaminants; Classroom; Indoor Air Quality (IAQ); Health; Student performance

1.0 Introduction

Over the past decade, attention has been directed toward the problem of indoor air quality. It has become increasingly clear that exposure to indoor air pollution may not only unpleasant, but can have adverse health effects are serious. Children may be more likely than adults to be affected by indoor air pollution (Sofuoğlu, 2011). Children breathe a greater amount of air relative to their body weight, and this can lead to a greater burden of pollutants in their bodies. In addition, children are less likely than adults to understand and clearly communicate their symptoms. Comfortable issues can also affect children. These issues can include too hot or too cold and this can cause them to become restless or sleepy while displaying other symptoms as a result of poor indoor air quality.

In schools, the percentage of children exposed to indoor air quality problems is much higher (Fraser, 2015). Although the school has become a platform for sharing knowledge, but the school also has the potential to become a platform for the diseases to spread rapidly among them especially in their learning environment. The learning environment is an important element that needs to be addressed in our efforts to improve learning outcomes. According to Fraser (Frenzel *et. al.*, 2007) the learning

environment is a place of teaching and learning, whether in the context of social, psychological and pedagogical that can influence student achievement and attitude. A conducive environment is said to help the learning process went smoothly. There are many aspects that lead to conducive environments during teaching and learning processes (Syazwan *et. al.*, 2012) includes the quality of the internal environment of the classroom (Che Nidzam *et. al.*, 2009). The study was performed on the learning environment shows that there is a relationship between indoor air quality and student learning outcomes in terms of performance, comfort, or student success. While, Colbeck and Nasir (2010) said, there are many factors that determine the quality of the learning environment and one of the most important aspects related to indoor air quality.

Indoor air quality (IAQ) is broadly defined in various forms. IAQ is a term referring to the air quality in the building and around the buildings related to the health and comfort of building occupants. According to the definition by the National Health and Medical Research Council (2003), the indoor air is defined as air within a building used for at least one hour by occupants of varying states of health. This can include the office, transport facility, shopping centre, hospital, house and classroom. ASHRAE (2004) has defined the indoor air quality is acceptable when 80 percent of the residents in the building feel comfortable and do not suffer from health problems while in the building. Poor IAQ can cause health of students and teachers distracted and cause discomfort during the teaching and learning process. This will cause problems to student achievement and poor perspective to the school itself in general. Thus, the effect of indoor air quality is one of the most important aspects of the teaching and learning environment that can be carried out smoothly.

1.1 Relationship Between IAQ And Learning Environment

Development and advancement of education in the country today are very encouraging. Our physical developments were included in the category of developing countries in the field of education. However, good physical developments not only complete with advanced equipment or facilities, but need to consider the quality of air movement in the building (Maimunah *et. al.*, 2009). Without good indoor air quality, the occupants of the building, especially the students will have an impact.

Table 1: Minimum ventilation rates in breathing zone

Category	People outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Default values				Air Class
	cfm/person	L/s*person	cfm/ft ²	L/s*m ²	Occupant Density #/1000 or #/100 m ²	Combined Outdoor Air Rate ft ²	cfm/person	L/s*person	
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9	25	17	8.6	2	
Classrooms	10	5	0.12	0.6	25	15	7.4	1	

(ages 5-8)								
Classroom	10	5	0.12	0.6	35	13	6.7	1
(age 9 plus)								
Lecture classroom	7.5	3.8	0.06	0.3	65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3	150	8	4.0	1
Art classroom	10	5	0.18	0.9	20	19	9.5	2
Science laboratories	10	5	0.18	0.9	25	17	8.6	-
Wood/metal shop	10	5	0.18	0.9	20	19	9.5	2
Computer lab	10	5	0.12	0.6	25	15	7.4	1
Media center	10	5	0.12	0.6	25	15	7.4	1
Music/theater/dance	10	5	0.06	0.3	35	12	5.9	1
Multi use assembly	7.5	3.8	0.06	0.3	100	8	4.1	1

According to the National Institute for Occupational Safety and Health Hazard Evaluation Report (NIOSH, 2011), the acceptable criteria for temperature in a room is between 23–26 °C at humidity 35 – 65 %. The average air movement to the occupied space not exceeding 0.25 m/sec. Air velocity below 0.07 m/s will give the students and inmate a sense of discomfort in the body. ASHRAE Standard ventilation for acceptable indoor air quality should be tailored to the local air temperature conditions to obtain cozy air as shown in Table 1 (ASHRAE, 2014).

In clarify the relationship between indoor air quality and learning environment, there is no means of institution that is successful up to the world class achievements but hailed their own students and staffs do not feel proud and excited to perform task due to health problems resulting from poor indoor air quality. This is very important especially when most students spend more time at work than at home.

1.2 Sources of Indoor Air Pollutant in the Classroom

In general, the quality of indoor air pollution comes from a variety of sources, such as temperature, dust, fungi, insects, carbon monoxide, bacteria or virus, ventilation, and chemicals. Scientifically, this contamination occurred as a result of the pollutants found in the air, known as air pollutants (Rahman *et. al.*, 2014).

In a typical building like school, pollutants fall into two source categories (Simoni *et. al.*, 2010). The first source is those that enter the building from the outside while the other source is those generated within the building itself. Both include various types and origins. Outdoor sources can include building stack exhaust, vehicle emissions, industrial processes and construction activities, as well as many others. Internal sources include maintenance or housekeeping activities, chemicals, cleaning agents, solvents, building renovation, new furniture, new materials, office equipment and various activities of the occupants.

ASHRAE (2004) defines the indoor air quality is acceptable in which the concentration of airborne contaminants are not harmful as suggested and when exposed to it, the majority of residents (80% or more) showed no discomfort. Industry Code of Practice on Indoor Air Quality (DOSH, 2010) reveals some parameters that indicate the status of air quality are:

- The content of substances such as carbon dioxide, carbon monoxide and formaldehyde.
- The physical conditions such as temperature, velocity and humidity.
- Biological agents such as viruses and spores.
- Radiation such as radon.

Syazwan *et. al.*, (2012) suggested that air pollutants can be categorized into three major classes of solid, liquid and gas. The three main classes of pollutants directly or indirectly would change the segment or element of the environment if pollution levels exceed the allowable concentration levels.

Suspended Solids. Biological contaminants consist of House Dust Mite (HDM), fungi and fungal, bacterial and viral contaminants.

Organic Materials. Consist of Environment Tobacco Smoke (ETS), Total Volatile Organic Compounds (TVOC), benzene, formaldehyde, chlorinated hydrocarbons and pesticides.

Inorganic Materials. The contaminants include inorganic carbon dioxide, radon, asbestos, metals and particulate matter.

1.3 Problems Associated with IAQ in Classroom

Problems associated with IAQ in classroom arise from several factors which are always correlated with the levels of atmospheric conditions such as humidity, atmospheric stability and wind speed and direction. Quality environment can be achieved if the learning environment is designed and prepared well and meets the criteria in line with the needs of students and curriculum goals. Imbalance learning environment such as poor air quality will contribute to the problems on student health and productivity of students in the classroom (Fraser, 2015).

Health effects

Poor indoor air quality can cause various health problems in short and long term. Health problems usually associated with poor indoor air quality include allergic reactions, respiratory problems, eye irritation, sinusitis, bronchitis and pneumonia (Rahman *et. al.*, 2014). This problem also occurs in buildings which include mechanical ventilation systems and air conditioning (MVAC) including split air conditioning units (Chin Meng *et. al.*, 2015). In addition, the code of practice also explains the health impacts resulting from these problems, which are:

- Health effects caused by environmental tobacco smoke (ETS)
- Sick Building Syndrome (SBS)
- Building related illnesses (BRI)
- Legionnaire's disease

As a result of polluted indoor air quality, someone could have trouble on the skin such as itching, allergies and so on. In addition, it also causes irritation to the eyes, sinusitis, stimulus asthma, headache and body becomes weak. Daily inhalation of contaminated air in the classroom, the

individual will experience up to get sinusitis sneeze and cough (Kim *et. al.*, 2013).

Unhealthy air can also cause problems for asthma because the fine particles contained can reach up into the lungs. If it persists, it can cause bronchitis and other health problems related to the lungs. Infection can also be spread through the air quickly spread like tuberculosis, influenza, SARS, anthrax and other biological manure if ventilated and not destroyed completely (Elsom, 2014). When one of the students had symptoms of virus or bacterial infection, duration of infection to others actually took place a few days before that. If a mechanical ventilation system is not working well for the air filter, the bacteria or virus that is easily spread to others. Humidity and moisture problems in the walls, floor and ceiling of the room can be a distribution such as *Aspergillus* and *Penicillium* spores that can affect the health of students and teachers (Fang *et. al.*, 2004).

Performance and productivity

At school, students spend most of their time in the classroom. Therefore the quality of the learning environment is very important (Fraser, 2015). Environmental quality of teaching and learning can be a contributing factor to the problem students. Among those to be considered are as layout of the classrooms, classroom size, furniture provided, and lighting as well as indoor air quality. Poor air quality may affect the performance of a student. This is because the learning environment will become uncomfortable because of the difficulty in getting fresh and clean air. Students will feel lazy, lethargic and sleepy. Students also will be less focused on knowledge. Some students who receive health impact will be on sick leave and this affects their learning process (Hulin *et. al.*, 2010).

2.0 Strategy to Overcome and Recommendations for Improvements

Several strategies have been recognizing as the steps to overcome and improve the indoor air quality in learning environment. Among the strategies and recommendations by Rahman *et. al.*, (2014) are:

- Check the air quality of their premises regularly and periodically. Open the window at least three times every day to 'dilute' the contaminated air.
- Maintain and cleaning the mechanical ventilation regularly
- Make sure the furniture layout promotes ventilation.
- Use the natural or environmentally friendly cleaner and fragrances. The use of cleaning agents or non-chemical alternatives is very good for removing stains and reduces chemical pollution.
- Use the tools that can trap and kill bacteria, fungi and microorganisms and clinically proven.
- Use Local Exhaust Ventilation with air filter High-Efficiency Particulate Arrestance (HEPA)

In short, even though these strategies and recommendations in providing good indoor air quality have been said earlier but the same situation follows suit. If there is no cooperation and awareness from all parties it will be difficult to overcome this matter.

3.0 Conclusion

Air pollution does not only happen in the outdoor air, but also occur in indoor air. Effects of indoor air pollution could lead to poor indoor air quality of a building. Poor indoor air quality is listed as unsatisfactory environmental threats to students and school members. This is likely due to contaminated air sources of pollutants such as organic, inorganic and biological materials. These contaminants are easily found in schools buildings or classrooms. Continuous exposure to substances that pollute the indoor air quality is likely to affect health, such as irritation of the eyes, sinusitis, asthma, headaches and possibly cause cancer. Sensitivity to ensure internal ventilation is always on the recommended standards is everyone's responsibility, including students and inmate in the building. Therefore, it can be concluded that the internal environmental factors need to be addressed as they plays an important role in influencing the health and productivity of students.

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