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Investigation of particulate matters of the university classroom in Slovakia

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Abstract

University students spend most of their time in classrooms that do not always represent an ideal environment for education. This is mainly due to the fact that most university buildings in Slovakia are old. Classrooms can be contaminated by various indoor pollutants, such as allergens, particles, volatile organic compounds etc. Indoor air pollution can lead to long-term and short-term health problems for students and staff but also can lead to decreasing productivity. It is therefore essential to deal with the monitoring of indoor environmental quality in universities in Slovakia and propose realizable measures to improve this situation. The aim of this study is to investigate the particulate matters. The measurements were carried out in the university classroom during lessons. These measurements were repeated during to lessons carried out once a week for the duration of one month. Handheld 3016 IAQ - device was used for determination of particulate matter concentrations. Air temperature and relative humidity was set with multifunction device Testo 435-4. Questionnaire survey based on subjective perception of indoor environmental quality was also performed during this study. Students fill in these questionnaires at the beginning and at the end of lessons. Analysis was used for investigation of occurrence of PM concentrations and subjective evaluation of students.

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Keywords: particulate matter, indoor environmental quality, perceived air quality, classroom

1. Introduction

Indoor environment quality (IEQ) is considered as an indicator of the level of comfort which is not confined to the thermal conditions, it includes elements such as thermal comfort, acoustic comfort, indoor air quality and visual

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comfort [1]. Balancing energy performance and IEQ performance has become a conventional tradeoff in sustainable building design. In recognition of the impact IEQ performance has on the occupants of educational facilities, universities are increasingly interested in tracking the performance of their buildings [2]. Nearly zero emission or nearly zero energy buildings are main goals in various country roadmaps for 2020 [3]. Thanks to energy building certification, more Low energy buildings are being built with regard to this, we must point out that: a low energy building does not always correspond to high indoor comfort quality [4]. Exposure to particulate matters (PM) has been associated with higher rate of morbidity and mortality in urban areas and World Health Organization's International Agency for Research on Cancer (IARC) has classified PM component of air pollution as a carcinogen [5]. Pollution of the atmosphere continues to be a global concern for scientific research, environmental health and climate change. The control of air pollution over the past fifty years has seen the achievement of significant improvements in the quality of air, particularly in the urban environment [6]. Particulate matter is a key indicator of air pollution brought into the air by a variety of natural and human activities. As it can be suspended over long time and travel over long distances in the atmosphere, it can cause a wide range of diseases that lead to a significant reduction of human life. The size of particles has been directly linked to their potential for causing health problems. Small particles of concern include "inhalable coarse particles" with a diameter of 2.5 to 10 μm and "fine particles" smaller than 2.5 μm in diameter [7]. PM has well-known negative health effects on humans. PM exposure occurs mainly indoors because people spend most of their time inside buildings, especially in their homes [8]. Global climate change and increasing energy requirements have led to the development of energy-saving buildings typically characterized by low air-exchange rates. Given that people may spend more than 90% of their time in such enclosed spaces during the main activities of living, working and transportation, the investigation of indoor air quality (IAQ) in these micro-environments is of paramount importance [9]. High concentrations of air pollutants in ambient air may cause acute or chronic health effects, and even cause premature deaths in the elderly people and people with asthma; thus, the air quality forecasting studies became an important research topic for public health. A wide range of operational alert systems have been developed utilizing statistical and hybrid models, to take precautions before and during air pollution episodes [10]. Many studies deals with measure the indoor air quality in classroom. In study [11] was measure the indoor air quality in classrooms with special emphasis on particulate matter (PM_{10}) and carbon dioxide (CO_2) and the impact of cleaning and ventilation. Another study [12] reports particle mass and number concentrations and student exposure in classrooms in three secondary schools in Lublin, Poland, during the winter (February–March) and summer (May–June) season measurements. Research [13] was conducted at three selected schools in semiurban areas of Bandar Baru Bangi and Putrajaya, Malaysia to investigate the influence of the local surroundings on the IAQ in the school classrooms. The concentrations of gas pollutants (CO, CO_2) and particulate matter (PM_{10}, $PM_{2.5}$ and PM_1) have been determined using automatic portable indoor air spectrometers. The purpose of another study [14] was to measure and compare the indoor concentration levels of particulate matter ($PM_{2.5}$ and PM_{10}) in order to find out the spatial and seasonal variations across Gaza strip schools. Study [15] evaluated indoor PM concentrations on different microenvironments of three rural nursery schools and one urban nursery school, being the only study comparing urban and rural nursery schools considering the PM_1, $PM_{2.5}$ and PM_{10} fractions (measured continuously and in terms of mass). Outdoor $PM_{2.5}$ and PM_{10} were also obtained and I/O ratios have been determined. Passive sampling methodology was applied in another study [16] to collection of PM in classrooms of urban and rural primary schools. The samples were taken during a year by passive deposition allowing the study of seasonal variability of the particles masses and chemical content. Another study [17] presents an assessment of schools' indoor environmental quality, based on investigations carried out in three Italian classrooms in Treviso, in the North-East of Italy. Portugal study [18] presents an alternative approach using different ventilation systems. This system was applied in a part of a school building and the indoor environment was monitored during two months. Studies have been showing strong associations between exposures to indoor PM and health effects on children [15]. This study aimed at investigating the particulate matters in university classroom. The measurements were carried out in the university classroom during lessons and repeated once a week for the duration of one month. Subjective perception by questionnaire survey of indoor environmental quality was also performed during this study.