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Original article

Indoor Air Quality Assessment at Biga Vocational School

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Abstract

Indoor air quality (IAQ) has gained significant importance by affecting health and occupational safety with the increase in time spent in indoor environments. In this study, IAQ at Çanakkale Onsekiz Mart University Biga Vocational School was evaluated and air pollutants such as particulate matter (PM), total volatile organic compounds (TVOC) and formaldehyde (HCHO) were examined in various indoor areas such as classrooms, canteen, corridors, laboratories and conference hall. Measurements were carried out using PCE RCM 15 Air Quality Measurement Instrument over multiple periods. The results show that PM concentrations were generally within acceptable limits but increased with student density and long-term occupancy. The intermittent exceedance of recommended TVOC thresholds underscores the necessity for enhanced ventilation strategies, particularly during periods of peak occupancy. HCHO levels remained low, indicating appropriate material selection in building construction and furnishing. The study emphasizes the necessity of periodic monitoring, optimized ventilation and awareness programs to improve indoor air quality and provide a healthier learning environment. Additionally, indoor temperature and humidity values were also measured and evaluated. The measurement results are thoroughly analyzed in the final section.

Keywords: Indoor Air Quality All, Occupational Health and Safety, Volatile Organic Compounds, Formaldehyde.

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INTRODUCTION

The living and non-living environment in which people live their lives throughout their lives is called the environment. Living and non-living environments cannot be considered independently of each other and are in constant harmony and interaction. Since the day man existed, he has used his environment to continue his life and continues to use it. When the environment is left to itself without outside intervention, it continues its existence in harmony. However, with the Industrial Revolution, living conditions all over the world have started to change. Although excessive and unconscious use of resources did not seem to be a problem at first thanks to the self-renewal feature of nature, this situation started to force the self-renewal capacity of nature over time and led to environmental problems. These problems, which are mainly caused by industrial activities, vehicle use, energy production from non-renewable sources, and improper waste management, grow with human impact and cause air pollution (Ağacan, 2014).

With the development of technology in the age we live in, the time spent in the natural environment has decreased compared to the previous generation, while the time spent with machines has increased. Since people generally spend more time in indoor environments instead in natural environments, it has become important to evaluate indoor environmental quality in terms of occupational health and safety. Barbaroğlu (Barbaroğlu, 2015) examined the indoor air quality in kindergartens for children who are more sensitive to the negative effects of air pollution than adults. Bulut (Bulut, 2012) analyzed indoor air quality and ventilation by measuring the amount of CO2 in different environments such as residences, offices, and classrooms. Güllü (Güllü, 2016) evaluated the indoor air environment quality in primary schools due to increasing asthma and respiratory diseases in children and made recommendations. Orhan and Kaya (Orhan and Kaya, 2016) analyzed indoor air quality and ethics in LEED-certified green buildings. Güneş et al (Güneş et al. 2015) examined the indoor air quality in Marmara University Central Library. Çibuk and Işık (Çibuk and Işık, 2015) made measurements on indoor air quality in Tunceli University's central canteen and dining hall by considering carbon dioxide, indoor air temperature, and relative humidity as indoor air quality parameters and presented various solutions and suggestions for improving indoor air quality. Başer and Kalıpçı (Başer and Kalıpçı, 2019) stated that the second most important environmental problem experienced in cities after water pollution in Turkey is 'air pollution' problem, which appears as the first, second or third priority environmental problem in 67 cities in total, and when the average SO2 measurement results for January 2016 are classified according to the air quality index; 69 cities are in the "1-good" class and according to PM10 measurement results, 12 cities are in the "3-sensitive", 37 cities are in the "2-moderate" index bracket and 24 cities are in the "1-good" class.

Air, which is as vital as water and nutrients for living things, is a mixture of 78.09% nitrogen, 20.95% oxygen, 0.093% argon, and 0.03% carbon dioxide gases that make up the atmosphere. In normal air, smoke, sulfurous, nitrogenous gases, and dust particles are either present in trace amounts or not present at all (Zencirci and Işıklı, 2017). Air pollution is defined as air pollution, that adversely affects the health of living things and is defined as the amount and density of foreign substances in the air reaching above normal, EPA (Environmental Protection Agency = US Environmental Protection Agency) defines air pollution as "the presence of pollutants in the air in a way that harms human health or well-being or creates other harmful environmental effects". The World Health Organization (WHO), on the other hand, defines air pollution as "the presence of substances in the outdoor atmosphere that is harmful to humans and the environment". Air pollution, one of the world's leading health risks, ranks fourth among fatal health risks after metabolic risks, nutritional risks, and smoking. Air pollution caused by air pollution is divided into two outdoor air pollution (atmospheric pollution) and indoor air pollution. When indoor air pollution is compared with the outdoors, it is seen that the indoor environment is 70 times more polluted than the outdoor environment (Ceylan, 2011).

Indoor Air Quality is defined as the characteristics of the factors that determine the quality of indoor and outdoor air. Air pollutants are particulate matter (coarse particles (PM10) and fine particles (PM2.5, PM1) and general gases (carbon monoxide (CO), carbon dioxide (CO2), Sulphur dioxide (SO2), nitrogen dioxide (NO2), ammonia (NH3), ozone (O3), gaseous hydrocarbons (HC), and volatile organic compounds (VOC). Particulate matter, which has an important place among air pollutants, consists of solid and liquid particles suspended in the air. Particle size is usually expressed in aerodynamic diameter; particles with diameters larger than 2.5µm (micrometer) are called coarse particles, particles smaller than 2.5 µm are called fine particles, and particles smaller than 100 nm (nanometer) diameter are called very fine particles. At the same time, particle size is also used when talking about adverse health effects. Particles larger than 10 µm in the respiratory tract are retained in the nose. Those smaller than 10 microns can cause the biggest problem and go deep into the lungs. Studies on the subject have shown that high levels of PM10 in the air can lead to cardiovascular diseases such as stroke, premature death, asthma attacks, decreased lung function, respiratory tract irritation, and heart failure, especially decreased lung function (Çağlar and Aygün, 2021).

Humidity and temperature values are also taken into consideration when determining indoor air quality. Indoor temperature is important for ensuring thermal comfort. The temperature between 20 °C and 25.5 °C is determined as the limit values by WHO and these values are taken as reference in Turkey. Another factor affecting thermal comfort is humidity. The humidity value measured indoors is the relative humidity (RH) value that gives the maximum amount of water that the air can carry. The appropriate indoor humidity rate is specified by WHO as less than 70% (Çağlar and Aygün, 2021). The temperature and relative humidity values of the indoor environment should be considered together

(Caner et al.2017). Table 1. shows the air quality index for 5 basic pollutants that the Ministry of Environment and Urbanization of the Republic of Turkey has created by adapting to the National Air Quality Index, EPA Air Quality Index, our national legislation, and limit values. These are particulate matter (PM10), carbon monoxide (CO2), Sulphur dioxide (SO), nitrogen dioxide (NO2) and ozone (O3).

Table 1. Republic of Turkey Ministry of Environment and Urbanization Air Quality Index

Air Quality Index (AQI)	Health Concern Levels	Colors	Meaning
0-50	Good	Green	Air quality is satisfactory, air pollution poses little or no risk.
51-100	Moderate	Yellow	For a very small number of people with favorable air quality but unusually sensitive to air pollution, moderate health concerns may arise for some pollutants.
101-150	Sensitive	Orange	Health effects may occur for sensitive groups.
151-200	Unhealthy	Red	Everyone may start to experience health effects, and there may be serious health effects for vulnerable groups.
201-300	Bad	Purple	It may constitute a health emergency. The entire population is likely to be affected.
301-500	Dangerous	Brown	Health alert: Everyone may experience more serious health effects.

Table 2. National Air Quality Index Cut-off Points

Indexes	AQI	SO_2 [µg/m^3]	NO_2 [µg/m^3]	CO [µg/m^3]	O_3 [µg/m^3]	PM10 [µg/m^3]
		1 Sa. Centre	1 Sa. Centre	8 hours. Centre	8 hours. Centre	24 hours. Centre
Good	0-50	0-100	0-100	0-5500	0-120	0-50
Moderate	51-100	101-250	101-200	5501-10000	121-160	51-100
Sensitive	101-150	251-500	201-500	10001-16000	161-180	101-260
Unhealthy	151-200	501-850	501-1000	16001-24000	181-240	261-400
Bad	201-300	851-1100	1001-2000	24001-32000	241-700	401-520
Dangerous	301-500	>1101	>2001	>32001	>701	>521

Prolonged overexposure to the volatile organic compound TVOC can lead to adverse health effects such as headaches, dizziness, fatigue, nausea, liver and kidney damage, and cancer (Güllü, 2016). Formaldehyde HCHO, which has a very common usage area, has damages that adversely affect social life during the day such as itching in the eyes, nasal congestion, asthma attacks, snoring, skin rash, drowsiness, dizziness, but the biggest harm is the risk of cancer (Işık and Zencirci Akbulut, 2017). Sofuoğlu (Sofuoğlu, 2016) investigated indoor air pollutants and the effect of pollutants on human health in his study on indoor air pollutant concentrations in schools and the effect of pollutants on human health and school success. He mentioned the importance of paying attention to ventilation standards to protect

the health of children in our country and mentioned the need for anti-pollution practices. Menteşe and Çotuker (Menteşe and Çotuker, 2021) measured monthly indoor and outdoor air quality at different sampling points in three districts of Çanakkale, namely Çan, Lapseki and Centre. They concluded that it is possible to reduce the effect of indoor pollutant sources by adequate ventilation in indoor environments. Yılmaz and Sarıahmetoğlu (Yılmaz and Sarıahmetoğlu, 2023) analyzed the results of indoor air quality measurements in areas where university employees and students spend their time in a state university. They analyzed the results from an occupational health and safety point of view, evaluating them in terms of engineering measures and proposed solutions. Şişman (Şişman, 2019) regularly monitored air pollution at national air quality monitoring stations located around a thermal power plant in Turkey using imported and lignite coal as fuel. He concluded that air quality monitoring has a share in the improvement of air quality and emphasized that more work should be done to improve the air quality of all regions.

Table 3. Limit Values for TVOC-HCHO Level and Measures

Index (GFEA) ($\mu g/m^3$)	Index (WHO) ($\mu g/m^3$)	Health Level	TVOC-HCHO Precautions
<300	<250	1. Very Good	Targeted Value
300-1.000	250-500	2. Good	Ventilation is recommended.
1.000-3.000	500-1.000	3. Moderate	Intensive ventilation is recommended.
3.000-10.000	1.000-3.000	4. Unhealthy	Intensive ventilation is required.
10.000-25.000	3.000+	5. Very Unhealthy	Complete ventilation is required.

In this study, indoor air quality measurement and evaluation of Çanakkale Onsekiz Mart University (ÇOMÜ) Biga Vocational School (MYO) was carried out considering the information and studies given above. The measurements and values and the evaluation of the results are given in the following sections respectively.

INDOOR AIR QUALITY MEASUREMENTS OF BİGA MYO

Çanakkale Onsekiz Mart University Biga Vocational School

Biga Vocational School, which started teaching at Trakya University in the 1990-1991 academic year, was affiliated with Çanakkale Onsekiz Mart University, which was established by Law No. 3837 in 1992. The new service buildings of the Vocational School have a closed area of 8345 square meters. The Vocational School has 18 classrooms, 4 workshop classrooms, 1 technical drawing classroom, a meeting hall, a modern conference hall with a capacity of 115 people, and a student canteen. There are also a Dairy and Products Technology Atelier (with a daily milk processing capacity of 1000 liters), Machinery Atelier, Automotive Technology Atelier, Furniture Program Atelier, Raw Milk Analysis Laboratory, Food Processing Laboratory, Chemical Analysis Laboratory, General Computer Laboratory

CAD-CAM Computer Laboratory, Computerized Accounting Laboratory, Electrical Program Control Laboratory, Electrical Program Electrical Machinery Laboratory, Electrical Program Electronics Laboratory.

MATERIAL and METHODS

The studies on indoor air quality at Çanakkale Onsekiz Mart University Biga Vocational School were carried out during the period of March-April-May when students and employees actively used the canteen, classrooms, and conference hall. CE-certified PCE RCM-15 particle counting device was used in indoor air quality measurements at ÇOMÜ Biga Vocational School and the device counts three different counts according to particle size as 1 micron, 2.5 micron and 10 micron and also counts total volatile organic compound (TVOC) and formaldehyde (HCHO) amounts. The device also shows the instantaneous temperature and humidity of the closed environment on the screen as given in Figure 1.

Figure 1. PCE RCM 15 Air Quality Measurement Instrument

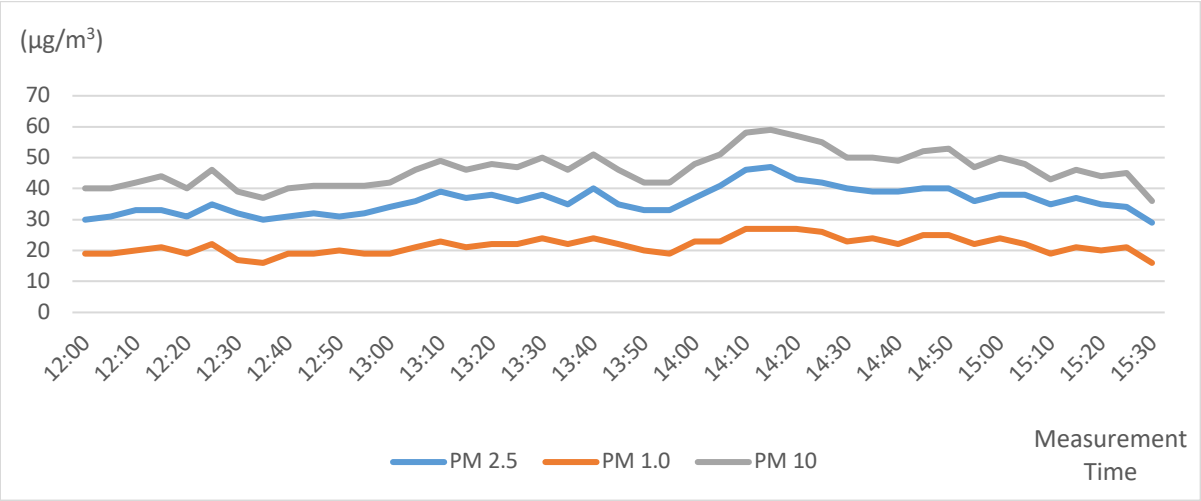
Indoor Air Quality Measurements in Classrooms

Indoor air quality measurements at ÇOMÜ Biga Vocational School were carried out in three different classrooms numbered 118, 218, and 219 on different dates, respectively, and were taken during lecture and exam times when students actively used the classrooms. In addition to PM, TVOC, and HCHO values, temperature and humidity values were also recorded. The measurements of the classrooms are given separately in the following sections.

Indoor Air Quality Measurements in Classroom No 118

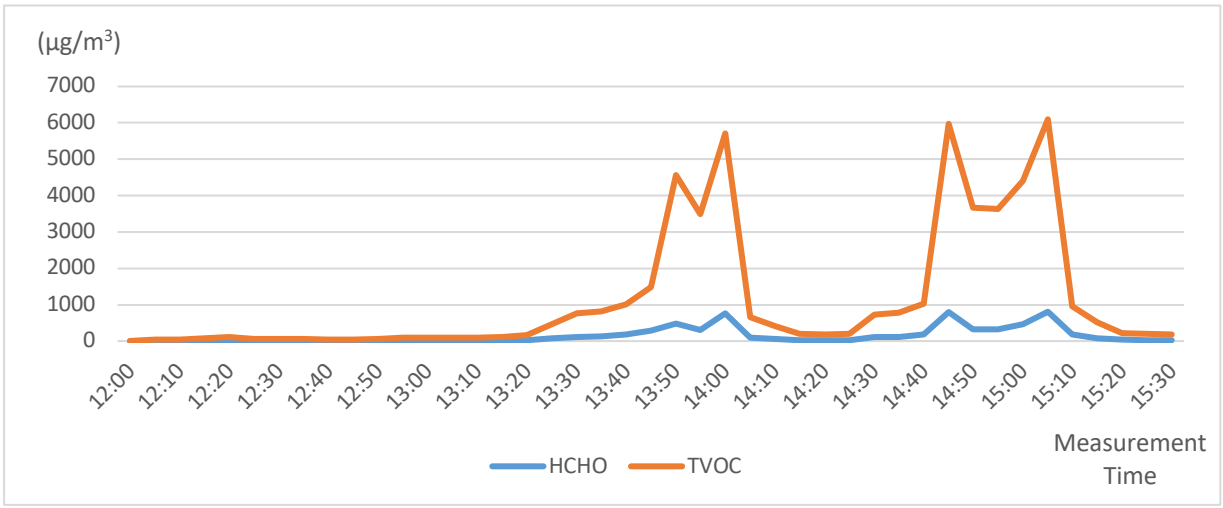
The average number of students attending the lectures held between 12:00-15:30 on 04 March 2024 in classroom 118 at Biga Vocational School was found to be 17 people. While classroom 118 was empty between 12:00-13:10, the class started at 13:10 and the first break was taken between 14:00-

14:10. The lesson ended at 15:00 and measurements were taken until 15:30 when the classroom was empty. The measurements made in classroom 118 are as given in Graph 1. and Graph 2.



Graph 1. PM Indices of Classroom 118

In Graph 1, it was determined that the PM index did not exceed the 1st health level when the classroom was empty at noon, but as the lesson started and the time progressed, especially after the 40th minute of the lesson, the 2nd health level was reached. For this reason, it is recommended that the classes should not be held in blocks and should not exceed 40 minutes.

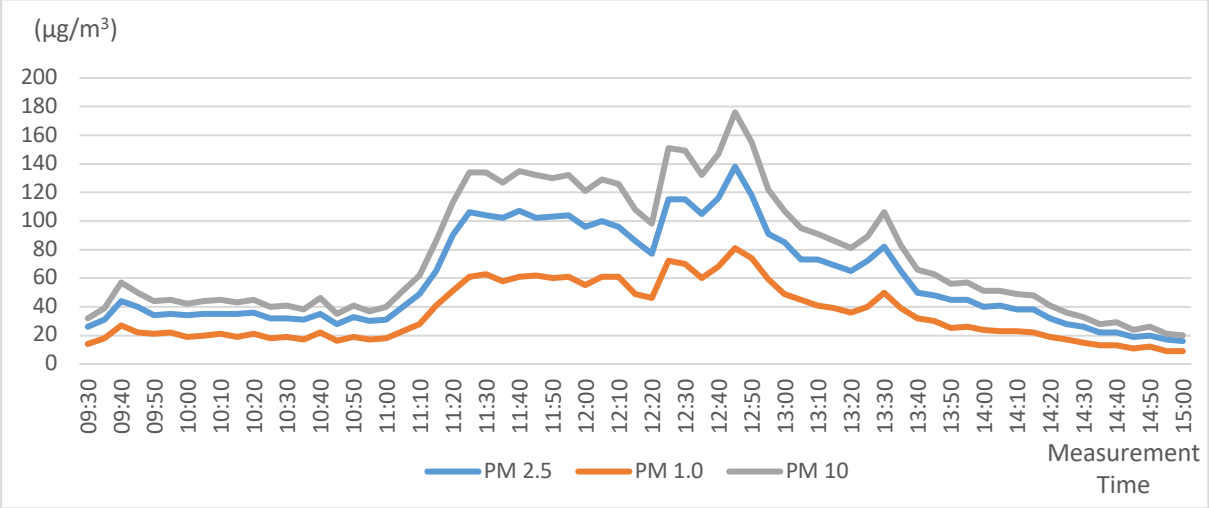


Graph 2. TVOC and HCHO Indices of Classroom 118

In Graph 2, it was observed that TVOC concentration was below the level 1 limit and HCHO level was quite low. However, the TVOC value increased to level 5 in the later periods of the lesson. Therefore, it is recommended to leave the environment and intensive ventilation for TVOC concentration at these levels. On this date, the average temperature was 23.23 °C and humidity was 36.51% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

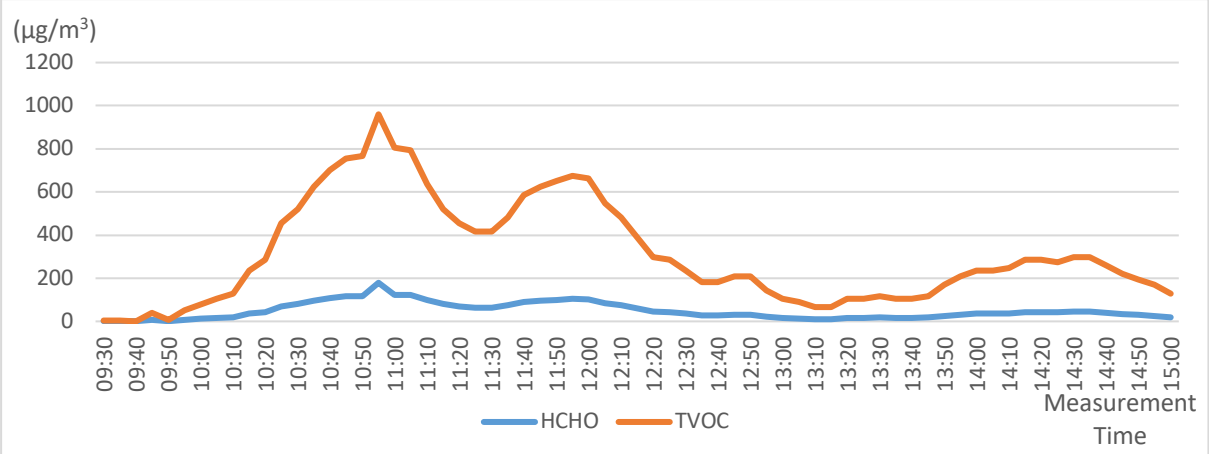
Indoor Air Quality Measurements in Classroom No 218

The average number of students attending the lectures held at Biga Vocational School, classroom 218 between 10:00-15:30 on 05 March 2024 was determined as 16 people. The measurements made during the relevant course are given in Graph 3. and Graph 4.



Graph 3. PM Indices of Classroom 218

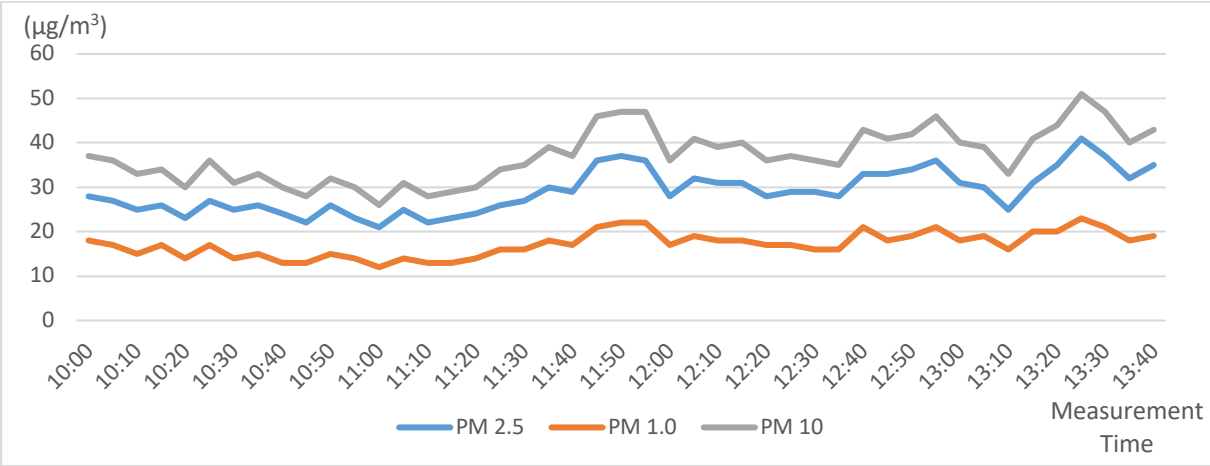
In Graph 3, it was determined that the PM index was at level 1 and level 2 at the beginning, increased to level 3 with the recess break at 11.00 and the opening of the windows reached its highest value at noon with fluctuations and reached level 4.



Graph 4. TVOC and HCHO Indices of Classroom 218

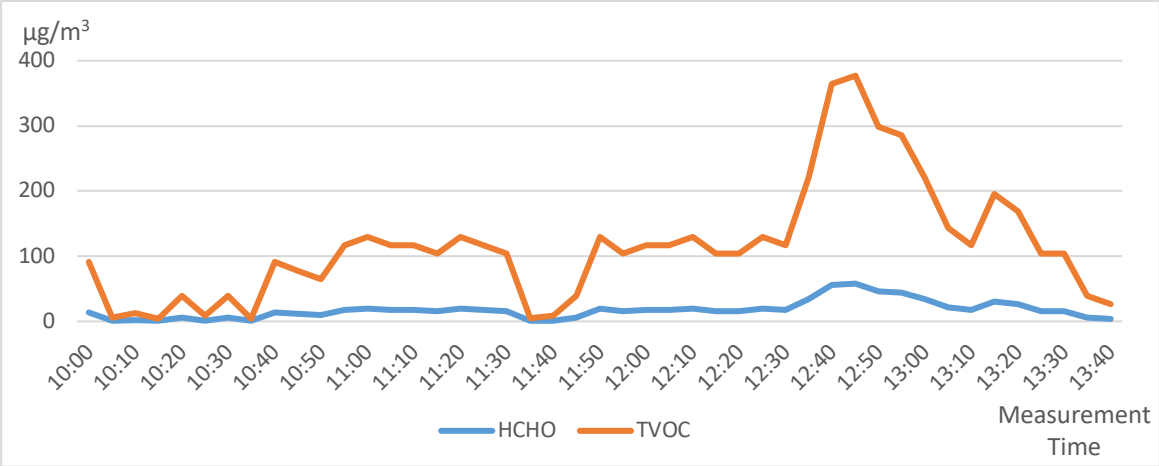
In Graph 4, it was determined that although the TVOC value momentarily rises to level 3, it is generally at level 2 and ventilation is required. It is seen that the HCHO level is quite low. On this date, the average temperature was 23.25 °C and humidity was 38.36% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

A second measurement was taken during the exams held on 12 November 2024 between 10:00 and 13:40 in classroom 218 at Biga Vocational School. In the first exam between 10:00 and 10:40, the average number of students was 45. In the second exam between 11:30 and 12:00, the average number of students was 50. In the third exam between 13:00 and 13:25, the average number of students was 42. In classroom 218, continuous measurements were taken between 10:00 and 13:40. The measurements made in classroom 218 are as given in Graph 5. and Graph 6



Graph 5. PM Indices of Classroom 218 (Examination)

Graph 5 shows that the PM index does not exceed the upper limit of health level 1. Therefore, classroom 218 can be considered good in terms of PM concentration for the date of indoor air quality measurement.



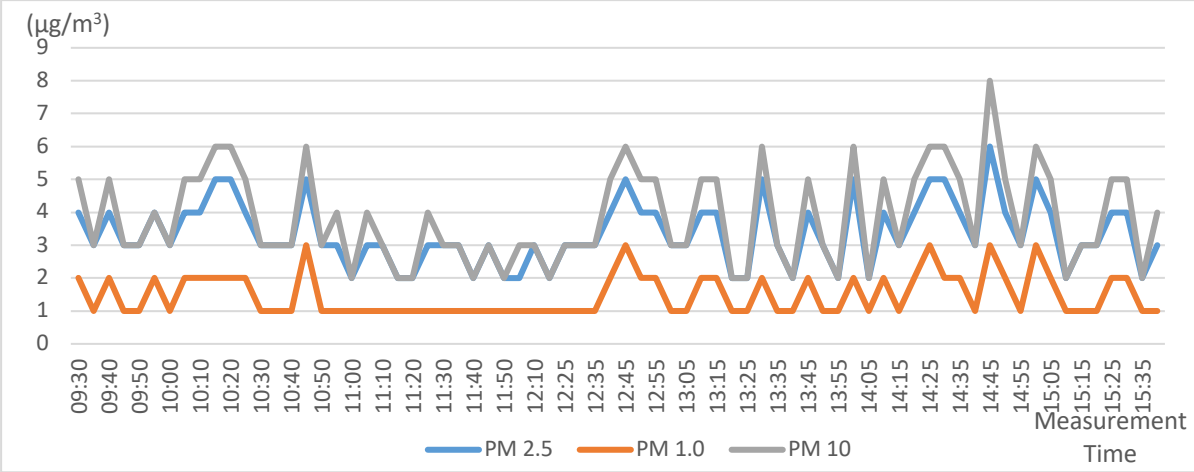
Graph 6. TVOC and HCHO Indices of Classroom 218 (Examination)

In Graph 6, it is observed that the TVOC value is generally at the 1st health level target value. In the 12:30- 12:50 period, it was observed that it increased to the 2nd health level for a short time due to the mobility in the classroom between the exams. It was determined that the HCHO level was at a low

level. On this date, the average temperature during the measurement hours was 21.67 °C and the humidity was 33.91%. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

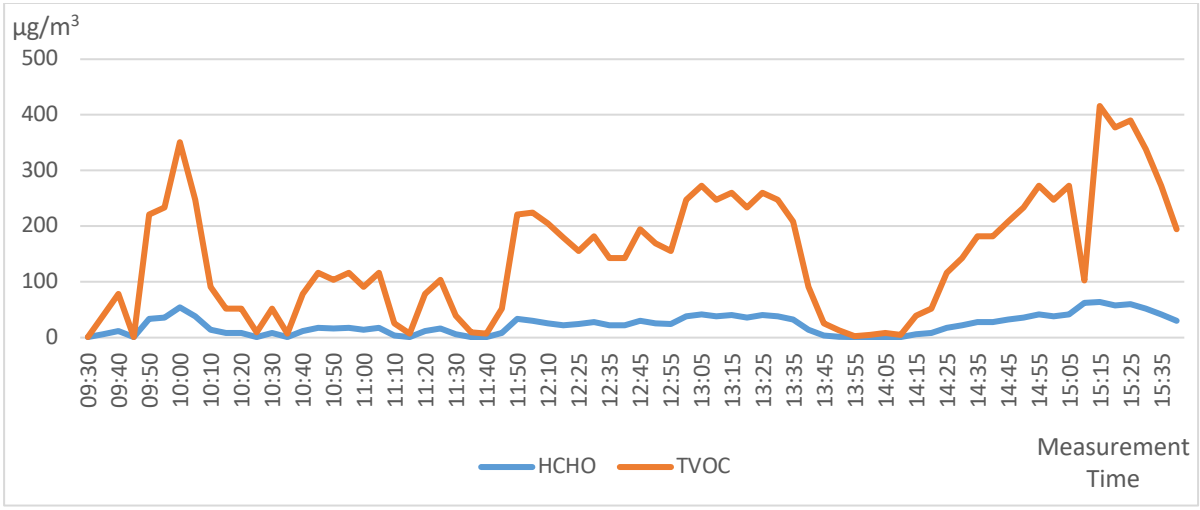
Indoor Air Quality Measurements in Classroom 219

Measurements started to be taken in classroom 219 at Biga Vocational School on 17 April 2024 between 09:30 and 10:00 when the classroom was empty. In the first exam at 10:00, the average number of students was 44. In the second exam, which started at 12:00, the average number of students was 30. In the other exams held at 13:30 and 15:00, the average number of students was 38. In classroom 219, continuous measurements were taken between 09:30 and 15:35. The measurements made in classroom 219 are as given in Graph 7. and Graph 8.



Graph 7. PM Indices of Classroom 219

Graph 7 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, the indoor air quality in classroom 219 can be considered good in terms of PM concentration for the date of measurement.

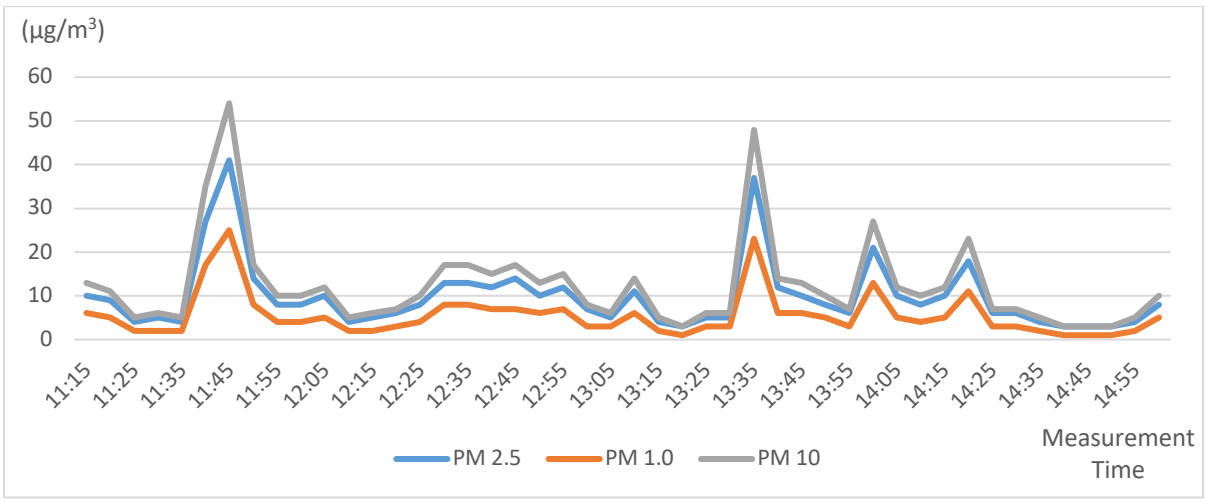


Graph 8. TVOC and HCHO Indices of Classroom 219

In Graph 8, it was observed that the TVOC density was at the 1st health level when the classroom was empty, increased to the 2nd health level when the exam started at 10:00, and returned to the 1st level when the windows were opened, and ventilation was done. The same situation is also valid in the afternoon exams and ventilation is recommended during the exam. HCHO level was found to be at a low level. On this date, the average temperature was 25.13 °C and humidity was 14.13% during the measurement hours. It was determined that the temperature value slightly exceeded the thermal comfort limits, and the humidity rate met the standards.

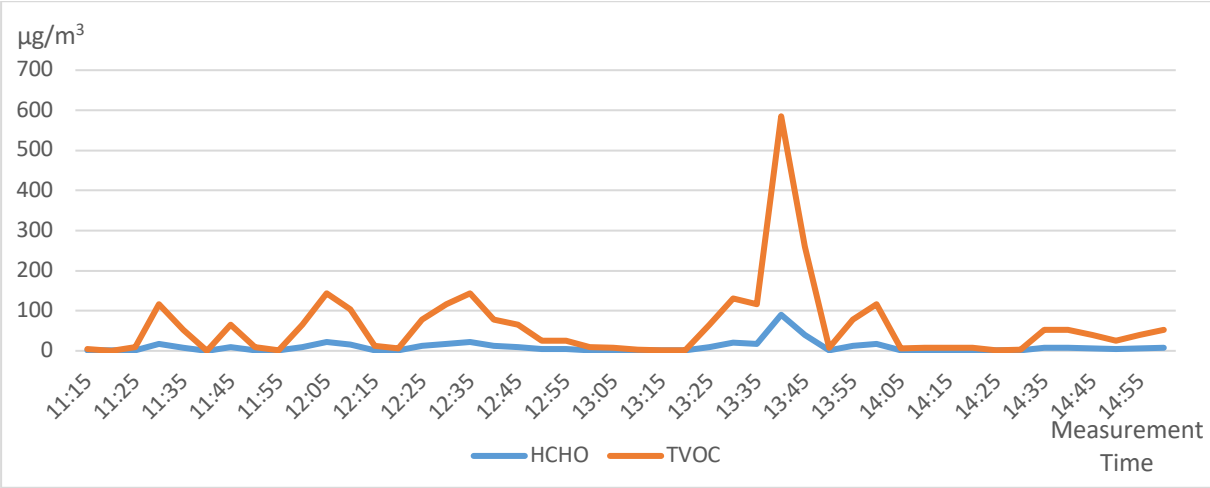
Canteen Indoor Air Quality Measurements

In the canteen of ÇOMÜ Biga Vocational School, measurements were taken on two different dates, 16.04.2024 when the density was high and 22.04.2024 when the density was low, and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded. Data of the measurements are shown in Graphs 9-12.



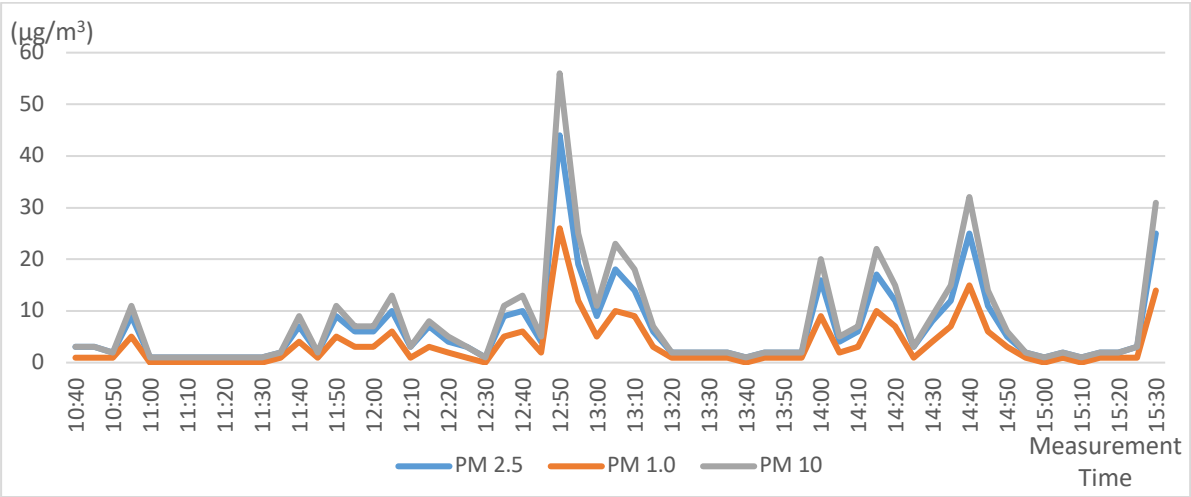
Graph 9. PM Indices of the canteen for the first measurement

Graph 9 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.



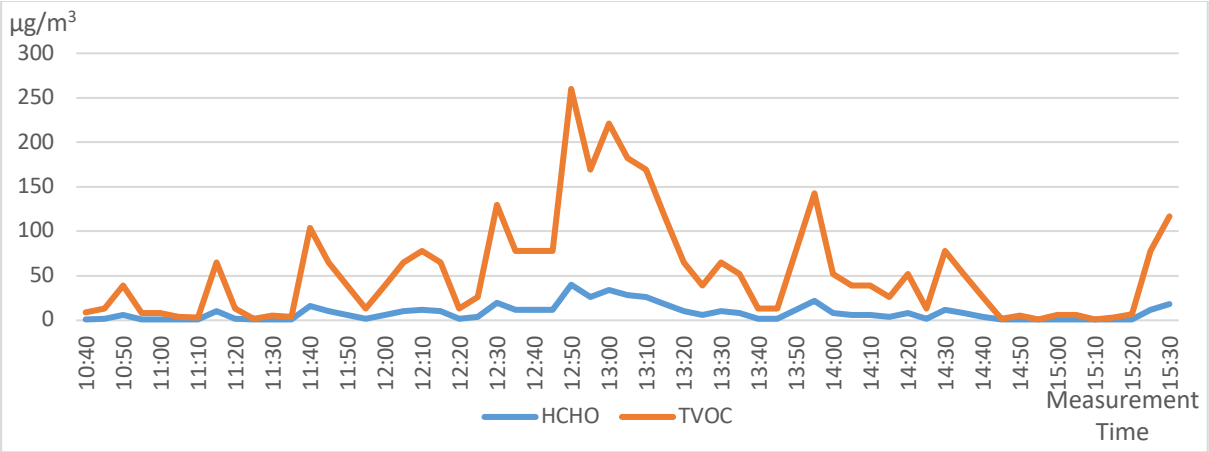
Graph 10. HCHO and TVOC Indices of the canteen for the first measurement

In Graph 10, it is observed that the TVOC value is generally at the 1st health level target value. In the 20 minutes between 13:25 and 13:45, an increase was observed due to the intensive use of food machines in the canteen. It is observed that the HCHO value is quite low. On this date, the average temperature was 26.04 °C and humidity was 22.61% during the measurement hours. It was determined that the temperature value slightly exceeded the thermal comfort limits, and the humidity rate met the standards.



Graph 11. PM Indices of the canteen for the second measurement

In Graph 11, it is observed that the PM index is at the 1st health level and only at the 12:40-13:00 time period when the midday activity is experienced, it briefly rises to the 2nd health level and is restored with ventilation.

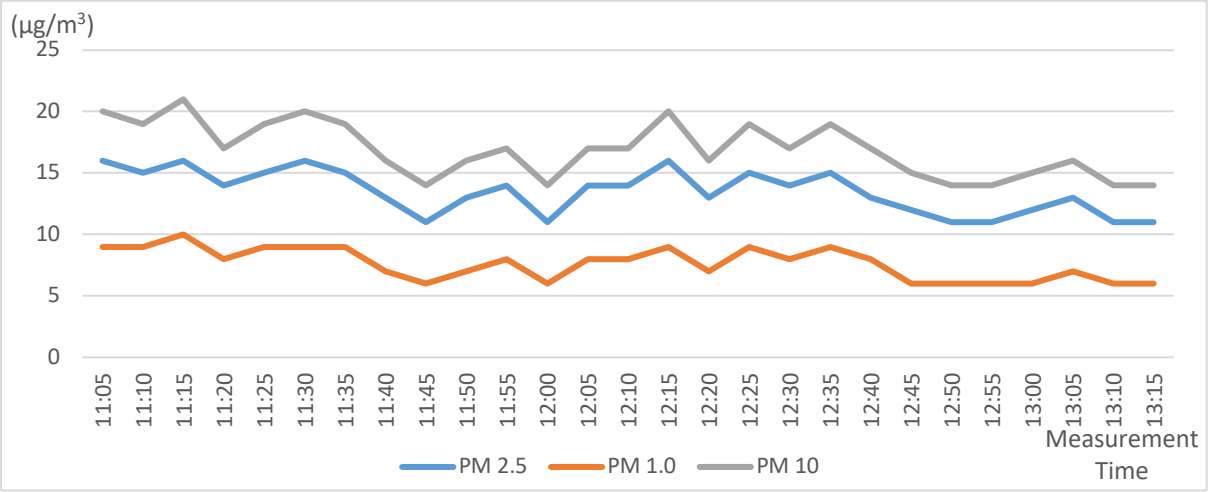


Graph 12. TVOC and HCHO indices of the canteen for the second measurement

In Graph 12, it is observed that the TVOC value is generally at the 1st health level target value. It was determined that the HCHO level was at a low level. On this date, the average temperature was 21.88oC and humidity was 34.12% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

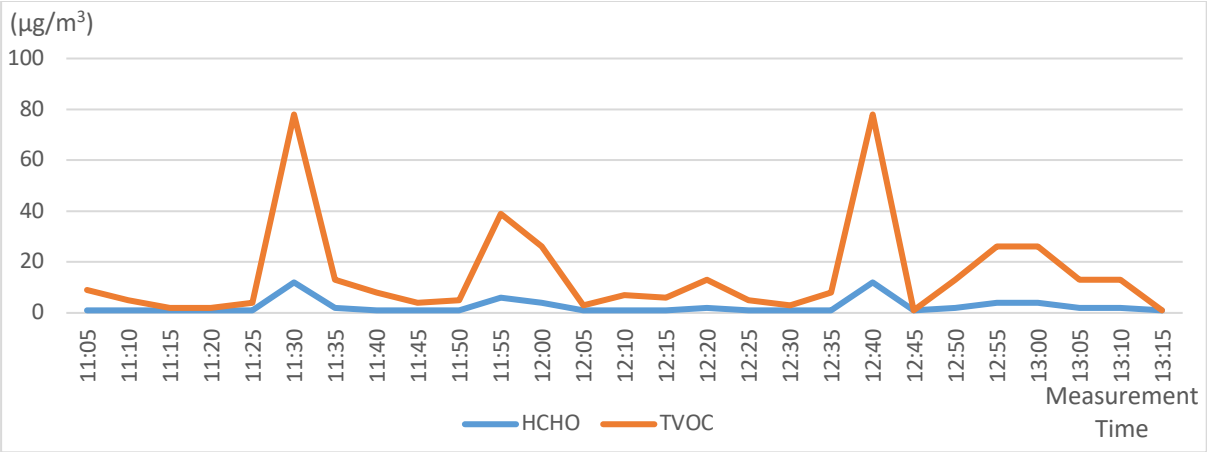
Indoor Air Quality Measurements in Corridor

Indoor air quality measurement was carried out on 11.03.2024 at Çanakkale Onsekiz Mart University Biga Vocational School 2nd floor offices corridor and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded and the measurements as given in Graphs 13. and 14.



Graph 13. PM Indices of Corridor

Graph 13 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.

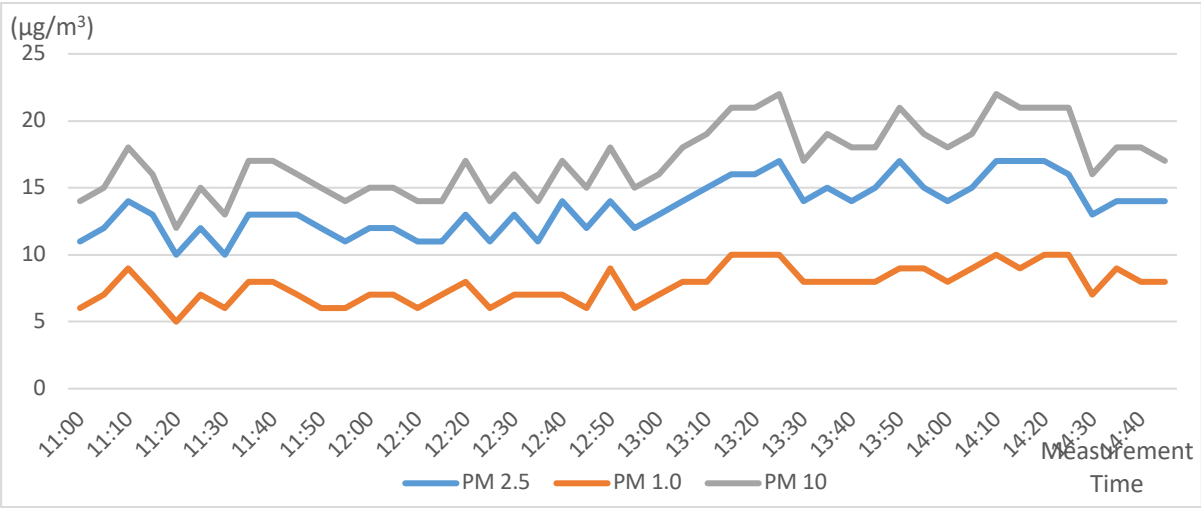


Graph 14. TVOC and HCHO Indices of Corridor

In Graph 14, TVOC concentration is below the level 1 limit and HCHO level is quite low. Therefore, it can be said that the values of the indoor air quality of the corridor in terms of TVOC and HCHO concentrations are very good. On this date, the average temperature was 20.78 °C and humidity was 32.37% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

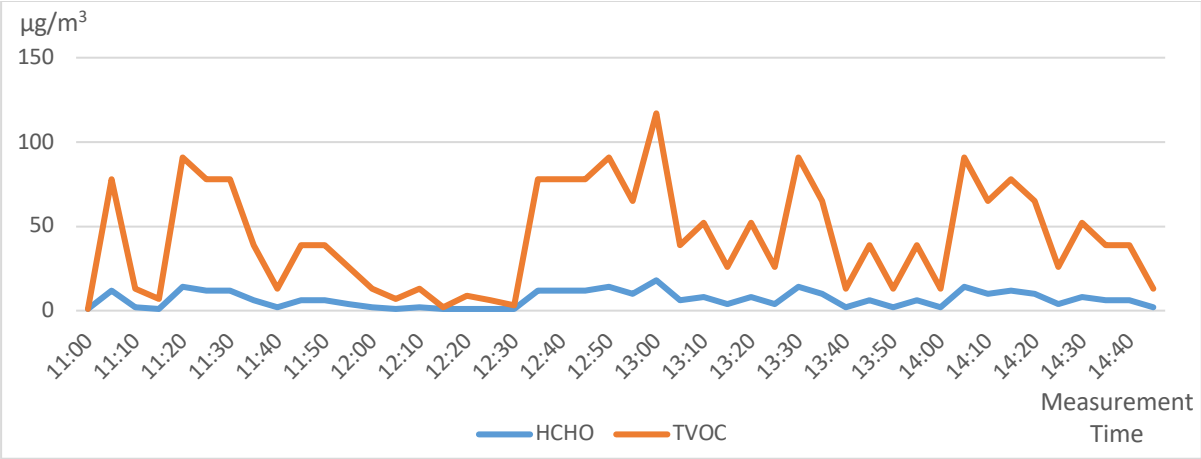
Indoor Air Quality Measurements in Academic Office

While the number of people in the office was 1 in one of the academic offices allocated to Çanakkale Onsekiz Mart University Biga Vocational School lecturers, indoor air quality measurement was made on 13.05.2024 and PM, TVOC, and HCHO values, as well as temperature and humidity values, were recorded and the measurements made as given in Graph 15. and Graph 16.



Graph 15. PM Indices of Academic Office

Graph 15 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.

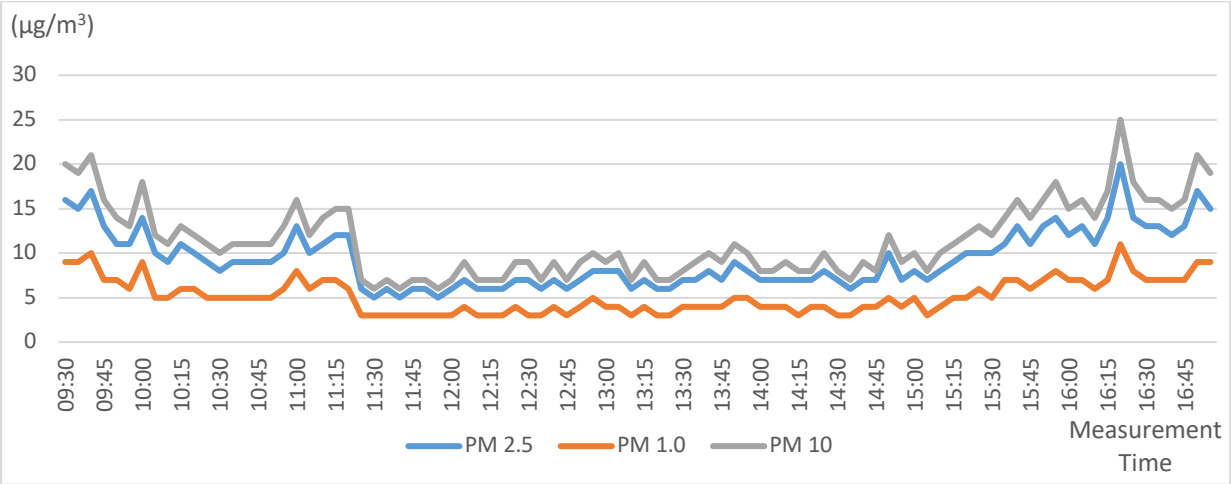


Graph 16. TVOC and HCHO Indices of Academic Office

Graph 16 shows that the TVOC concentration is below the level 1 limit and the HCHO level is quite low. Therefore, it can be said that the indoor air quality values of the academic office in terms of TVOC and HCHO concentrations are very good. On this date, the average temperature was 22.2 °C and humidity was 42.04% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

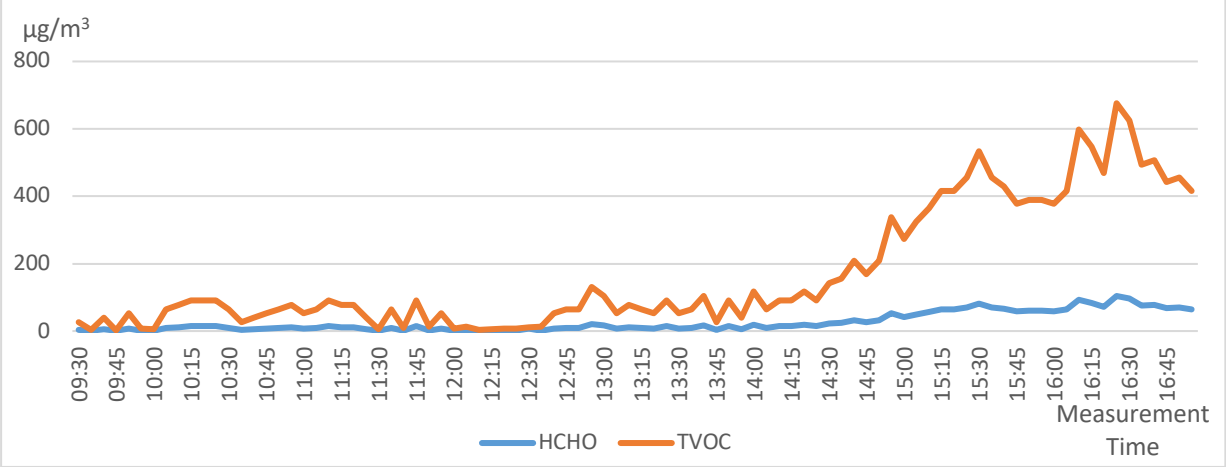
Indoor Air Quality Measurements in Build Entrance

Indoor air quality measurement at the building entrance of Çanakkale Onsekiz Mart University Biga Vocational School was carried out on 24.04.2024 and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded and the measurements as given in Graphs 17. and 18.



Graph 17. PM Indices of Building Entrance

Graph 17 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.

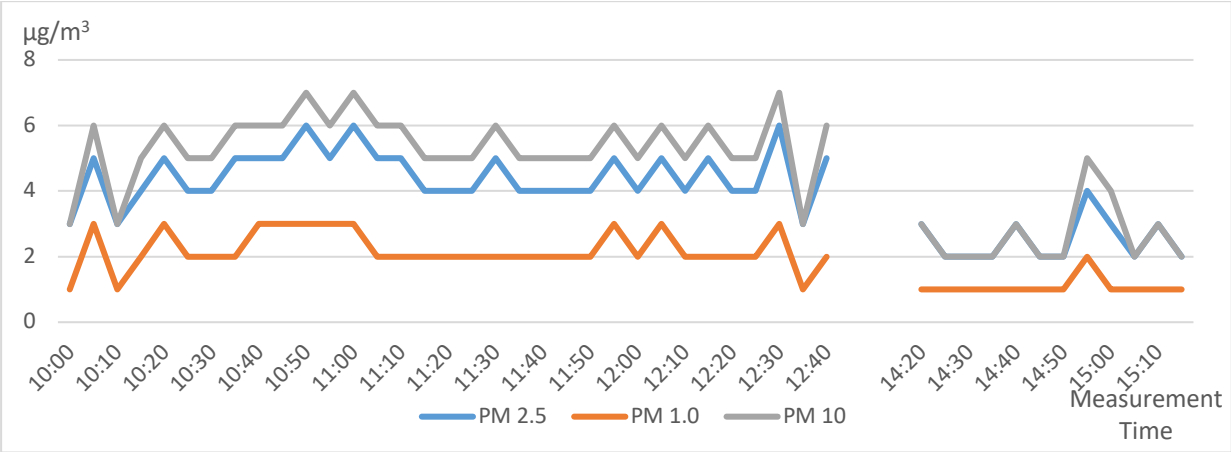


Graph 18. TVOC and HCHO Indices of Building Entrance

In Graph 18, although TVOC concentration was observed below the level 1 limit until 14:00, it increased to level 3 after 14:00 due to the effect of dust abrasion in the air. Although the HCHO level increased at the same time, it is seen that it is too low to pose a risk. On this date, the average temperature was 23.44 °C and humidity was 47.07% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

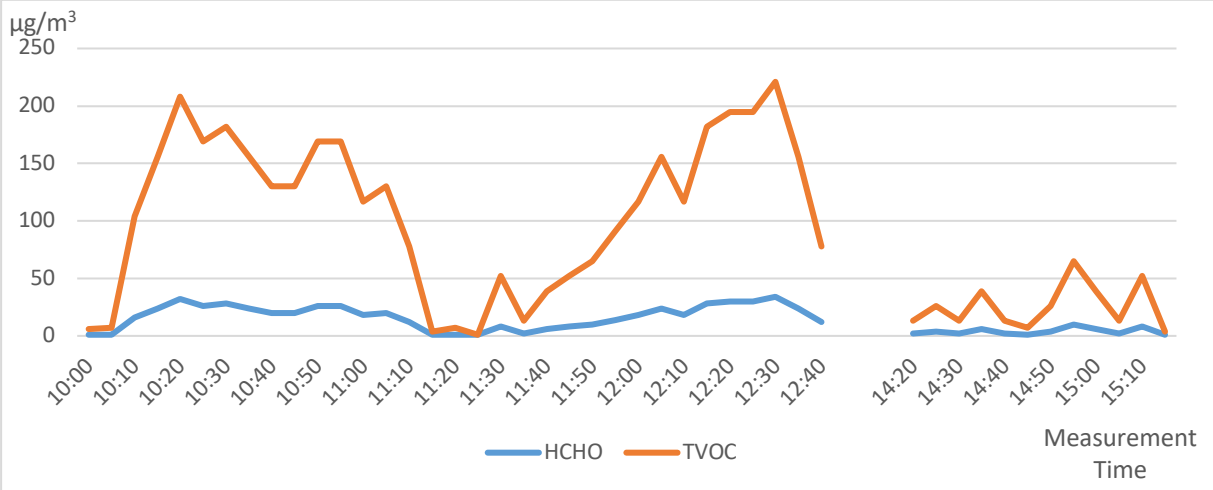
Indoor Air Quality Measurements in Conference Hall

The Career Days event organized by Çanakkale Onsekiz Mart University Biga Vocational School was held in two sessions in the conference hall on 15.05.2024. The average number of people in the morning session between 10:00-12:40 was 105 people, and the average number of people in the afternoon session between 14:20-15:10 was 70 people. Indoor air quality measurements were made in the Conference Hall and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded, and the measurements are given in Graph 19. and Graph 20.



Graph 19. PM Indices of Conference Hall

Graph 19 shows that the PM index does not exceed the upper limit of the 1st health level. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.

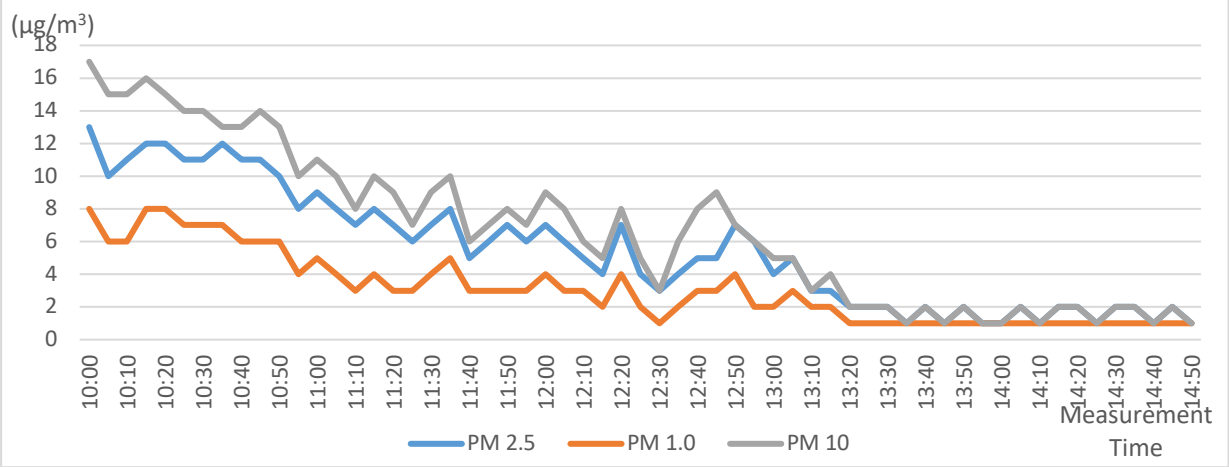


Graph 20. TVOC and HCHO Indices of Conference Hall

In Graph 20, TVOC concentration is below the level 1 limit and HCHO level is quite low. Therefore, it can be said that the values of the indoor air quality for the conference hall in terms of TVOC and HCHO concentrations are very good. On this date, the average temperature was 21.84 °C and humidity was 42.04% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

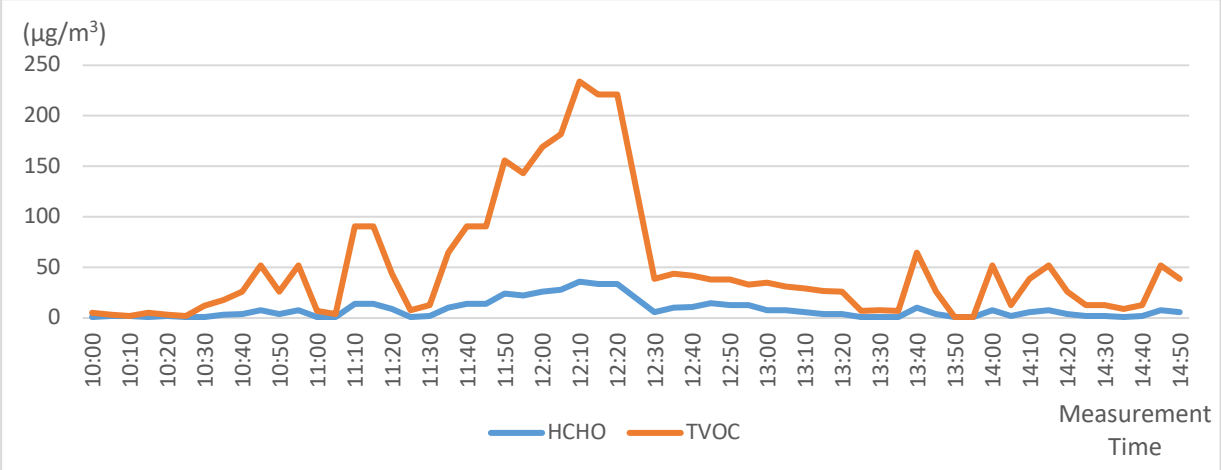
Indoor Air Quality Measurements in Computer Laboratory

The average number of students participating in the courses held in the computer laboratory at Biga Vocational School on 05 November 2024 between 10:00 and 14:50 hours was determined as 17 people. The first lesson in the laboratory was held between 10:00-11:00. After a 20-minute break, the second lesson started at 11:20 and ended at 12:00 and a lunch break was given. At 14:00, the third lesson started, and the laboratory door was open during the lesson. The related lesson ended at 14:50. Indoor air quality measurements were made in the computer laboratory and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded, and the measurements are given in Graph 21. and Graph 22.



Graph 21. PM Indices of Computer Laboratory

Graph 21 shows that the PM index does not exceed the upper limit of health level 1. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement. Especially for the last lesson when the door was open and the room was continuously ventilated, PM values were found to be quite low.



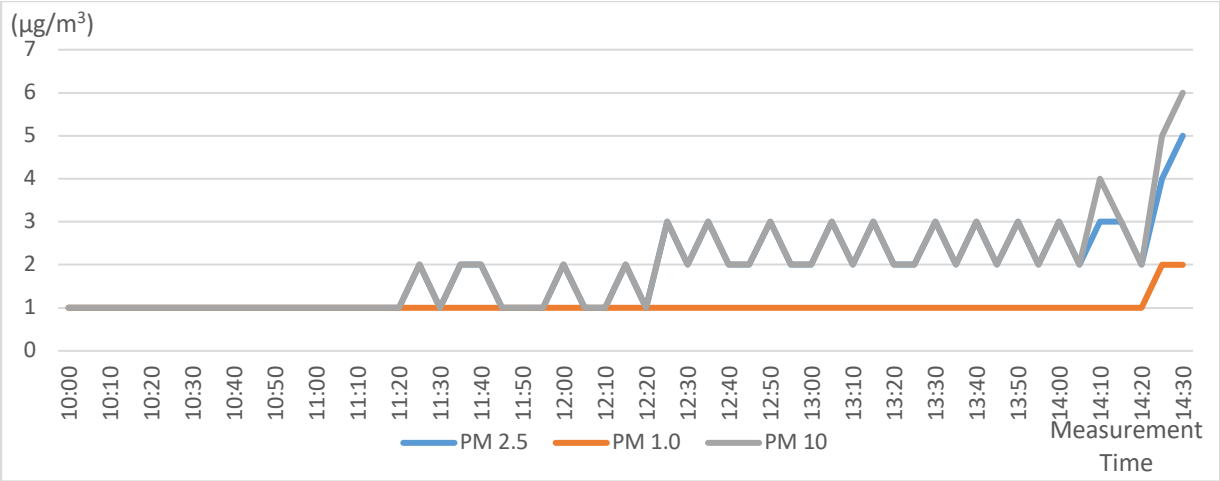
Graph 22. TVOC and HCHO Indices of Computer Laboratory

In Graph 22, TVOC concentration is below the level 1 limit and HCHO level is quite low. Therefore, it can be said that the indoor air quality values of the laboratory in terms of TVOC and HCHO concentrations are very good. On this date, the average temperature was 21.93 °C and humidity was 30.25% during the measurement hours. It was determined that the temperature value was within the thermal comfort values and the humidity rate met the standards.

Indoor Air Quality Measurements in Automotive Atelier

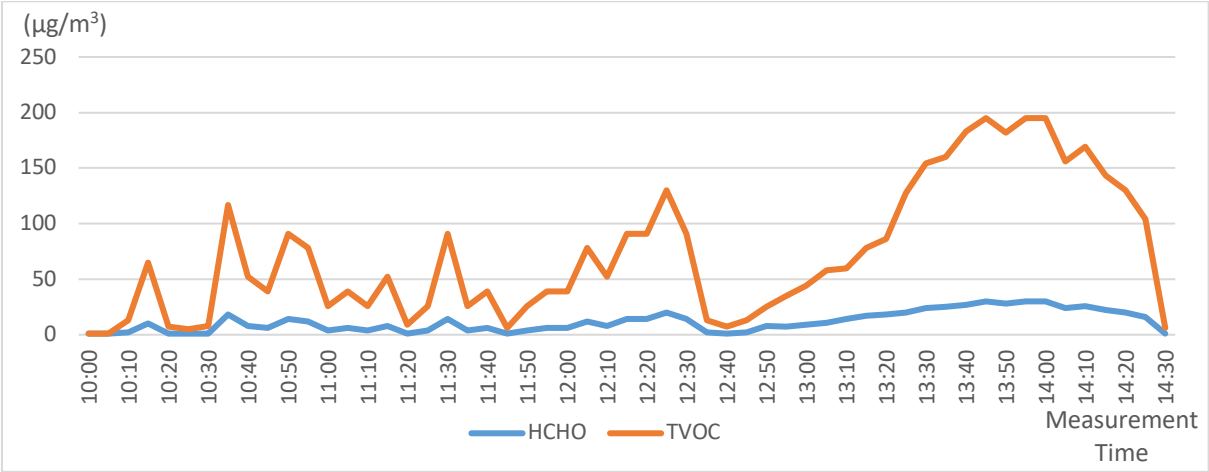
Although there was an increase in the number of people from time to time during the traditional activities held in the automotive workshop at Biga Vocational School between 10:00-14:30 on 06 November 2024, the average number of people was determined as 50. Indoor air quality measurements

were made in the Automotive Atelier and PM, TVOC, and HCHO values as well as temperature and humidity values were recorded, and the measurements are as given in Graph 23. and Graph 24.



Graph 23. PM Indices of Automotive Atelier

Graph 23 shows that the PM index does not exceed the upper limit of health level 1. Therefore, indoor air quality can be considered good in terms of PM concentration for the date of measurement.



Graph 24. TVOC and HCHO Indices of Automotive Atelier

In Graph 24, it is observed that TVOC concentration is below the level 1 limit and HCHO level is quite low. On this date, the average temperature was 15.8 °C and humidity was 32.98% during the measurement hours. It was determined that the temperature value was below the thermal comfort values and the humidity rate met the standards.

CONCLUSIONS

Air pollution has become a global problem due to increasing industrialization, urbanization, energy production from non-renewable sources, and increased use of vehicles. The amount and intensity of air pollution above normal adversely affect living health. For this reason, an indoor air quality

assessment was carried out at Biga Vocational School to improve air quality. In this study, the canteen, classrooms, corridor, conference hall, building entrance, academic office, computer laboratory, and automotive workshop were evaluated.

Considering the research results obtained, the following evaluations were made and are presented in Tables 4 and 5.

- Indoor air quality measurements were made in classrooms 118, 218, and 219 of ÇOMÜ Biga Vocational School on different dates both during the exam and during the course. These data taken on different dates revealed the effects of student density, course duration, and environmental factors on indoor air quality. It was found that while the PM concentration of the classrooms was generally at normal values, it increased with the prolongation of the class time and the increase in class density. In order to prevent this increase, it is recommended that the duration of the classes should not exceed 40 minutes, and this situation should be taken into consideration if block classes are to be held. When analyzed in terms of TVOC values, no situation threatening human health was encountered in general. However, as a precaution against increasing values, it is recommended that the classrooms should be regularly ventilated between exams and classes. HCHO values were generally found to be at low levels, indicating that the building materials, paint, furniture, and cleaning materials used for the classroom were selected correctly.
- In order to evaluate the indoor air quality in the canteen of ÇOMÜ Biga Vocational School, measurements were taken on two separate days when the density was different. As a result of these measures, it was concluded that the canteen's indoor air quality is generally suitable for user health. However, short-term increases in TVOC and PM values due to the absence of a mechanical ventilation system during the peak hours of the canteen indicate that the natural ventilation system should be made more effective during these hours. In addition, regular maintenance of food machines and periodic measurements of indoor air quality are recommended.
- The Career Days event held in the conference hall of ÇOMÜ Biga Vocational School was held in two sessions, one in the morning and one in the afternoon. In both sessions, it was determined that the indoor air quality was at the desired values despite the high number of participants. This shows that the ventilation system works effectively as well as the suitability of the materials preferred in the conference hall.
- In the indoor air quality measurement carried out in the corridor of ÇOMÜ Biga Vocational School, it was determined that the values were suitable for human health. This situation shows that regular and sufficient cleaning is carried out in Vocational School. It was determined that

the indoor air quality level was at level 1 during the day by cleaning the building after the end of class hours and removing volatile organisms from the environment with active ventilation.

- On 24 April 2024, when indoor air quality was measured at the entrance of ÇOMÜ Biga Vocational School building, dust transport from North Africa was observed in and around Biga. On this date, air quality reached "sensitive" values of 150 micrograms with high wind speeds in the region. Although the indoor air quality at the entrance of the building was generally within the normal limit values, the TVOC value increased with the dust transport that occurred after 14:00. In such cases, it is recommended to take adequate precautions and ventilation in poorly ventilated areas and build entrances.
- In the measurement made in the academic office of ÇOMÜ Biga Vocational School, it was determined that the indoor air quality was at the desired value because there was 1 person, and the ventilation conditions of the office were sufficient.
- It was determined that indoor air quality was generally at the desired value in terms of human health in the morning and afternoon classes in the computer laboratory of ÇOMÜ Biga Vocational School. Especially in the afternoon classes, unlike the morning classes, leaving the classroom door open during the class provided natural ventilation and allowed the indoor air quality values to improve further.
- Indoor air quality was measured during the traditional event at the automotive workshop of ÇOMÜ Biga Vocational School. As a result of these measurements, it was determined that the indoor air quality had very low values for an automotive workshop, and it is thought that this is due to the cleaning with pressurized water the day before, although the number of participants increased from time to time during the event. In addition, another striking factor during the measurement was that the environment was quite cold. The coldness of the automotive workshop not only negatively affects the indoor air quality but may also pose risks to the health of the students. The weakening of natural ventilation in cold environments leads to the accumulation of chemical pollutants emitted from vehicles and engines, causing deterioration of indoor air quality. In addition, cold weather can cause students' body temperature to drop, leading to health problems such as muscle aches and colds. This situation may also negatively affect students' focus and concentration and may cause work accidents in jobs requiring fine motor skills. For these reasons, keeping the temperature level of the workshop environment at an appropriate level is extremely important both for improving indoor air quality and for students to work healthily and efficiently.

Table 4. Average and Range of IAQ Pollutant Levels by Location (μg/m^3)

		PM 1.0	PM 2.5	PM 10	TVOC	HCHO
Classroom 118	Minimum	16	29	36	3	1
	Maximum	27	47	59	6098	807
	Average	21.53	36.07	46.21	1152.33	145.35
Classroom 218	Minimum	9	16	20	0	1
	Maximum	81	138	176	960	179
	Average	35.18	59.6	75.99	314.73	48.91
Corridor	Minimum	6	11	14	1	1
	Maximum	10	16	21	78	12
	Average	7.63	13.48	16.89	15.22	2.52
Canteen	Minimum	1	3	3	0	0
	Maximum	25	41	54	585	90
	Average	5.52	9.87	12.33	60.78	9.43
Classroom 219	Minimum	1	2	2	1	1
	Maximum	3	6	8	416	64
	Average	1.47	3.36	3.83	146.17	22.93
Canteen (Less Dense)	Minimum	0	1	1	1	1
	Maximum	26	44	56	260	40
	Average	3.54	6.59	8.02	54.8	8.51
Building Entrance	Minimum	3	5	6	2	1
	Maximum	11	20	25	676	104
	Average	5.17	9.34	11.49	170.59	26.32
Academic Office	Minimum	5	10	12	1	1
	Maximum	10	17	22	117	18
	Average	7.74	13.52	17.09	43.43	6.72
Conference Hall	Minimum	1	2	2	1	1
	Maximum	3	6	7	221	34
	Average	1.91	3.96	4.67	88.04	13.58
Laboratory	Minimum	1	1	1	1	1
	Maximum	8	13	17	234	36
	Average	3.1	5.49	6.75	50.59	8.59
Automotive Workshop	Minimum	1	1	1	1	1
	Maximum	2	5	6	195	30
	Average	1.04	1.85	1.91	72.24	11.58
Classroom 218 (Examination)	Minimum	12	21	26	4	1
	Maximum	23	41	51	377	58
	Average	17.13	29.04	37.09	114.36	17.6

Table 5. Health Levels Status

	PM	TVOC	HCHO	Humidity	Temperature
Classroom 118	1. Good	4. Unhealthy	1. Very Good	Appropriate	Appropriate
Classroom 218	2. Modorate	2. Good	1. Very Good	Appropriate	Appropriate
Corridor	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Canteen	1. Good	1. Very Good	1. Very Good	Appropriate	High
Classroom 219	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Canteen (Less Dense)	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Building Entrance	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Academic Office	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Conference Hall	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Laboratory	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate
Automotive Workshop	1. Good	1. Very Good	1. Very Good	Appropriate	Low
Classroom 218 (Examination)	1. Good	1. Very Good	1. Very Good	Appropriate	Appropriate

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REFERENCES

Ağacan, İ. (2014). *Çevre Kirliliği Sorunları Ile Mücadelelerde Türkiye'De Uygulanan Çevre Vergileri ve Çevre Vergisi Bilinci*. Master's Thesis, Sakarya University, Institute of Social Sciences, Sakarya.

Barbaroğlu, A. (2015). Anaokullarında İç Ortam Hava Kalitesi. *Tesisat Mühendisliği, 150*, 5-12.

Başer, V., & Kalıpcı, E. (2019). Coğrafi Bilgi Sistemi (CBS) ve Hava Kalitesi Verileri Kullanılarak Türkiye'nin Hava Kirliliğinin Değerlendirilmesi. *Black Sea Journal of Science and Technology, 9*(2), 377-389.

Bulut, H. (2012). Havalandirma ve İç Hava Kalitesi Açisindan CO2 Miktarinin Analizi. *Tesisat Mühendisliği, 128*, 61-70.

Çağlar, H., & Aygün, (2021). Ulupınar Gözlemevi'nin Hava Kalitesi Açısından İncelenmesi. *International Journal of Innovative Approaches in Science Research, 5* (4), 220-250.

Güneş, G., Bozkurt, E., Sönmez, S., & Çakır, N., (2015). An Investigation of the Indoor Air Quality in Libraries: Marmara University Central Library. *Bilgi Dünyas, 16* (2), 222-241.

Ceylan, A. (2011). *Negative Effects of Air Conditioning Systems on Indoor Air Quality*. Master's thesis, Institute of Science and Technology.

Çibuk, S., & Işık, E. (2015). Yemekhaneler ve Kantinlerde İç Hava Kalitesi ile İlgili Ölçüm Sonuçları ve Analizi. *Mühendislik Dergisi, 1*,39-50.

Güllü, G. (2016). İlköğretim Okullarında İç Ortam Hava Kalitesi Ve Sağlık Etkileşimi. *Tesisat Mühendisliği 152*, 31-42.

Zencirci S. A., & Işıklı B., (2017) Hava Kirliliği. *Türk Dünyası Uygulama ve Araştırma Merkezi Halk Sağlığı Dergisi 2* (2), 24-36. .

Orhan, İ. H., & Kaya, L. G. (2016). LEED Belgeli Yeşil Binalar ve İç Mekan Kalitesinin İncelenmesi. *Mehmet Akif Ersoy Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 7*(Special, 1), 18-28.

Menteşe, S., & Çotuker, O. (2021). Partikül Madde, Karbon Monoksit ve Karbondioksit Seviyelerinin Iç Ve Diş Ortamlarda Değişimi. *Mühendislik Bilimleri Ve Tasarım Dergisi, 9*(3), 723-734. https://doi.org/10.21923/jesd.811053.

Yılmaz, Y., & Sarıahmetoğlu, A. B. (2023). Üniversite Toplu Kullanim Alanlarinda İç Ortam Hava Kalitesinin İş Sağliği Ve Güvenliği Açisindan Değerlendirilmesi. *Niğde Ömer Halisdemir Üniversitesi Mühendislik Bilimleri Dergisi, 12*(4), 1392-1402. https://doi.org/10.28948/ngumuh.1313830.

Şişman, E. (2019). Türkiye'de Seçilen Hava Kalitesi İzleme İstasyonları için Eğilim (Trend) Değerlendirmeleri. *Journal of Natural Disasters and Environment, 5*(1), 134-152.

Sofuoglu, C. S. (2016). İç Hava Kirleticileri ve İnsan Sağlığına Etkisi. *Tesisat Mühendisliği, 153*, 33-44.