

# Indoor air chemical pollution at a school in JAPAN

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## Abstract

This study measures the chemical compounds concentration of a classroom and a special classroom in the elementary school and junior high school in Niigata City. As results of this study, the concentrations of all the rooms are a low level. These concentrations of the rooms are under the guideline concentration of the Ministry of health, Labor and welfare of JAPAN. In order to the formaldehyde concentration that temperature was corrected by the formula of Inoue, the elemental school A is 28 to 65  $\mu\text{g}/\text{m}^3$ , school B is 42 to 59  $\mu\text{g}/\text{m}^3$ , school C is 29 to 39  $\mu\text{g}/\text{m}^3$  and the school D is 33 to 94  $\mu\text{g}/\text{m}^3$ . The acetone concentration is the highest value by this measurement. p-Dichlorobenzene isn't detected in most classrooms.

**Keywords:** Indoor Air Chemical Pollution; formaldehyde; VOCs Concentration at school

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## Introduction

Recently, a indoor air pollution due to the chemical compounds is a big social problem. These problems of indoor air quality are not only the problems in a house, but also problem of an office building and a hospital, the building such as a theater on school as well. So that it is needed to survey that the chemical compounds concentrations and the ventilation rate.

The School is very high public buildings. Both elementary school and junior high school are compulsory education on Japan, it must keep good environment in order to growth and health for a student.

This study measures the chemical compounds concentration of a classroom and a special classroom on the elementary school and junior high school in Niigata City.

## Outline of Method

Three elementary schools and one junior high school in Niigata City that has different building age and reconstruction times were sampled. All investigated schools were measured the indoor concentration at the classroom, special classroom, corridor and rest room. Table 1 shows the outline of the measurement. Elementary school A was established 11 years ago. Elementary school B was established three months ago. Elementary school C redecorated 6-1 classroom, 6-3 classroom, restroom, science room, corridor and arts room three months ago. Junior high school D redecorated the arts room, 1-5 classroom, corridor and restroom three months ago. And the library was redecorated two years three months ago, and science room and 3-5 classroom was redecorated three years three months ago.

Table 1 The outline of measurement

school	The measurement date	Outdoor air temperature [ ]	Indoor air temperature [ ]	
Elementary school A	25-Dec-01	9.1	5.6 ~ 14.2	Established 11 years ago.
Elementary school B	27-Dec-01	8.3	7.8 ~ 13.2	Established three months ago.
Elementary school C	07-Jan-02	1.3	4.9 ~ 7.9	Repaired 6-1 classroom, 6-3 classroom, restroom, science room, corridor and arts room three months ago.
Junior high school D	04-Jan-02	0.2	3.6 ~ 17.5	Repaired the arts room, 1-5 classroom, corridor and restroom three months ago. The library was repaired two years three months ago. Science room and 3-5 classroom was repaired three years three months ago.

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Table 2 shows the outline of measurement method. The concentration was measured by the standard sampling and analyzing method that is discussed by the review meeting of sick-house, Ministry of health, Labor and welfare. Measurement is carried out during the winter vacation (December 25, 2001 – January 7, 2002), and both windows and classroom entrance doors are closed.

Table 2 The outline of measurement method

Concentration of CARBONYL (13 substance)		
The DNPH cartridge was used to measure the concentration of formaldehyde etc., HPLC were used to analyze.		
Formaldehyde	Crotonaldehyde	Tolualdehyde
Acetaldehyde	Butyraldehyde	Hexaldehyde
Acetone	Benzaldehyde	2,5-Dimethylbenzaldehyde
Acrolein	Isovaleraldehyde	
Propionaldehyde	Valeraldehyde	
Concentration of VOC (21 substance)		
TenaxTA was used to measure the concentration of VOCs, GC-MS with TDS were used to analyze.		
Dichloromethane	1,2-Dichloropropane	Stylene
MEK	Trichloroethylene	o-Xylene
Chlorohorm	Toluene	a-Pinene
1,1,1-Trichloroethane	MIBK	4-Ethyltoluene
1,2-Dichloroethane	Tetrachloroethylene	1,3,5-Trimethylbenzene
Benzene	Ethylbenzene	1,2,4-Trimethylbenzen
Tetrachloromethane	m.p-Xylene	p-Dichlorobenzene

## Results of elementary school A

### (1) Results of Formaldehyde concentration

Figure 1 shows the result of the Formaldehyde, Acetaldehyde and Acetone concentration. At these measurement points, Formaldehyde concentration are lower than the guideline of Ministry of health, Labor and welfare of JAPAN ( $100\mu\text{g}/\text{m}^3$ ), the concentration is in the range of 10 to  $15\mu\text{g}/\text{m}^3$ . Acetone concentration shows a tendency to increase after gymnasium wax cleaning.

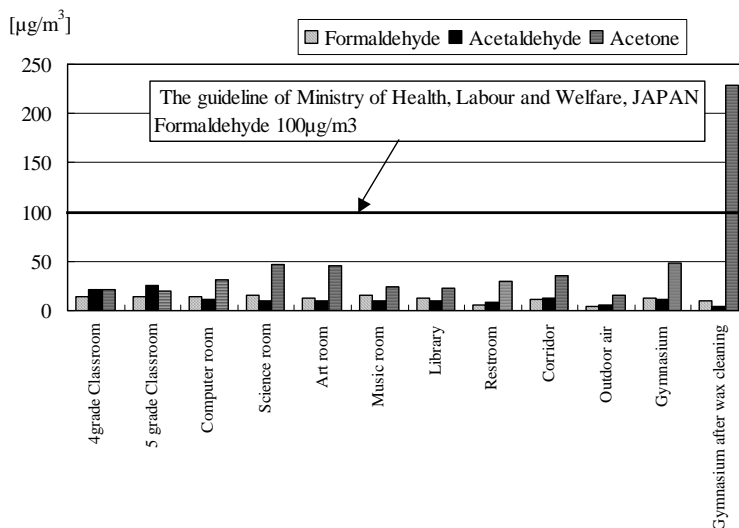


Figure1 Formaldehyde, Acetaldehyde and Acetone concentration (School-A)

### (2) Formaldehyde concentration after the temperature compensation

A classroom temperature is low because it was not heated during the measurement. So that the result is corrected by the formula of Inoue in the condition of 25 °C, 50% concentration. Figure 2 shows the compensated concentration by the formula of Inoue.

At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. It is the value of 28 to  $65\mu\text{g}/\text{m}^3$ . There is no difference between the classroom and the special classroom concentration.

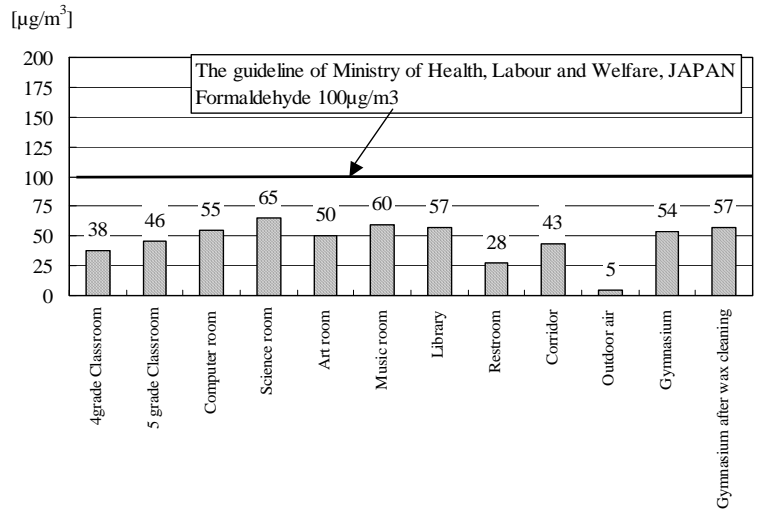


Figure2 Formaldehyde concentration after the temperature compensation (School-A)

**(3) Results of TVOC concentration**

Figure 3 shows the results of the Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration. At these measurement points, every VOC's concentrations are lower than the guideline of Ministry of health, Labor and welfare. Figure 4 shows the results of total VOC concentration. The total VOC concentration by this measurement is the simple addition concentration of the 21 substance measured by TenaxTA. At these measurement points, TVOC concentration is lower than the guideline of Ministry of health, Labor and welfare (400µg/m<sup>3</sup>)

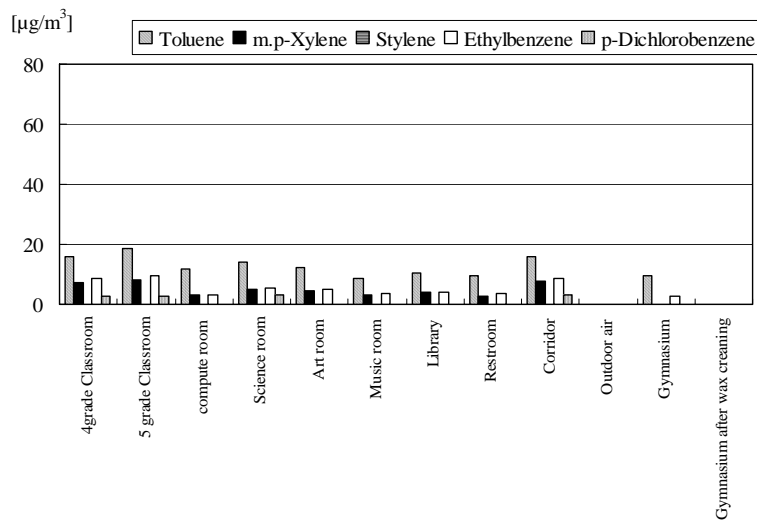


Figure3 Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration (School-A)

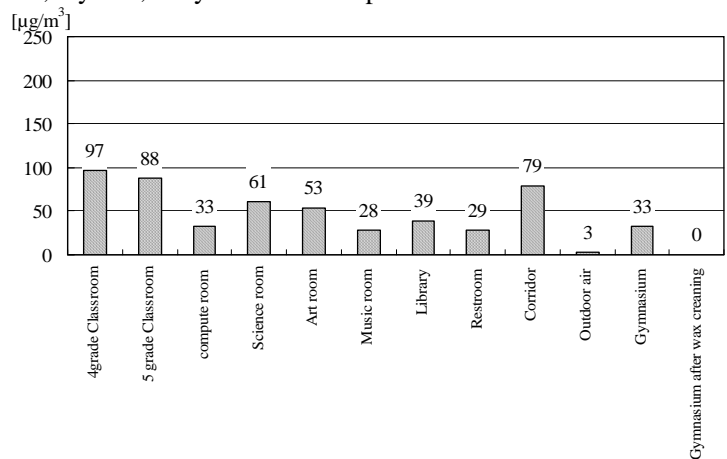


Figure4 TotalVOC concentration (School-A)

## Results of Elementary school B

### (1) Results of Formaldehyde concentration

Figure 5 shows the result of the Formaldehyde, Acetaldehyde and Acetone concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. The concentration is in the range of 10 to 19  $\mu\text{g}/\text{m}^3$ . Acetone concentration of science room, the music room, the rest room is higher than other measurement points.

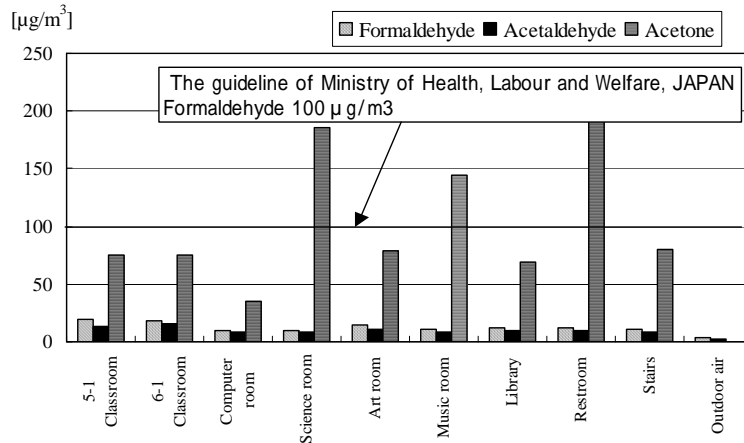


Figure 5 Formaldehyde, Acetaldehyde and Acetone concentration (School-B)

### (2) Formaldehyde concentration after the temperature compensation

Figure 6 shows the compensated concentration by the formula of Inoue in the condition of 25 °C, 50% concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. It is the value of 42 to 59  $\mu\text{g}/\text{m}^3$ .

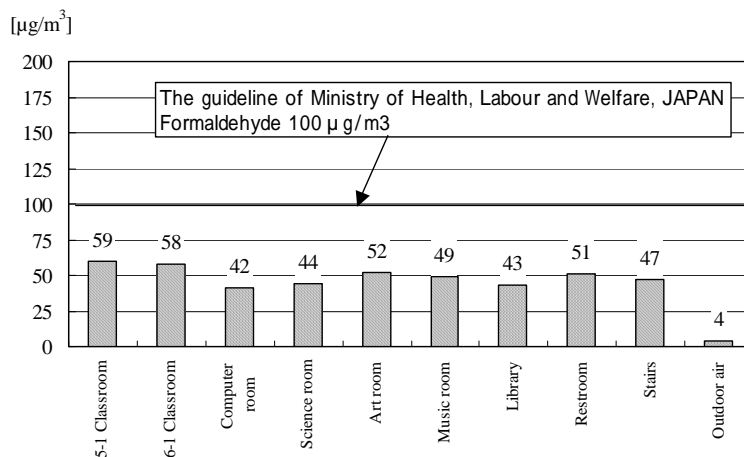


Figure 6 Formaldehyde concentration after the temperature compensation (School-B)

### (3) Results of TVOC concentration

Figure 7 shows the results of the Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration, and Figure 8 shows the result of total VOC concentration. At these measurement points, every VOC's concentrations are lower than the guideline of Ministry of health, Labor and welfare. The total VOC concentration at the computer room and 6-1 classroom are relatively low.

## Results of Elementary school C

### (1) Results of Formaldehyde concentration

Figure 9 shows the results of the Formaldehyde, Acetaldehyde and Acetone concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. The concentration is in the range of 6 to 9  $\mu\text{g}/\text{m}^3$ . Acetone concentration at science room, the music room, the rest room is higher than other measurement points.

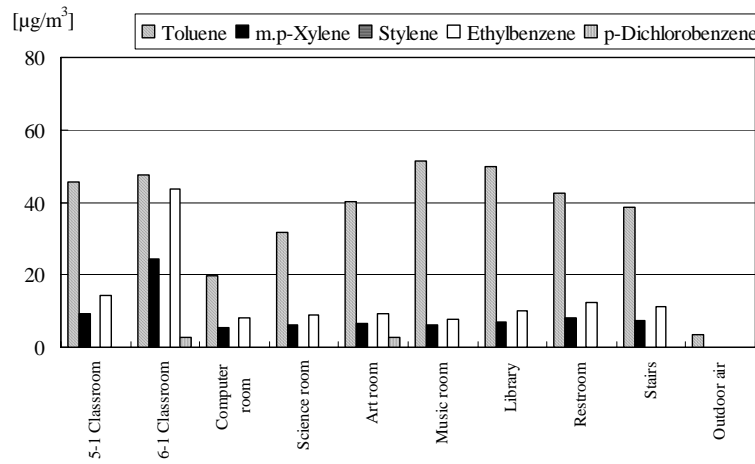


Figure 7 Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration (School-B)

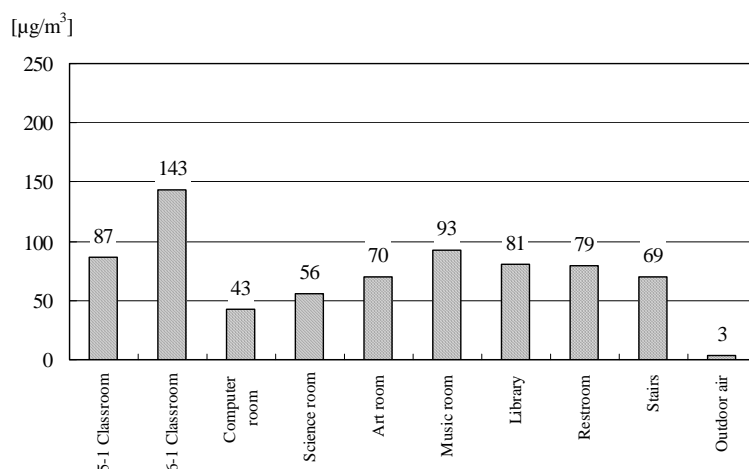


Figure 8 Total VOC concentration (School-B)

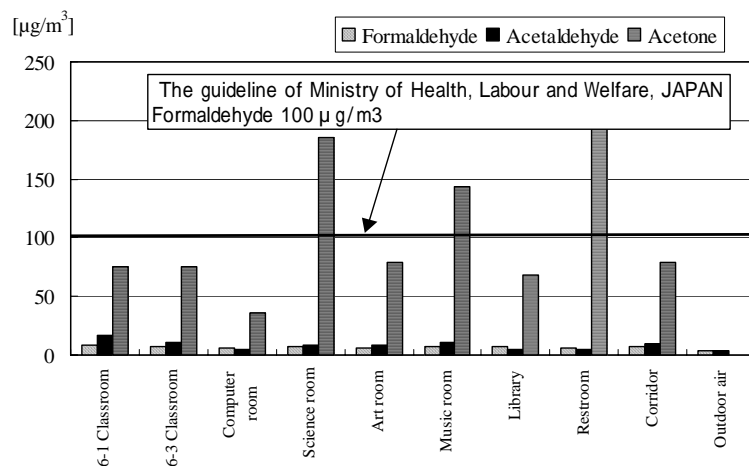


Figure 9 Formaldehyde, Acetaldehyde and Acetone concentration (School-C)

### (2) Formaldehyde concentration after the temperature compensation

Figure 10 shows the compensated concentration by the formula of Inoue in the condition of 25 °C, 50% concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. It is the value of 29 to 39 µg/m<sup>3</sup>. There is no difference between the classroom and the special classroom concentration.

### (3) Results of TVOC concentration

Figure 11 shows the results of the Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration,

and Figure 12 shows the results of total VOC concentration. At these measurement points, every VOC's concentrations are lower than the guideline of Ministry of health, Labor and welfare. The total VOC concentration at the arts room is higher than other measurement point's concentration.

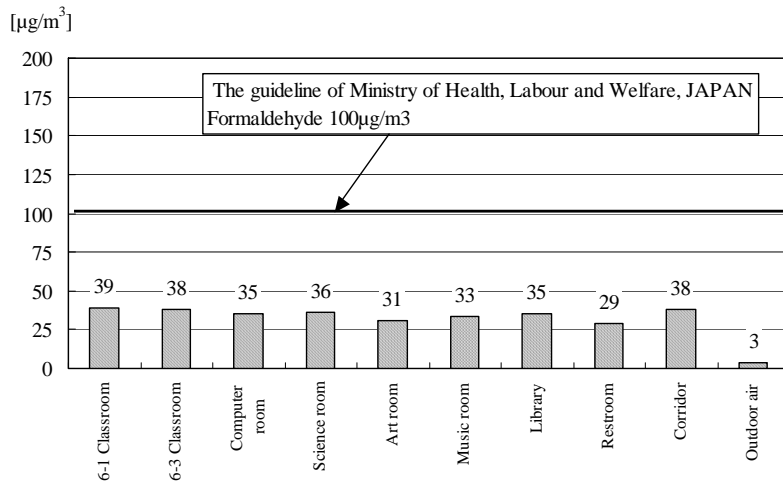


Figure10 Formaldehyde concentration after the temperature compensation (School-C)

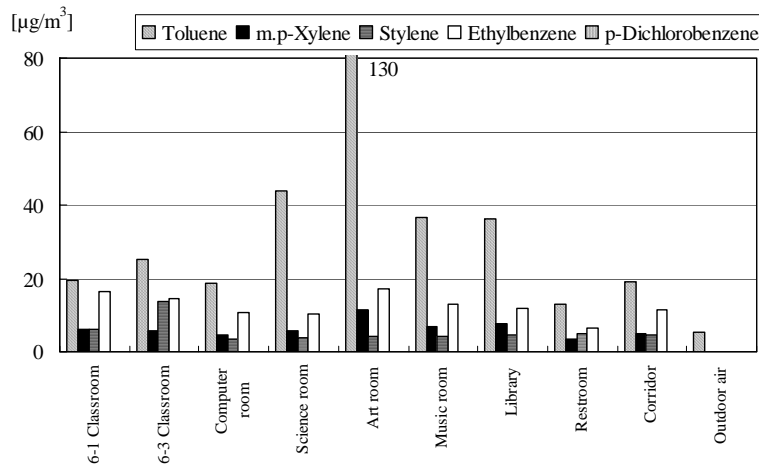


Figure11 Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration (School-C)

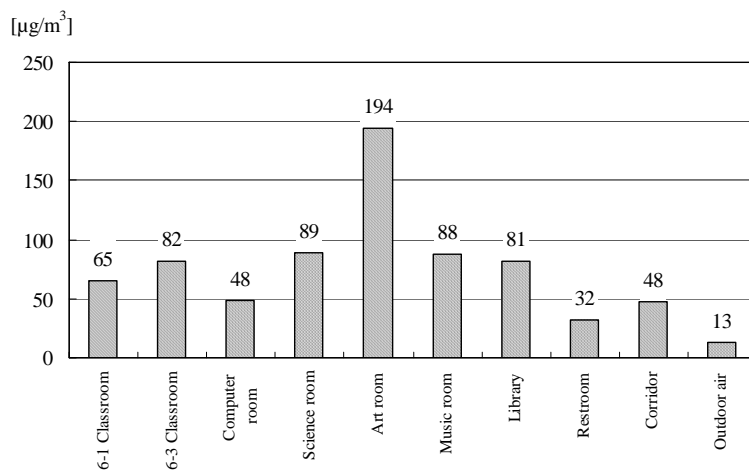


Figure12 Total VOC concentration (School-C)

## Results of junior high school D

### (1) Results of Formaldehyde concentration

Figure 13 shows the result of the Formaldehyde, Acetaldehyde and Acetone concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor

and welfare. The concentration is in the range of 6 to 44 $\mu\text{g}/\text{m}^3$ . Acetone concentration at science room, the music room, the rest room is higher than other measurement points.

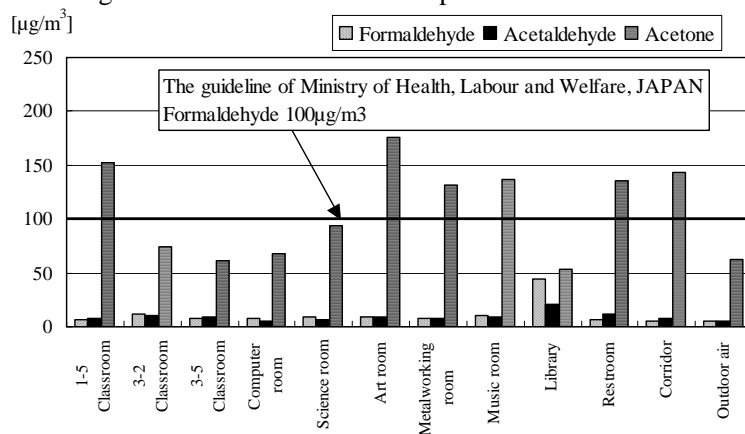


Figure13 Formaldehyde, Acetaldehyde and Acetone concentration (School-D)

**(2) Formaldehyde concentration after the temperature compensation**

Figure 14 shows the compensated concentration by the formula of Inoue in the condition of 25 °C, 50% concentration. At these measurement points, Formaldehyde concentrations are lower than the guideline of Ministry of health, Labor and welfare. It is the value of 33 to 94 $\mu\text{g}/\text{m}^3$ . Formaldehyde concentration at the library is a level as guideline concentration. It shows a tendency of being high in comparison with other measurement points.

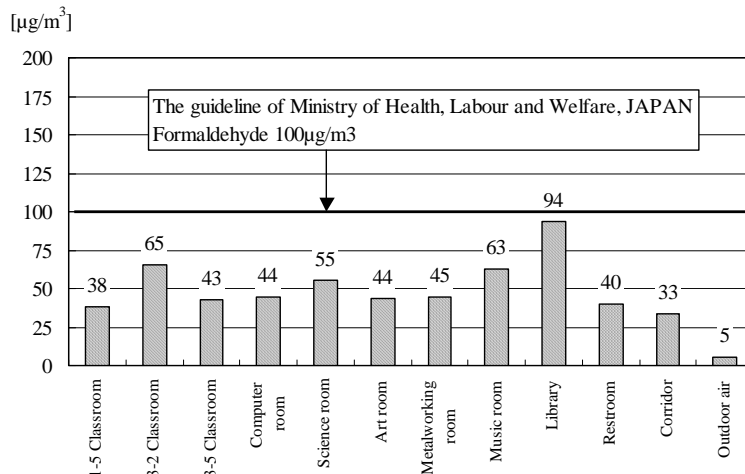


Figure14 Formaldehyde concentration after the temperature compensation (School-D)

**(3) Results of TVOC concentration**

Figure 15 shows the results of the Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration, and Figure 16 shows the result of total VOC concentration. At these measurement points, every VOC's concentrations are lower than the guideline of Ministry of health, Labor and welfare. p-Dichlorobenzene is lower than the not detected limit concentration( $2 \mu\text{g}/\text{m}^3$ ).

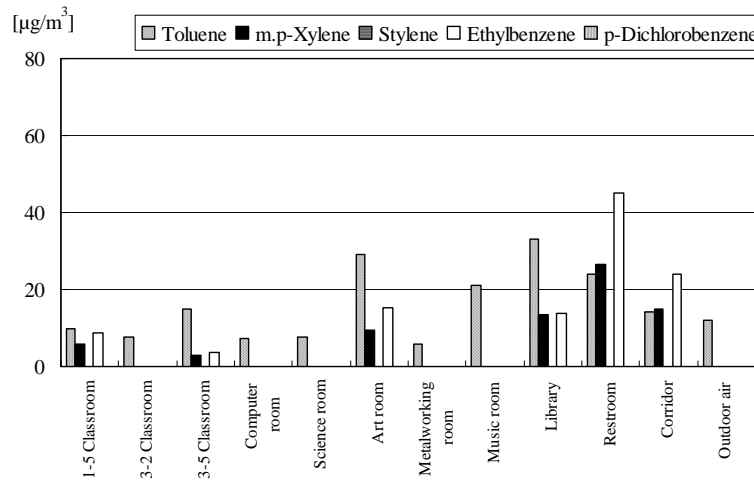


Figure15 Toluene, Xylene, Ethylbenzene and p-Dichlorobenzene concentration (School-D)

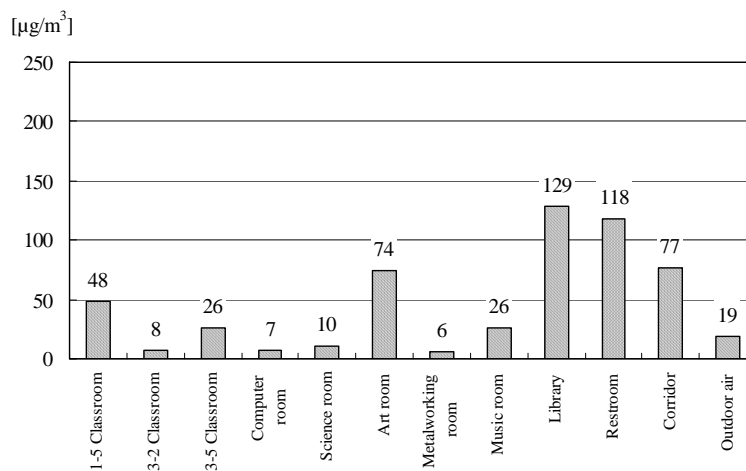


Figure16 Total VOC concentration (School-D)

### Conclusions

As the results of this study, the concentrations of all the classrooms are a low level. The every concentration of the rooms is under the guideline value of the Ministry of health, Labor and welfare of JAPAN. The formaldehyde concentration that temperature was corrected by the formula of Inoue, the elemental school A is 28 to 65  $\mu\text{g}/\text{m}^3$ , school B is 42 to 59  $\mu\text{g}/\text{m}^3$ , elementary school C is 29 to 39  $\mu\text{g}/\text{m}^3$  and the school D is 33 - 94  $\mu\text{g}/\text{m}^3$ . The acetone concentration is the highest value by this measurement. p-Dichlorobenzene isn't detected in most classrooms.

### Reference

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