OR 6/2010

Air Quality in the Classroom

2009 Scandinavian student-based research campaign

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Preface

Student research campaigns (*forskningskampanjer*) have been an annual event in connection to Research Days (*Forskningsdagene*) since 2003 in Norway. The campaigns invite students from all over the country to participate in a common scientific research event, always connected to a special environmentally related theme – the past campaigns include: *Air Quality in the Classroom* (2003), *Pollution along Roads* (2004), *Bacteria in Drinking Water* (2005), *The Rain Check* (2006), *CO_2 on the Way to School* (2007), and the *Solar Energy Campaign* (2008).

The research campaign theme for 2009 attempted to replicate the success of the 2003 air quality campaign (Innset et al., 2003). The 2003 campaign was one of the most successful campaigns which produced excellent results and was highlighted in various media reports after the campaign. The 2009 campaign repeated the same methods as the 2003 campaign, with the added measurement of mold. The campaign included the hands-on activity of taking CO_2 measurements and growing mold spores in the classroom, in which this data was then entered on the campaign website according to each class. In addition, this year both Denmark and Sweden participated in the campaign, adding the value of having a joint Scandinavia campaign, and having results to compare between the countries. Results from the campaign indicate better air quality indications in Norway and Sweden in comparison to Denmark, and improved results in Norway in comparison to 2003.

We would like to sincerely thank all of the schools and classes which participated, both the teachers as driving forces, and the students as cooperative participants. We are certain that the results of the campaign will be of interest to educators, students, parents, and researchers alike. We also thank the Norwegian Research Council (*Forskningsrådet*) and Norden for the financial support to create the campaign as well as for covering the costs of the equipment, and the Centre of Schools' Science Education at the University of Bergen (*Skolelaboratoriet i realfag*) for organizing and designing the campaign website. Thanks also to Teknolab for distributing the equipment to the schools in an efficient manner. The campaign was also a success due to the cooperation with the Danish Natural Science Arrangement (Dansk *Naturvidenskabsformidling*) and the Swedish Research Friday (*Forskarfredag*).

NOTE: A summary of this report is also available in Norwegian: *Inneklima i norsk klasserom: Elevbasert forskningskampanje som del av Forskningsdagene 2009* (Randall, NILU OR 13/2010).

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1 Introduction

The 2009 Scandinavian Research Campaign "Air Quality in the Classroom" was carried out in cooperation between the Norwegian Research Council's Science Days (*Forskningsdagene*), the Centre of Schools' Science Education at the University of Bergen (*Skolelaboratoriet*), the Norwegian Institute for Air Research (*NILU*), the Danish Natural Science Arrangement (Dansk *Naturvidenskabsformidling*) and the Swedish Research Friday (*Forskarfredag*). The Centre of Schools' Science Education handled the most important task of designing and managing the campaign site at www.miljolare.no which guided the entire campaign.

The campaign ran from week 38-40 (September 18th – October 7th, 2009) in Norway, Denmark, and Sweden. The campaign was designed to repeat the *Air Quality in the Classroom* (Innset et al., 2003) student campaign conducted in Norway in 2003 which measured indoor CO_2, while in addition, the 2009 campaign measured indoor mold. As in the 2003 campaign, the 2009 campaign hoped to raise awareness of indoor air quality issues in the classroom through educating students and teachers on monitoring indoor air, air quality indicators, ventilation routines, and associated health risks.

Campaign participants were guided towards increasing their knowledge of indoor air quality through taking real measurements and entering the collected data on the campaign site. Participants also answered basic questions regarding the classroom and school facilities. As with previous campaigns, this campaign was entirely facilitated by the www.miljolare.no website for obtaining guidance, entering the collected data, links to background information, as well as later data analysis (betweens schools, regions, countries, etc.).

The primary goals for the campaign as it was designed are as follows:

- Giving students the experience of taking scientific measurements, reading the results, and entering the data.
- Educate the students on specific indicators for air quality.
- An understanding that the indicators used in the campaign can represent more serious components in the air, pointing towards unhealthy situations in the classroom.
- Educate the students that indoor air quality is important to the development of one's health.
- Learn about the Norwegian Educational Statue §9a regarding the requirements of the physical indoor environment for schools, which states "the air should be fresh and good to breathe in, and not contain harmful elements or gasses".

A secondary goal of the campaign is to apply the results to identify schools which can improve their indoor air quality through better ventilating routines or improved ventilation systems – for the benefit of student's health.

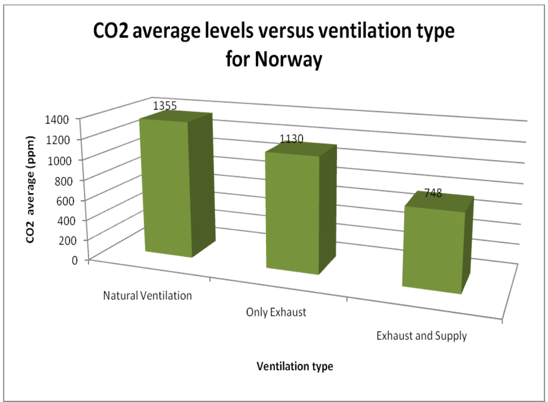
The campaign results show that schools in Norway and Sweden in general have better indoor air quality indications than schools in Denmark. The 2009 results summaries (see Figure 1 and Figure 2) also show improved indicators in Norway in comparison to the 2003 campaign (see Figure 3). However, there are still many classrooms in Norway (22%) which are in the *problematic* and *unacceptable* ranges for the CO_2 indicator – these schools require attention to remediate these poor air quality conditions (mostly likely ventilation issues). There were also classes which measured high numbers of mold colony and/or species growth – these schools also require attention to remediate these poor conditions (mostly moisture and ventilation issues). The results from the campaign can be seen as a successful educational exercise for many students throughout Scandinavia, and it is hoped that these results will initiate action for addressing the schools with indicators for poor conditions. Suggested measures for classrooms with poor indicators include improving the ventilation system/routines, installing continuous CO_2 alert monitors, and/or performing additional monitoring campaigns.

# of schools which registered data (CO_2 + mold):	201
Participation of all schools:	6%
# classrooms (just CO_2 data)	286
# CO_2 measurements	495
Avg. CO_2 concentration:	924
Min CO_2 concentration:	350
Max CO_2 concentration:	5000
% rooms >1000 ppm:	22.4%
% rooms w/ventilation system:	80.7%

 # rooms (avg. concentration)*:

<=800ppm	**OK**	167
801-1000ppm	**ACCEPTABLE**	56
1001-2000ppm	**PROBELMATIC**	55
>2000ppm	**UNACCEPTABLE**	9

**range generated by NILU in the 2003 report (Innset et al., 2003)*



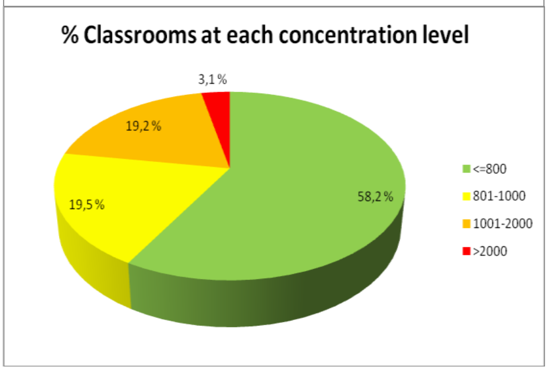
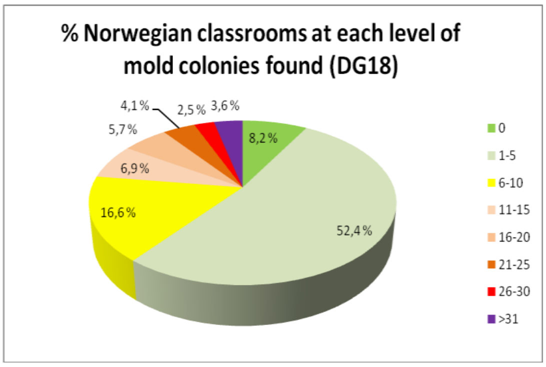


Figure 1: 2009 Norwegian Campaign CO_2 Results Summary.

# of schools which registered data (CO_2 + mold):	201
Participation (%):	6
# classrooms (just mold data)	200
# mold measurements	324
Avg. # colonies:	7.9
Avg. # species:	2.6
>=10 colonies	22.8%
>=4 species	20.7%
% rooms w/ventilation system:	80.7%

 # samples at each species level:

0 species	26
1 species	100
2 species	76
3 species	51
4 species	17
5 species	10
6 species	3
7 species	14
8 species	22



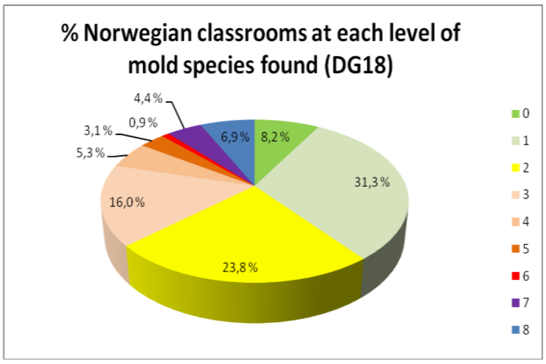


Figure 2: 2009 Norwegian Campaign Mold Results Summary[1]

1.1 Background – 2003 Campaign Results

Since this year's campaign was modeled after the 2003 campaign which was performed only in Norway, it is beneficial to reiterate the findings from this original campaign. The 2003 campaign report (Innset et al., 2003) summarized the results as following.

There were 1018 schools (28% of Norway's schools) which registered for the campaign, while 688 schools (19% of Norway's schools) uploaded data within the deadline. Over 2/3 of these schools completed all parts of the campaign.

Figure 3 below shows a compiled overview over the most important results from the campaign. The results were also assessed against additional parameters such as ventilation systems, room volume per student, and manual ventilation of the classes.

[1] Only DG18 data was used in this summary table, which totals 319 total measurements.

# of schools which registered data:	688
Participation (%):	19
# classrooms:	1085
Avg. CO_2 concentration:	1175
Min CO_2 concentration:	400
Max CO_2-concentration.:	5000
% rooms over 1000 ppm:	42
% rooms with ventilation:	82
# rooms:	
<=800	354
801-1000	275
1001-2000	377
>2000	79

% Classrooms in each level

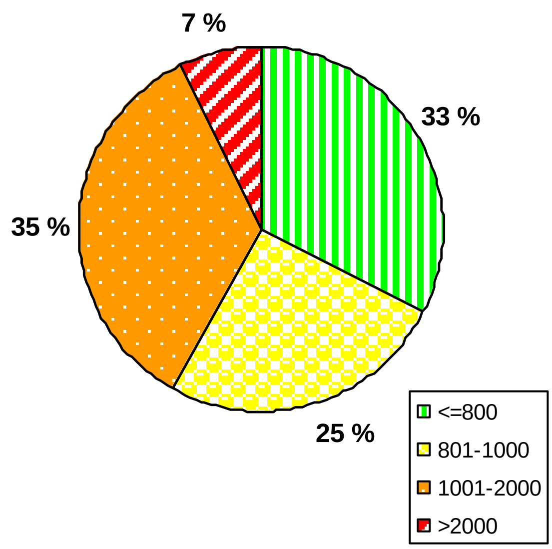


Figure 3: 2003 Campaign Results Summary (only CO_2).

The results from the 2003 campaign give the following conclusions:

- A majority (58%) of the classrooms had CO_2 concentrations lower or equal to the recommended average and are thus considered "acceptable".
- 35% of the classrooms had "problematic" air quality, and 7% had "unacceptable" air quality.
- There is considerably better air quality in classrooms with ventilation systems than classrooms without, even though some classrooms with ventilation systems still had "problematic" or "unacceptable" air quality.
- Air quality is directly correlated to the room volume per person in the classroom (ie. higher density of student results in poorer air quality).
- There is a correlation between how the students experience the air quality in the classrooms and the actual measured values.

Due to these 2003 results, NILU recommended that schools with poor air quality focus on utilizing all options available to improve the conditions. These include improving the maintenance routines for the ventilation systems and reducing the about of students in a given room. In addition, to investigate if whether better manual ventilation routines and reduced occupation time in a given room will give positive results.

One of the primary recommendations from the 2003 campaign was to repeat the same campaign within a few years to compare results and begin to visualize trends, while also continuing to educate students and teacher on indoor environment issues. The 2009 accepted this recommendation through repeating the campaign, and following the same methods to ensure comparability.

2 Methodology

The campaign methods were similar to the previous student research campaigns in Norway in that the classes registered for the campaign on the campaign website (*www.miljolare.no/kampanjer/forskningskampanjen/2009/*), the classes then received the necessary equipment, performed the measurements, and entered the data on their class account on the campaign website. All supporting documentation and guidance information was also available on the campaign site as well. The guidance and documentation was broken into two categories: CO_2 (*www.miljolare.no/aktiviteter/by/ressurs/br9/*) and mold (www.miljolare.no/aktiviteter/by/ressurs/br35/).

2.1 Materials and methods

The campaign activity involved three primary elements:

1. The schools registered on the campaign website, and collected the equipment (Figure 4 and Figure 5). The equipment package consisted of the following components:
   - One 100ml hand pump with silicon adapter tube
   - Two CO_2 absorption tubes, 300-5000ppm detection (Gastec 2LL)
   - One Metal file (not all packages contained a file, those without were instructed to use scissors)
   - Six DG18 prepared petri dishes
   - Six V8 prepared petri dishes

Figure 4: CO_2 equipment.

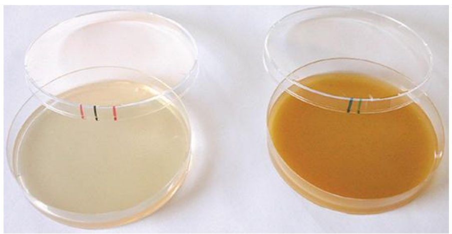


Figure 5: DG18 and V8 Petri dishes.

2. The classes performed at least one CO_2 measurement using the hand pump (the number of measurements depended on the number of CO_2 absorption tubes ordered). The CO_2 measurement(s), including other parameters describing the classroom, was entered under the registered class account on the campaign site. The guidance material for this exercise can be found in Appendix A, and the data sheet in Appendix B, this information is also on the campaign site (www.miljolare.no/aktiviteter/by/ressurs/br9/?vis=veiledning).

3. The classes set out six petri dishes (three dishes prepared with DG18, and three prepared with V8) in the classroom for a one hour exposure period. DG18 (Dichloran 18% Glycerol agar) is a mixture based on Glycerol which reduces water activity, making this mixture excellent for capturing airbourne molds in drier environments; V8 is a vegetable based agar which is best at capturing molds in humid environments. After the petri dishes were exposed, they were placed in plastic bags and left in a dark area at room temperature. After seven days in this condition, the dishes were removed, and the mold growth was identified and counted using a mold spore key (the key can be found in Appendix C). The mold data, including other parameters describing the classroom, was entered under the registered class account on the campaign site. The guidance material for this exercise can be found in Appendix D, and the data sheet in Appendix E, this information is also on the campaign site (www.miljolare.no/aktiviteter/by/ressurs/br35/?vis=veiledning).

The students and teachers were also given links on the campaign site to explore addition background material on indoor air quality, and how the campaign is linked to the teaching curriculum goals (in Norwegian):

- Background information (CO_2):
  www.miljolare.no/aktiviteter/by/ressurs/br9/?vis=ressurser
- Connection to teaching plans (mold):
  www.miljolare.no/aktiviteter/by/ressurs/br9/?vis=lareplan
- Background information (mold):
  www.miljolare.no/aktiviteter/by/ressurs/br35/?vis=ressurser
- Connection to teaching plans (mold):
  www.miljolare.no/aktiviteter/by/ressurs/br35/?vis=lareplan

2.2 Participants

From Denmark there participated 325 different schools which resulted in 820 unique measurements, which occurred in approximately 600 different classrooms.

From Sweden there participated 132 different schools which resulted in 245 unique measurements, which occurred in approximately 200 different classrooms.

201 different schools from Norway participated in the campaign, all from varying regions, with a relatively equal distribution by population which means more participants in the southern regions (see Figure 6, and Table 1 below). Approximately 414 Norwegian classrooms were measured for all campaign exercises, with a total of 716 unique CO_2 measurements and 324 unique mold measurements, which totaled over approximately 12,000 students participating in this year's campaign - a full list of all participating schools can be found in Appendix F. 58 of the 201 participating schools (28%) also participated in the 2003 campaign, see Appendix G.

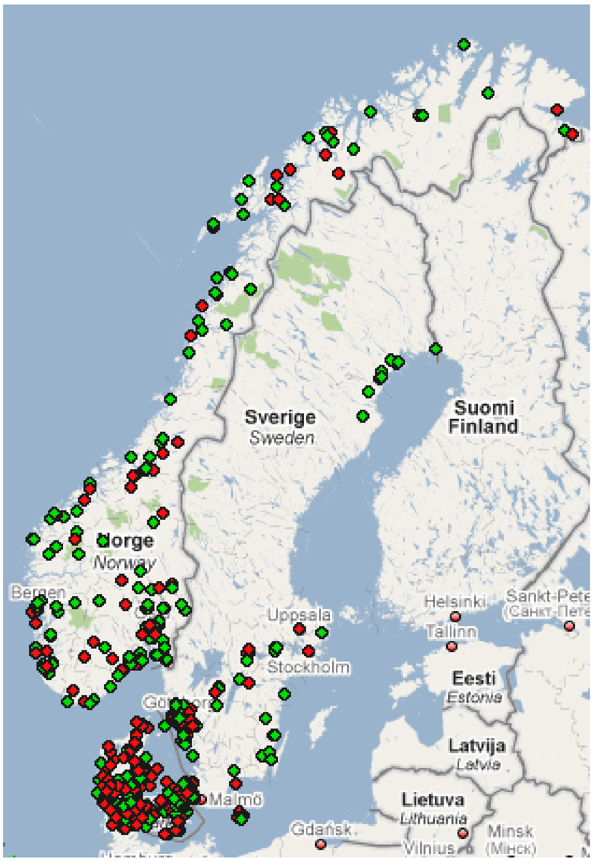


Figure 6: Map of participating schools for all of Scandinavia.

Table 1: Number of participating schools and classes by region in Norway (for the CO_2 exercise).

Region	Schools	Classes	Measurements
Akershus	16	36	60
Aust-Agder	2	6	6
Buskerud	5	8	18
Finnmark	8	16	23
Hedmark	9	22	34
Hordaland	24	60	101
Møre og Romsdal	11	20	43
Nord-Trøndelag	7	12	22
Nordland	20	45	70
Oppland	10	25	37
Oslo	11	16	23
Rogaland	16	36	67
Sogn og Fjordane	7	12	25
Sør-Trøndelag	8	13	23
Telemark	11	23	40
Troms	16	34	66
Vest-Agder	6	11	20
Vestfold	6	7	18
Østfold	8	12	20
Total	**201**	**414**	**716**

3 Results

Results from the campaign are broken down into the CO_2 and the mold exercise results. The results entered during the campaign period were visible in real time, and are still available on the campaign site to view and compare between/within countries, regions, and schools. While this report presents the results from the entire Scandinavian campaign, the primary focus of the results and analysis will be on the Norwegian data collected.

3.1 CO_2 Results

The results are first presented at the Scandinavian level in the first sub-section below, and the following sub-section concentrates on the Norwegian results. The data-set analyzed for this section was the data available after the campaign on October 29th 2009, and this data-set was treated to remove outliers[2]. The raw CO_2 results are fully analyzed, and in addition, the following variables are compared to the CO_2 results at both geographical levels:

- Classroom temperature
- Classroom student density
- Age of school building
- Classroom Ventilation type
- Perception of indoor AQ problems in classroom (using smell)

The 2003 campaign CO_2 results (and any of the other available variables listed above) were also compared to the 2009 CO_2 data for Norway. As previously mentioned, approximately ¼ of the schools which participated in the 2009 campaign also participated in the 2003 campaign, so these comparisons are not equal data sets, and are presented to show rough generalizations of potential trends.

CO2 as an *indicator*: CO2 measurements are often used to analyze indoor air quality. CO2 in itself is not directly detrimental to human health at the levels found in the campaign, but concentrations of this gas point to how good the air quality is, and if there is a need for better fresh air influx. High CO2 levels can be a sign that the airflow is poor in relation to the number of people in the room; it can also mean that the air contains high levels of more health damaging pollutions as well.

As presented in the Introduction section of this report, the CO_2 concentrations (measured as ppm, or parts per million) can be categorized as follows[3]:

<=800	**OK**
801-1000	**ACCEPTABLE**
1001-2000	**PROBELMATIC**
>2000	**UNACCEPTABLE**

[2] The outliers removed included values that were below the approximate atmospheric value of 400ppm CO2.

[3] This categorization was generated by NILU for the 2003 campaign report (Innset et al., 2003).

CO_2 concentrations at 800ppm or lower can signify that there are no high indicators for poor air quality, and the classroom can be designated as “OK” regarding CO_2 concentrations. CO_2 concentrations between 801ppm and 1000ppm can signify that there are elevated indicators for poor air quality, but the classroom can be designated as “acceptable”. CO_2 concentrations between 1001-2000ppm can signify that there are high indicators for poor air quality, and the classroom can be designated as “problematic”. CO_2 concentrations over 2000ppm can signify that there are very high indicators for poor air quality, and the classroom can be designated as “unacceptable”. It should again be noted however that CO_2 levels in themselves are not harmful at these concentrations, but elevated CO_2 is a good indicator for the potential presence of other more harmful components in the air which effect air quality – such as Volatile Organic Compounds (VOC’s), by-products from cleaning chemicals, and particulates, sometimes Ozone, Radon, and Carbon Monoxide can also be considered in this category.

3.1.1 CO_2 Results Scandinavia

CO_2 summary results for Norway, Denmark, and Sweden can be seen in Table 2, where the most dramatic results of the campaign are the differences between Denmark and Norway/Sweden. CO_2 results for Norway and Sweden show that approximately 20% of the classrooms have concentrations in the problematic to unacceptable range, where Danish classrooms have over 50% in this range. All of the combined results for Scandinavia can be found in Table 3, and the combined percentage of all measurements at each concentration level can be seen in Figure 7. Specific results for Denmark and Sweden can be found in Appendix H and Appendix I respectively. It should be noted that the comparison of data between countries in this section is reyling on datasets of different sizes.

Table 2: CO_2 summary results for Denmark, Norway, and Sweden.

Country	Schools	Measurements	Rooms	<1000 ppm	> 1000 ppm	proportion over/under 1000 pm
Denmark	326	790	737	45%	55%	
Norway	201	716	414	78%	22%	
Sweden	136	245	222	84%	16%	

Table 3: Combination of all Scandinavia CO_2 results.

1-100 ppm	0%	4
101-200 ppm	1%	13
201-300 ppm	2%	28
301-400 ppm	3%	50
401-500 ppm	8%	114
501-600 ppm	14%	214
601-700 ppm	6%	92
701-800 ppm	8%	123
801-900 ppm	3%	47
901-1000 ppm	17%	250
1001-1100 ppm	1%	22
1101-1200 ppm	4%	66

1201-1300 ppm	1%	17
1301-1400 ppm	4%	53
1401-1500 ppm	2%	32
1501-1600 ppm	3%	45
1601-1700 ppm	1%	18
1701-1800 ppm	2%	37
1801-1900 ppm	1%	8
1901-2000 ppm	5%	80
2001-2100 ppm	0%	4
2101-2200 ppm	1%	19
2201-2300 ppm	0%	3
2301-2400 ppm	3%	47
2401-2500 ppm	0%	1
2501-2600 ppm	1%	12
2601-2700 ppm	0%	1
2701-2800 ppm	1%	19
2801-2900 ppm	0%	2
2901-3000 ppm	1%	11
3101-3200 ppm	1%	19
3201-3300 ppm	0%	1
3301-3400 ppm	0%	5
3501-3600 ppm	0%	7
3701-3800 ppm	0%	4
3901-4000 ppm	0%	7
4001-4100 ppm	0%	4
4401-4500 ppm	0%	1
4701-4800 ppm	0%	1
4901-5000 ppm	0%	1
5901-6000 ppm	0%	2

Total

<=1000 ppm	63%	935
>1000 ppm	37%	549

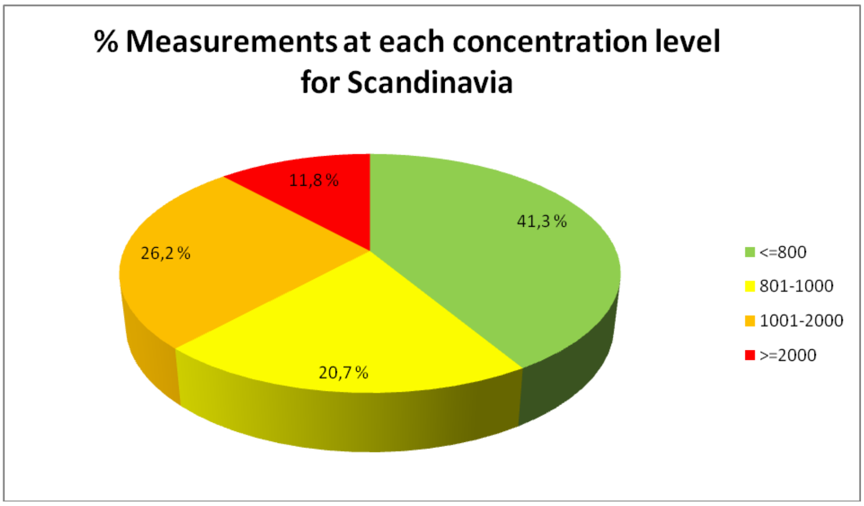


Figure 7: Percentage of measurements at each concentration level for Norway, Sweden, and Denmark combined.[4]

Elevated CO_2 levels can also be associated with higher classroom temperatures, which can be seen as an indication of poor ventilation during cooler outdoor periods. The ideal comfort range for indoor temperature is 20-22 degrees Celsius, and temperatures above this range (during cooler periods) can be problematic. Table 4 shows all of the combined Scandinavian temperature measurements taken during the CO_2 exercise (temperature measurements were taken at the same height of the CO2 measurments), where almost 2/3 of the classrooms are outside of the ideal range. Figure 8 presents temperature and CO_2 levels for each country, where these two variable comparisons show no clear correlation.

Table 4: Combination of all Scandinavian Temperature results taken during CO_2 exercise.

3-4 ºC	0%	1
11-12 ºC	0%	1
14-15 ºC	0%	1
15-16 ºC	0%	1
17-18 ºC	0%	4
18-19 ºC	2%	42
19-20 ºC	4%	100
20-21 ºC	18%	404
21-22 ºC	19%	431
22-23 ºC	21%	488
23-24 ºC	16%	367
24-25 ºC	10%	225
25-26 ºC	6%	136
26-27 ºC	2%	51
27-28 ºC	1%	24
28-29 ºC	0%	8

[4] The percentages indicated here are slightly different that the totals shown in Table 4 above because this figure is based on a treated dataset which has removed all values below 350ppm.

29-30 ºC	0%	1
30-31 ºC	0%	1
33-34 ºC	0%	1
Total		
Within the ideal temp (20-22 ºC)	37%	835
Outside the ideal temp	63%	1452

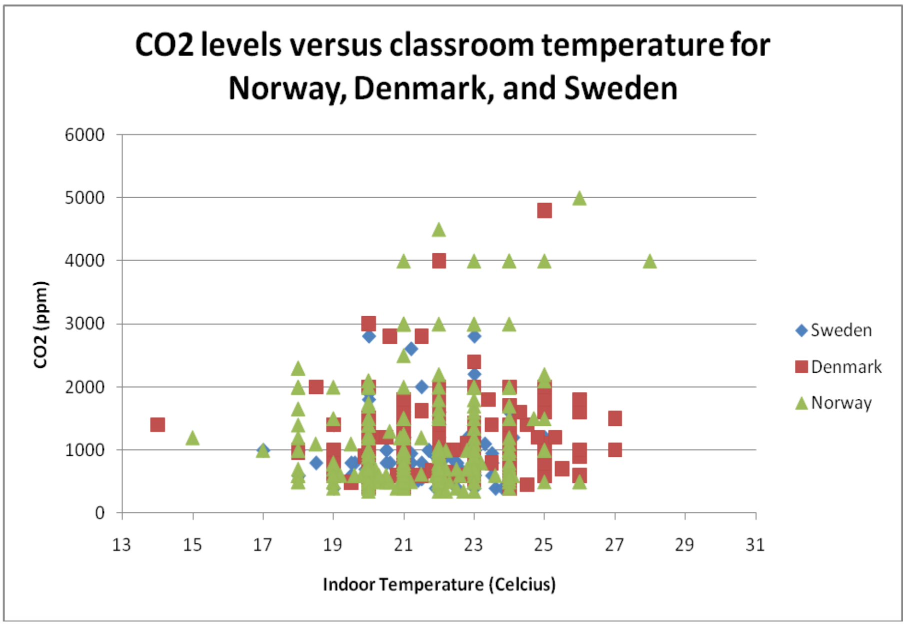


Figure 8: Classroom CO_2 levels and temperature for Norway, Sweden, and Denmark.

The density of students per classroom can directly influence the CO_2 levels through respiration if there is poor ventilation. So student density is also an important component to analyze and consider regarding indoor air quality assessments. For Norway, the average number of students per classroom was 18.9, with 12.3m^3 available for each student. For Sweden, the average number of students per classroom was 21.0, with 11.1m^3 available for each student. For Denmark, the average number of students per classroom was 19.6, with 11.3m^3 for each student. These values seem fairly similar, however, compared to Denmark and Sweden, there are slightly fewer Norwegian students in each classroom, and each of these students have approximately 1m^3 more volume in the room. Figure 9 shows that student density is actually not well correlated to CO_2 levels in Scandinavian classrooms in this campaign.

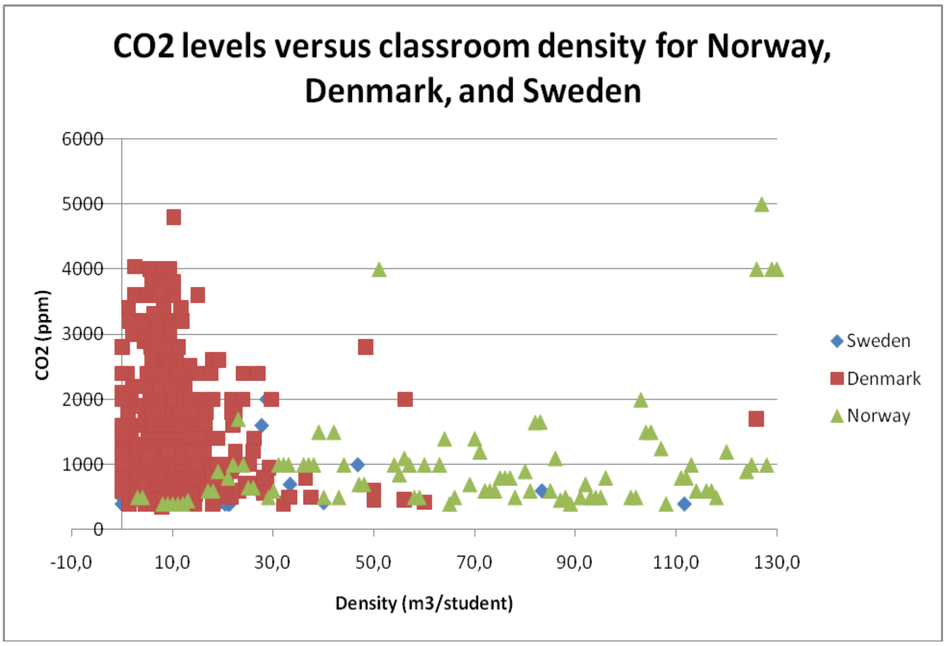


Figure 9: Classroom CO_2 levels and student density for Norway, Sweden, and Denmark.

The age of the school buildings can determine the ventilation strategy or system constructed to handle the indoor air flow, where it should be generalized that newer schools should have better installed ventilation systems (whether they are mechanical and/or manual) to insure improved air quality. Figure 10 shows the year that the school was built in comparison to the CO_2 values recorded, where no correlation between these variables is evident.

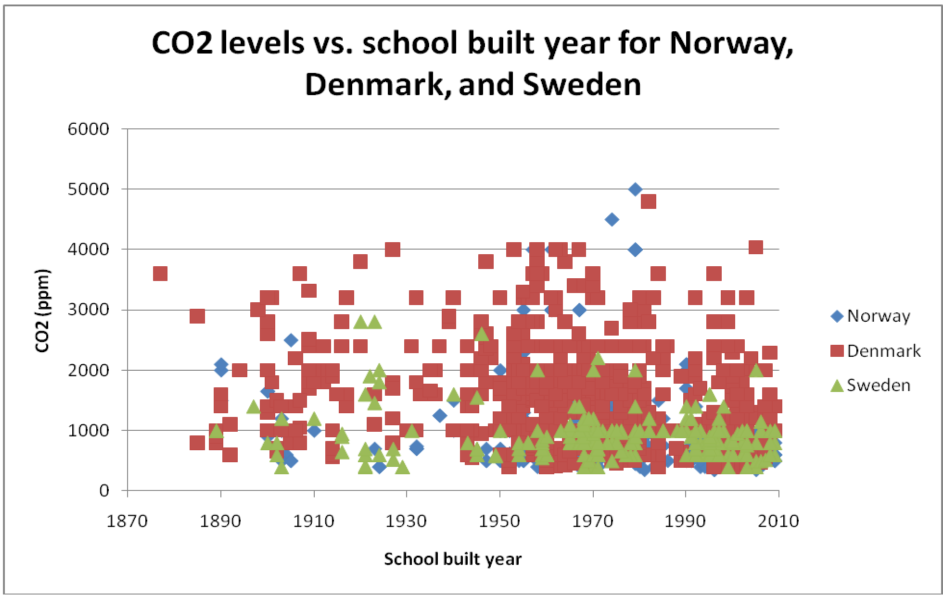


Figure 10: Classroom CO_2 levels and school age for Norway, Sweden, and Denmark.

The most important variable that dictates indoor CO_2 levels, and corresponding air quality issues, is the quality of the ventilation system to remove and replenish air in the classrooms. As indicated earlier, the Danish CO_2 levels were staggeringly higher than Norway and Sweden, and this can be attributed to the more basic ventilation systems (ie. mostly categorized as "manual ventilation") seen on average in Denmark compared to Norway[5], see Table 5. This table shows that Norway has a higher percentage of classrooms with "mechanical" and "advanced mechanical" ventilation systems in comparison to Denmark.

Table 5: Ventilation system distribution in Denmark and Norway.

Ventilation type	Category	Denmark	Norway
Natural Ventilation	Manual	51%	19%
Only Exhaust	Mechanical	18%	17%
Exhaust and Supply	Advanced Mechanical	31%	64%

The campaign results proved the fact that mechanical type ventilation systems produce lower CO_2 levels, and in turn, ***indicating*** better air quality conditions. Figure 11 shows that CO_2 levels slightly decreased as the ventilation system quality increased, for both Denmark and Norway, however the standard deviations for these average values are large which does not lend significant confidence to this comparison.

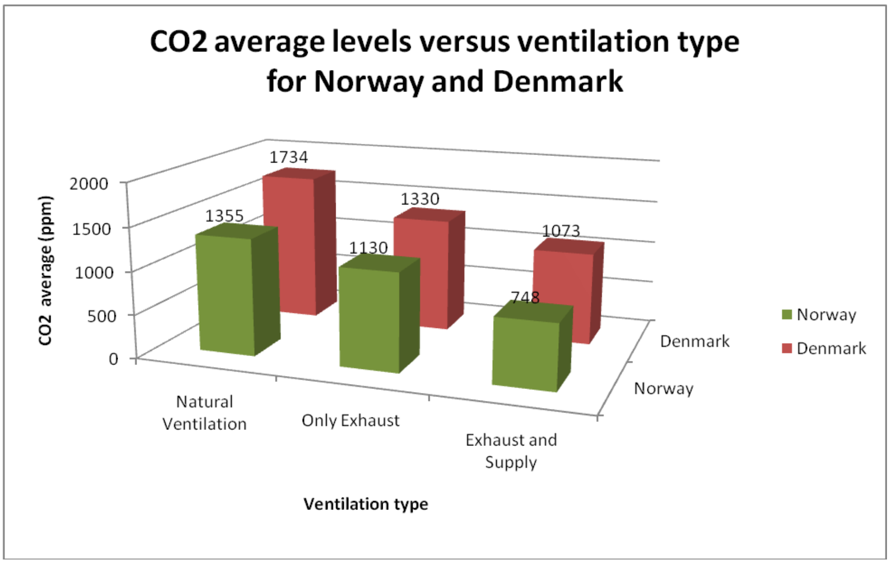


Figure 11: Average CO_2 values for each ventilation type for Norway and Denmark.

An unexplainable factor regarding the results of Figure 11 is why the results differ so largely between Norway and Denmark for each ventilation system category. For example, for classrooms with exhaust and supply (the most optimal ventilation type), the average CO_2 measurement for this category in Norway was 748ppm, and 1073ppm in Denmark. The other categories also show a 200-300ppm increase of average CO_2 values for each category for Denmark.

[5] The Swedish campaign did not investigate ventilation systems, so no results are available.

3.1.2 CO_2 Results Norway, and 2003 comparisons

A distribution of all of the 495 CO_2 measurements for Norway can be seen in Table 6. This distribution shows that 79% of all collected values are less than or equal to 1000ppm, and 21% of the values are greater than 1000ppm. These 495 measurements were collected in 286 different classrooms (each classroom took an average of 1.7 measurements), and a similar breakdown can be seen between the classrooms, where 78% of the classrooms have an average CO_2 value which is less than or equal to 1000ppm, and 22% of the classrooms have an average greater than 1000ppm. Figure 12 shows the percentage of Norwegian classrooms at each concentration level, and the associated air quality indicator color rating as presented in Section 3.1.

Table 6: Distribution of all 495 CO_2 measurements in Norway (2009)[6].

301-400 ppm	5.1 %	25
401-500 ppm	17.2 %	85
501-600 ppm	18.6 %	92
601-700 ppm	10.7 %	53
701-800 ppm	7.5 %	37
801-900 ppm	2.4 %	12
901-1000 ppm	17.4 %	86
1001-1100 ppm	1.6 %	8
1101-1200 ppm	2.4 %	12
1201-1300 ppm	1.2 %	6
1301-1400 ppm	1.4 %	7
1401-1500 ppm	4.6 %	23
1501-1600 ppm	0.4 %	2
1601-1700 ppm	1.2 %	6
1701-1800 ppm	0.6 %	3
1901-2000 ppm	3.0 %	15
2001-2100 ppm	0.6 %	3
2101-2200 ppm	0.4 %	2
2201-2300 ppm	0.4 %	2
2401-2500 ppm	0.0 %	0
2901-3000 ppm	0.2 %	1
3901-4000 ppm	1.4 %	7
4401-4500 ppm	1.2 %	6
4901-5000 ppm	0.2 %	1
Total		
<=1000 ppm	78.8%	390
>1000 ppm	21.2%	105

[6] Values <=349ppm were removed from the dataset because they are lower than the atmospheric standard of approximately 380ppm.

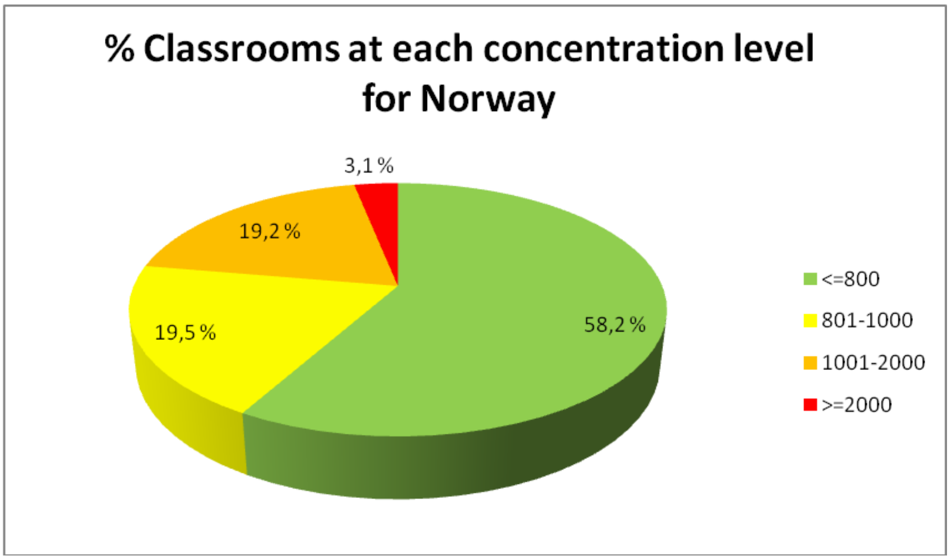


Figure 12: Percent of Norwegian classrooms at each concentration level (2009).

The 2009 values can be generalized as a possible improvement in comparison to the 2003 campaign performed in Norway (Figure 13)[7]. Table 7 examines the potential improvement of these values between the years, where 20% more classrooms were under 1000ppm in 2009 compared to 2003, and Figure 14 shows that that the average CO_2 value has decreased by 250ppm from 2003 to 2009, however the standard deviation for this comparison is large for both values.

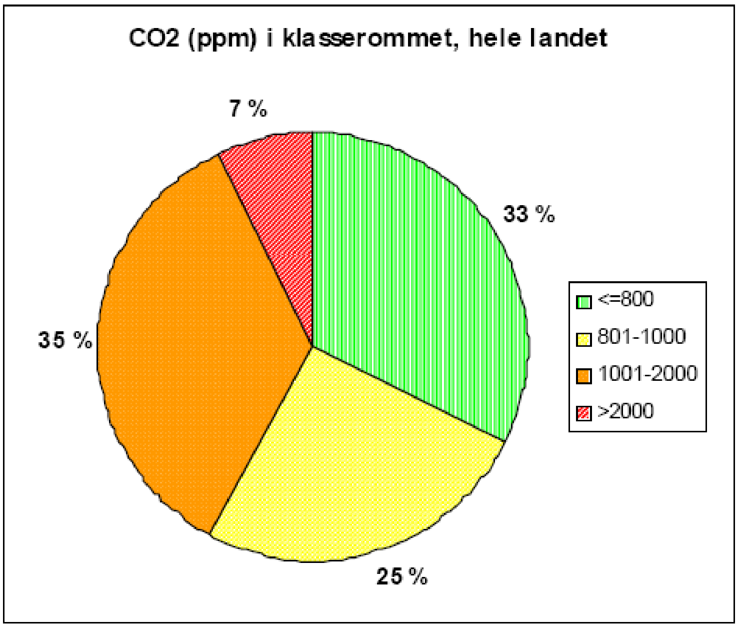


Figure 13: Percent of Norwegian classrooms at each concentration level (2003). (Source: Innset et al., 2003)

[7] As previously stated, only 28% of the schools are similar between the two datasets (2003 and 2009), so this comparison is rough, see Appendix G.

Table 7: Comparison of concentration level values between years, and the percentage difference for each level.

	2003		2009		
	# Classroom	%Classroom	# Classrooms	% Classroom	% difference
<=800ppm	354	33%	167	58%	+25%
801-1000ppm	275	25%	55	20%	-5%
1001-2000ppm	377	35%	56	19%	-21%
>2000ppm	79	7%	9	3%	-4%

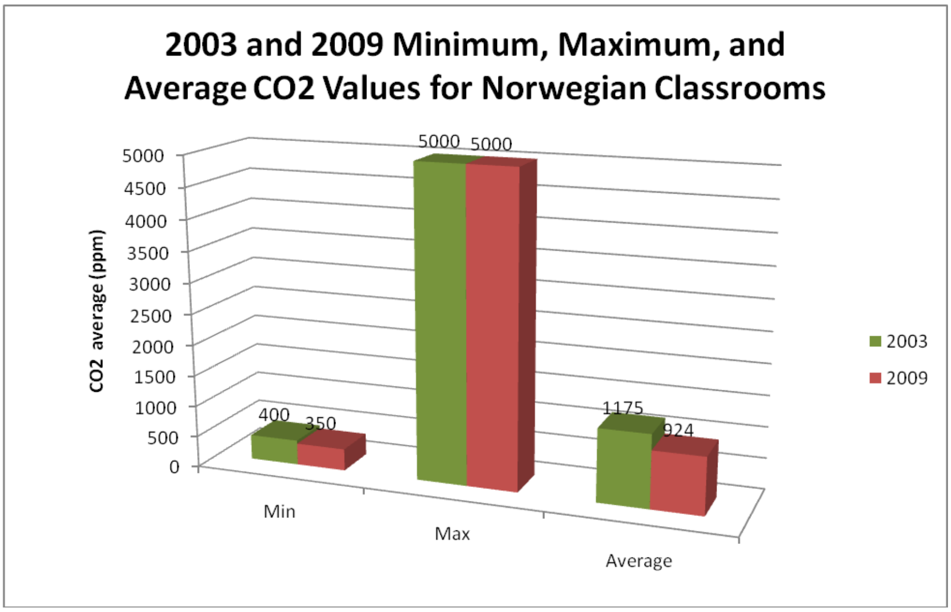


Figure 14: Minimum, maximum, and average CO_2 values for Norwegian classrooms (2003 and 2009).

The total measurement results are also divided for each region, and can be seen in Table 8. There is a large variation between regions for average values when examining them at the 1000ppm cut-off level. Almost half of the measurements taken in Sør-Trøndelag have an average value greater than 1000ppm, in comparison to regions like Vestfold and Nordland where less than 10% of the measurements are greater than 1000ppm. Oslo is the second highest region, where 38% of the measurements taken are greater than 1000ppm. These large differences can be attributed to the fine resolution of examining the values at the regional level, i.e. the sample size within each region is too small to be able to compare the regional values between eachother, thus this comparison can not be seen as being statistically significant.

Table 8: Number of schools, number classrooms, and total measurements per region, with a focus on % above/below 1000ppm (2009).[8]

Region	Schools	Measure ments	Room	<1000 ppm	> 1000 ppm	proportion over/under 1000 pm
Akershus	16	36	60	88%	13%	
Aust-Agder	2	6	6	75%	25%	
Buskerud	5	8	18	71%	29%	
Finnmark	8	16	23	75%	25%	
Hedmark	9	22	34	70%	30%	
Hordaland	24	60	101	86%	14%	
Møre og Romsdal	11	20	43	81%	19%	
Nord-Trøndelag	7	12	22	76%	24%	
Nordland	20	45	70	92%	8%	
Oppland	10	25	37	83%	17%	
Oslo	11	16	23	63%	38%	
Rogaland	16	36	67	89%	11%	
Sogn og Fjordane	7	12	25	79%	21%	
Sør-Trøndelag	8	13	23	52%	48%	
Telemark	11	23	40	76%	24%	
Troms	16	34	66	67%	33%	
Vest-Agder	6	11	20	69%	31%	
Vestfold	6	7	18	93%	7%	
Østfold	8	12	20	87%	13%	

Table 9 contains the temperature results for Norway which shows that a majority of classrooms (54%) are within the optimal range, where 24% of the measurements are on the border above or below this optimal range, and 17% of the measurements are too high (23C+). For Norway, there was no significant correlation between temperature and CO_2 values (Figure 15).

Table 9:Temperature distributions associated with each measurement (2009).

3-4 ºC	0%	1
11-12 ºC	0%	1
15-16 ºC	0%	1
17-18 ºC	0%	3
18-19 ºC	4%	29
19-20 ºC	6%	41
20-21 ºC	30%	220
21-22 ºC	24%	180
22-23 ºC	18%	136
23-24 ºC	9%	67
24-25 ºC	6%	44
25-26 ºC	2%	15
26-27 ºC	0%	3
28-29 ºC	0%	1
Total		
Within the ideal temp (20-22 ºC)	54%	400
Outside the ideal temp	46%	342

[8] This %values for ><1000pppm are generated from a later dataset after the official campaign was completed, but they are considered consistent with the dataset used throughout this report.

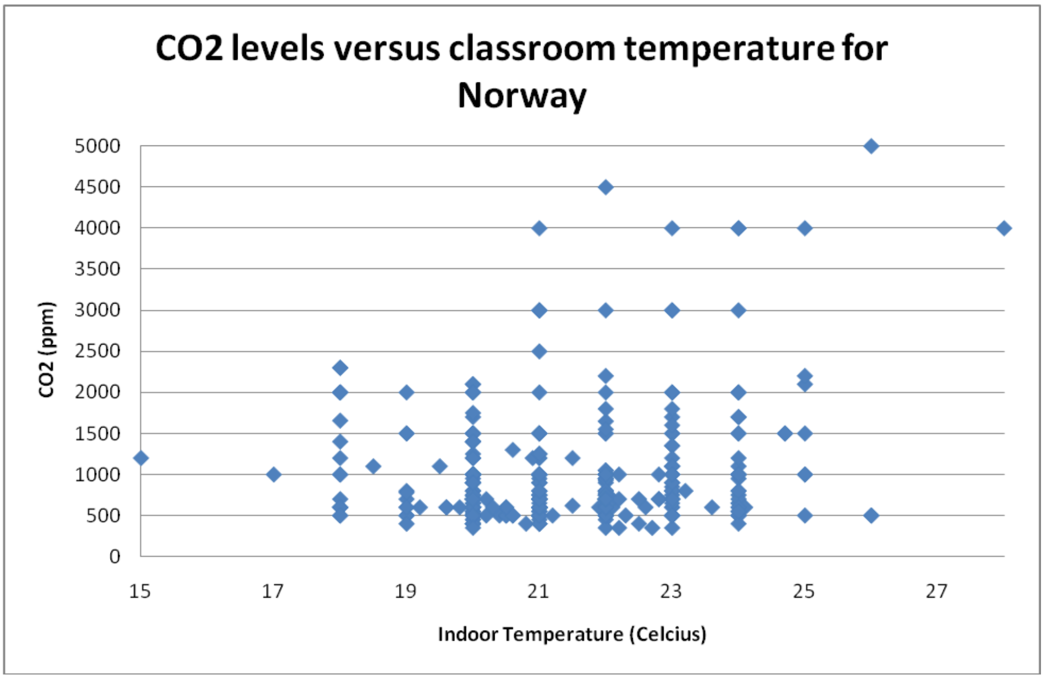


Figure 15: CO_2 value versus classroom temperature for Norway (2009).

In the previous section it was mentioned how classroom density did not correlate to the CO_2 levels for Norway, but it is interesting to compare these values to a similar plot for 2003 (Figure 16 and Figure 17). It does not appear that there was a correlation for this comparison in 2003 either, but it should be noted that the two plots are very dissimilar for unknown reasons.

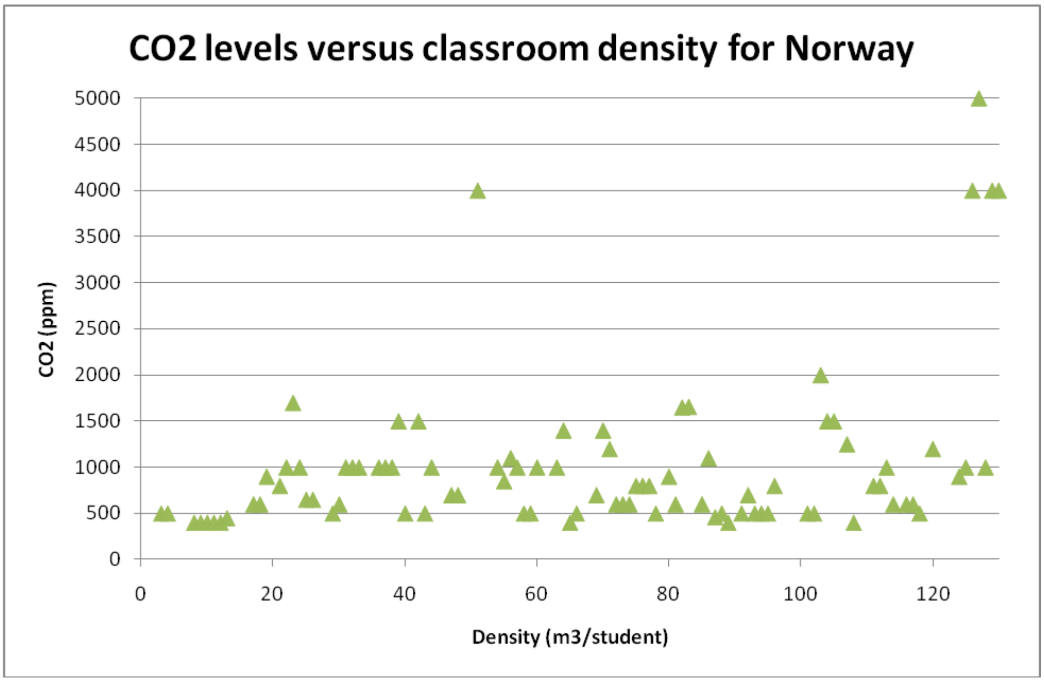


Figure 16: 2009 CO_2 levels versus classroom density (m3/student) for Norway (2009).

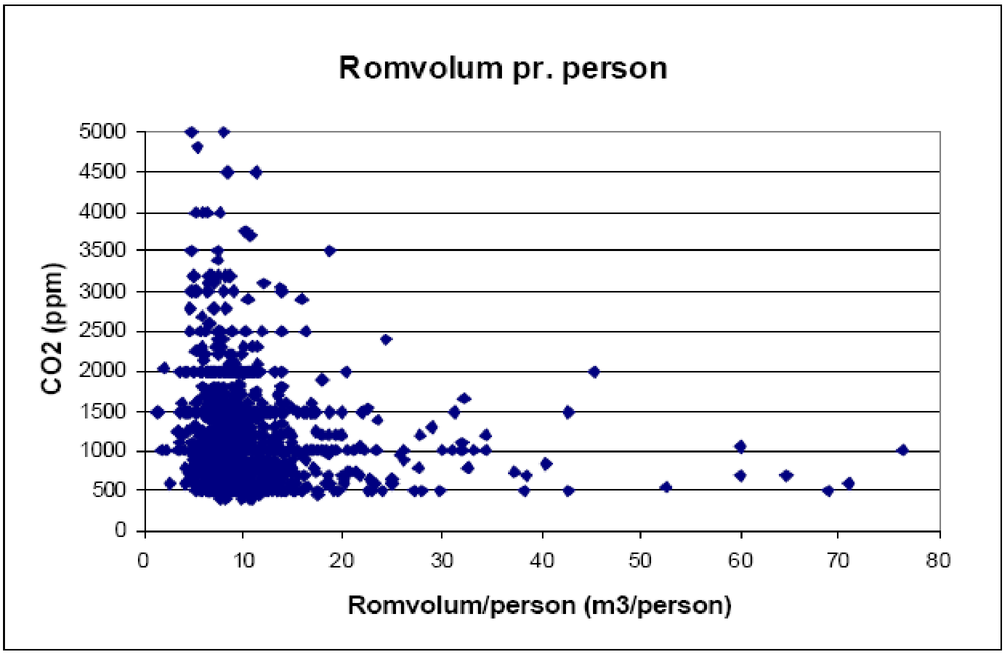


Figure 17: 2003 CO_2 levels versus classroom density (m3/student) for Norway. (Source: Innset et al., 2003)

CO_2 values as a factor of school age in Norway are shown in Figure 18. There is no significant correlation between these variables, where similar results were found during the 2003 campaign, see Figure 19.

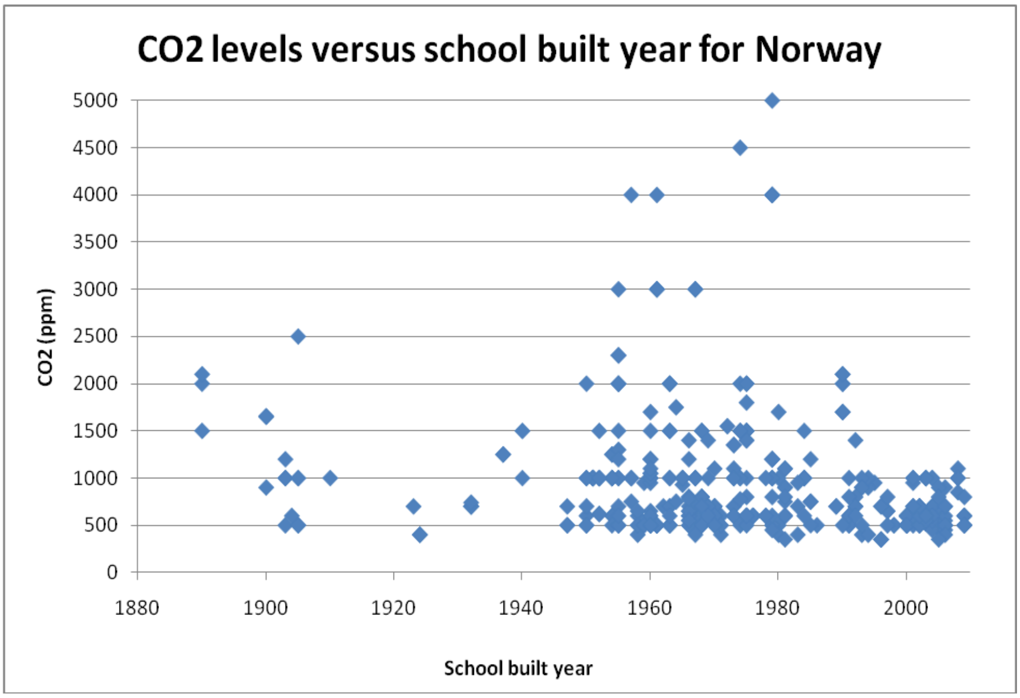


Figure 18: CO_2 levels versus age of school for Norway in 2009.

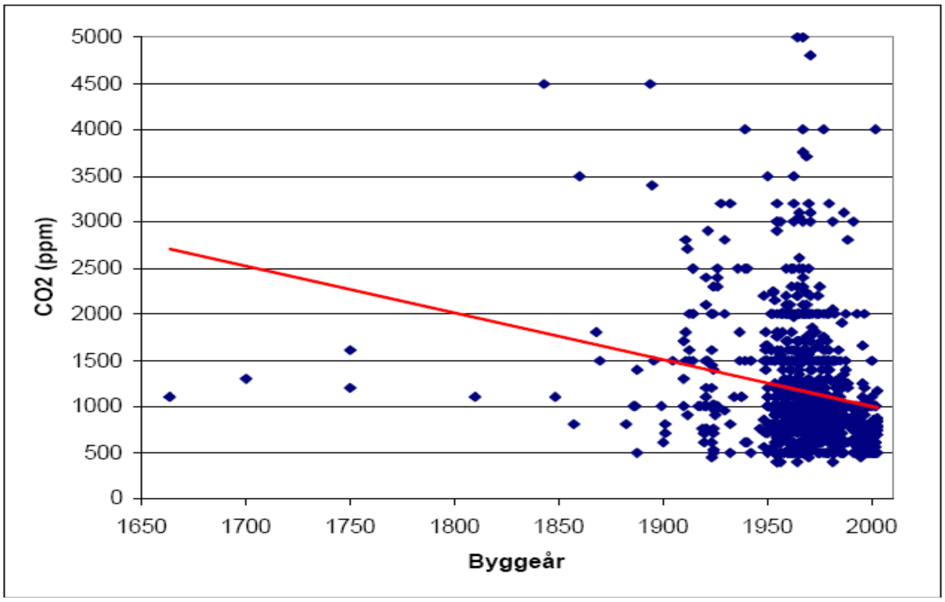


Figure 19: CO_2 levels versus age of school for Norway in 2003. (Source: Innset et al., 2003)

The student consensus is that 16% of the classrooms smell bad (54 responses), and 84% does not smell bad (274 responses). Of the classrooms that smells bad, the average CO_2 value was 1115 ppm (n=160), and of the classrooms that did not smell bad, the average CO_2 value was 872ppm (n=26),[9] see Figure 20. The standard deviations for the average value comparison are large which make these trends difficult to prove significant.

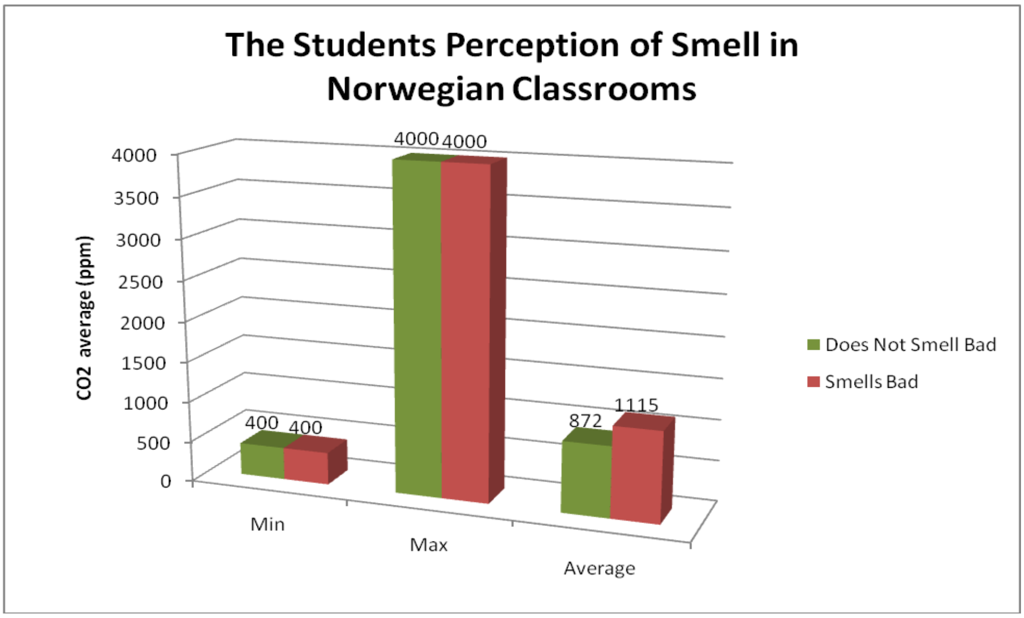


Figure 20: Students perception of smell in Norwegian classrooms.

[9] Not all of the classrooms answered the smell question, and some of those that did answer the question did not have an associated CO2 measurement; a reason why the totals do not match.

A similar perception related question was asked in the 2003 campaign, but because of wording and structure differences between the questions, they are not directly comparable – but a similar trend is evident. Figure 21 shows that when students perceived the indoor air quality to be bad, the measured CO_2 value was an average of 1539ppm, and when the students perceived the indoor air quality to be bad, the measured CO_2 value was an average of 724ppm. Both the 2003 and 2009 campaign can possible indicate a connection between the perceived indoor air quality and the measured CO_2 values (i.e. the worse the perceived air quality, the higher the measured CO_2 value).

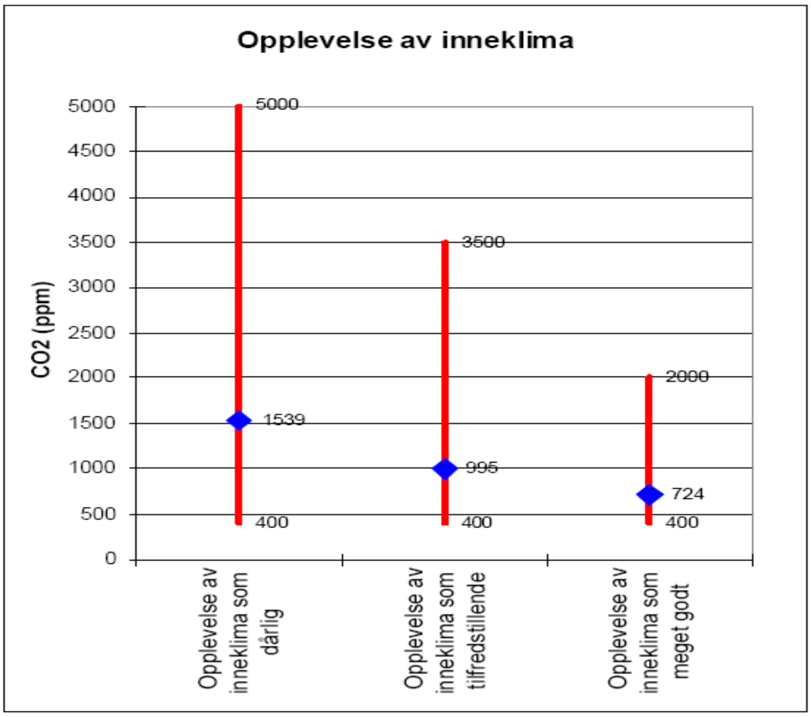


Figure 21: Perceived indoor air quality and associated average CO_2 values in Norway (2003). (Source: Innset et al., 2003)

As previously mentioned (and referred to in Table 5), the classroom ventilation type is the highest determining factor of the classrooms air quality. The ventilation types were simplified for the campaign into three categories: *natural ventilation* (ventilation only from windows or vents, ie. "manual"), *only exhaust* (ventilation from a mechanical system blowing air out of the room, ie. "mechanical"), and *exhaust and supply* (ventilation from a mechanical system blowing air in and out of the room, ie. "advanced mechanical"). Some simple results based on ventilation type can be seen in Table 10, showing that a majority of classroom have the most advanced mechanical ventilation system of exhaust and supply and that over half of the classrooms that answered the ventilation type question, also measured a CO_2 value. Figure 22 shows the average CO_2 value across all classrooms for each ventilation type, demonstrating the previous stated connection between the advanced ventilation type and lower CO_2 values – however the standard deviations between these average values are large, making any significant determinations difficult.

Table 10: Ventilation type related results.

Ventilation Type	Category	#rooms	% of total	CO results available	Average CO2	Regularly Manually Ventilated	Bad Smell In the room
Natural Ventilation	Manual	62	19%	37 (60%)	1355	44 (71%)	12 (19%)
Only Exhaust	Mechanical	55	17%	31 (56%)	1130	33 (60%)	13 (24%)
Exhaust and Supply	Advanced Mechanical	204	64%	116 (57%)	748	94 (46%)	28 (14%)

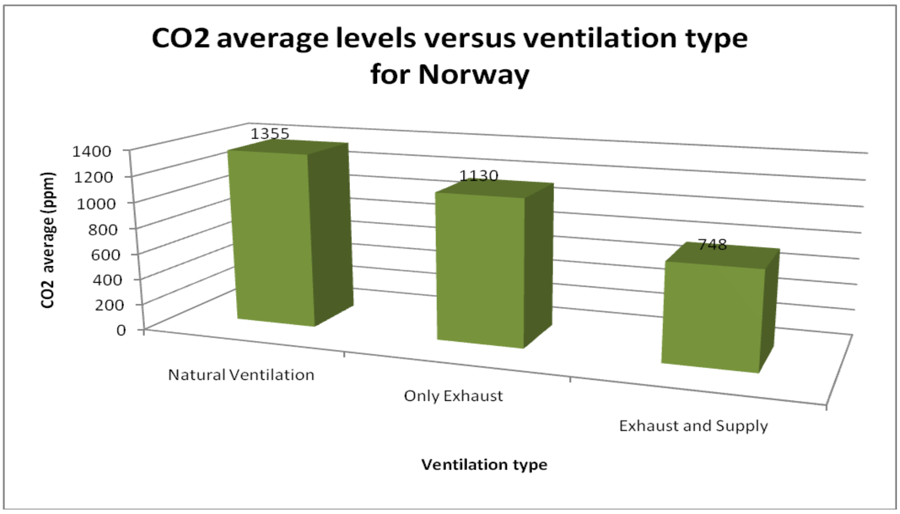


Figure 22: Average CO_2 levels versus ventilation type for Norway.

Looking at the classrooms with each ventilation type independently shows some interesting results, see Figure 23, Figure 24, and Figure 25. More than 50% of classrooms with natural ventilation have CO_2 values greater than 1000ppm; this decreases to 29% of classrooms with only exhaust, and 8% of classrooms with exhaust and supply. It is peculiar that the classrooms with only exhaust ventilation have a such a high percentage of classrooms (13%) which are greater than 2000ppm (compared to 5% with natural ventilation, and 1% with exhaust and supply ventilation).

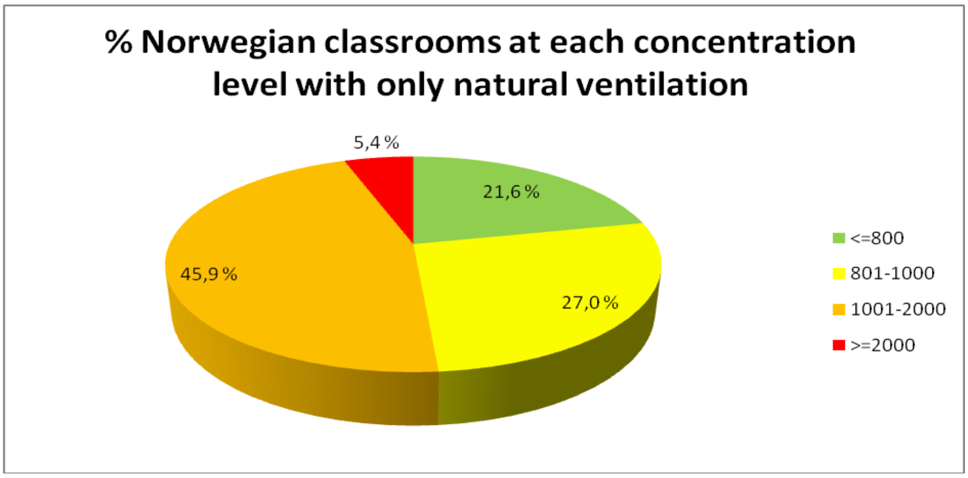


Figure 23: Percentage Norwegian classrooms at each concentration level for only those classrooms with natural ventilation.

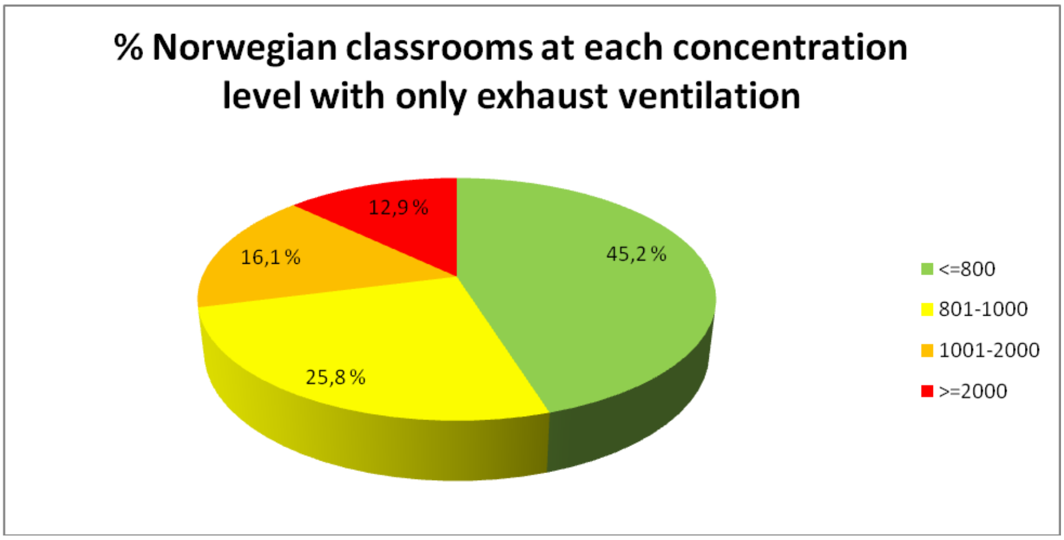


Figure 24: Percentage Norwegian classrooms at each concentration level for only those classrooms with only exhaust ventilation.

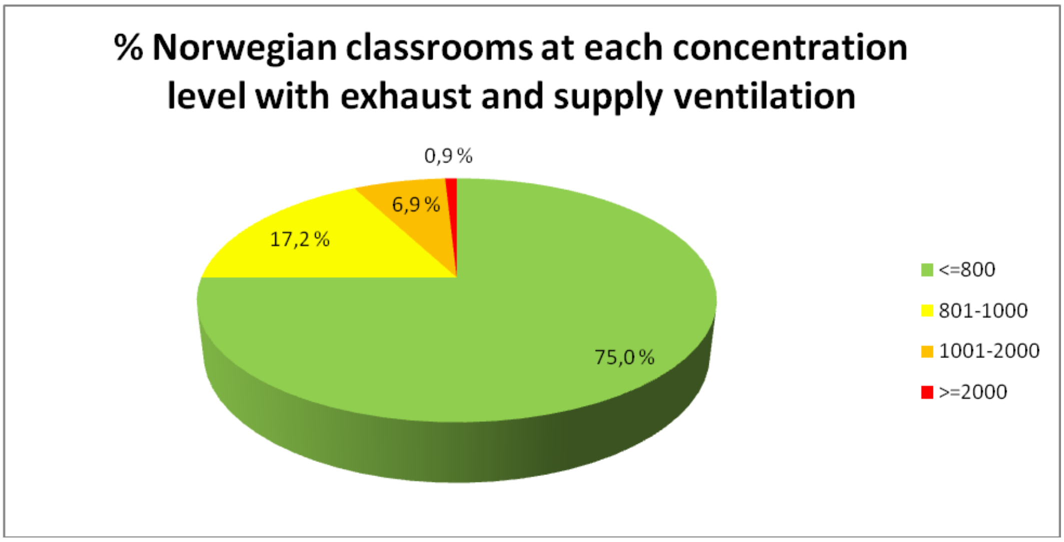


Figure 25: Percentage Norwegian classrooms at each concentration level for only those classrooms with exhaust and supply ventilation.

3.2 Mold Results

The results are first presented at the Scandinavian level in the first sub-section below (concentrating on the ventilation variable), and the following sub-section concentrates on the Norwegian results. The data-set analyzed for this section was the data available after the campaign on October 29th 2009. The raw mold results are will be presented, and in addition, similarly to the CO_2 results, the following variables are compared to the mold results at the Norwegian level:

- Classroom temperature
- Classroom student density
- Age of school building
- Classroom Ventilation type
- Perception of indoor AQ problems in classroom (using smell)

Mold data was not collected during the 2003 campaign results, so this year's campaign mold data does not have an earlier data-set to compare these results to.

Mold as an *indicator*: Like CO_2, mold measurements are also often used to assess indoor air quality. Mold is present in our indoor environments, but it is the quantity and species of the molds which determines if they are harmful to human health. Mold growth indicates humidity or moisture problems, which is most often tied to ventilation issues. So if mold quantity and speciation is high, this can in itself be dangerous, and also be indicating other indoor air quality problems due to ventilation issues.

Note: The following results present the mold data in two different formats, "DG18" and "V8". As described in Section 2 and seen in Figure 5, these labels pertain to the differences in how the petri dishes were treated. Each equipment package sent to the classes contains 3 DG18 petri dishes, and 3 V8 petri dishes – and the results are presented to distinguish these apart from each other. More information regarding these dishes can be seen in Appendix D.

3.2.1 Mold Results Scandinavia

Mold summary results for Norway and Denmark[10] can be seen below in Table 11, where the differences between Norway and Demark are as great here as they are for the CO_2 exercise. Mold results show that the Danish classrooms have on average approximately 3.5 times the amount of mold colony growth with twice as many species in comparison to the Norwegian classrooms. As with the CO_2 result comparisons between countries, it should be noted that the data size between these datasets are different.

Table 11: Mold Summary Results for Norway and Denmark.

	Schools	Attempts	Rooms	Mold Colonies DG18 (avg)	Mold Species DG18 per dish (avg)	Mold Colonies V8 (avg)	Mold Species V8 per dish (avg)
Denmark	329	805	755	31.2	5.0	29.6	5.0
Norway	157	319	200	7.9	2.6	9.3	2.9

[10] As previously mentioned, Sweden did not participate in the mold exercise.

As mentioned in the CO_2 exercise section, a reason for the differences between Norway and Denmark can be due to the varying distribution of ventilation systems between the two countries, see Table 5. Examining the mold results between the two countries for each ventilation type shows similar results as for this similar comparison done for the CO_2 results. In general, a potential trend is that the better the ventilation type, the lower the mold colonies and species, while Norwegian classrooms still hold much lower values for all of these categories in comparison to Denmark, see Figure 26, Figure 27, Figure 28, and Figure 29. However, the average values for all of these figures are difficult to compare within each country because they are so near eachother, and with considering the standard deviations, it would make the comparisons not statistically significant.

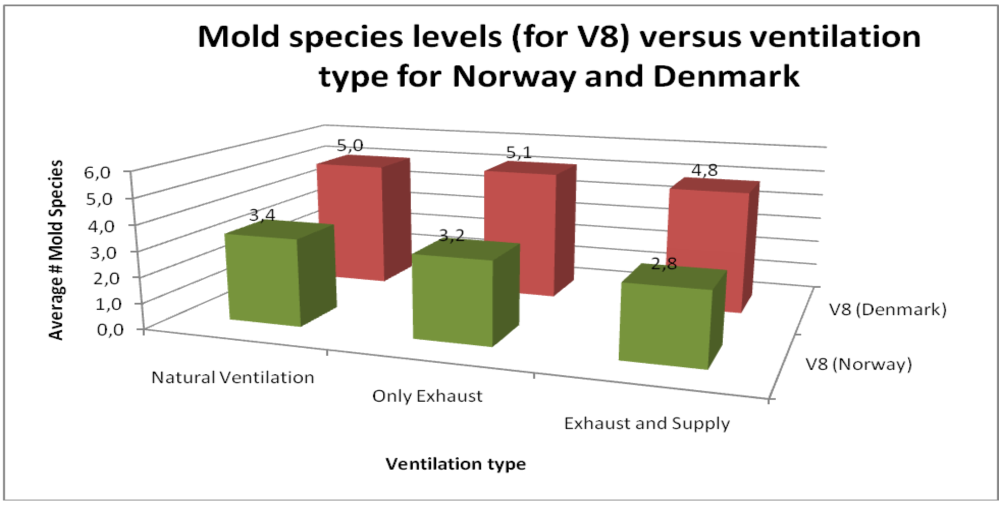


Figure 26 Average mold species levels (for V8) versus ventilation types for Norway and Denmark.

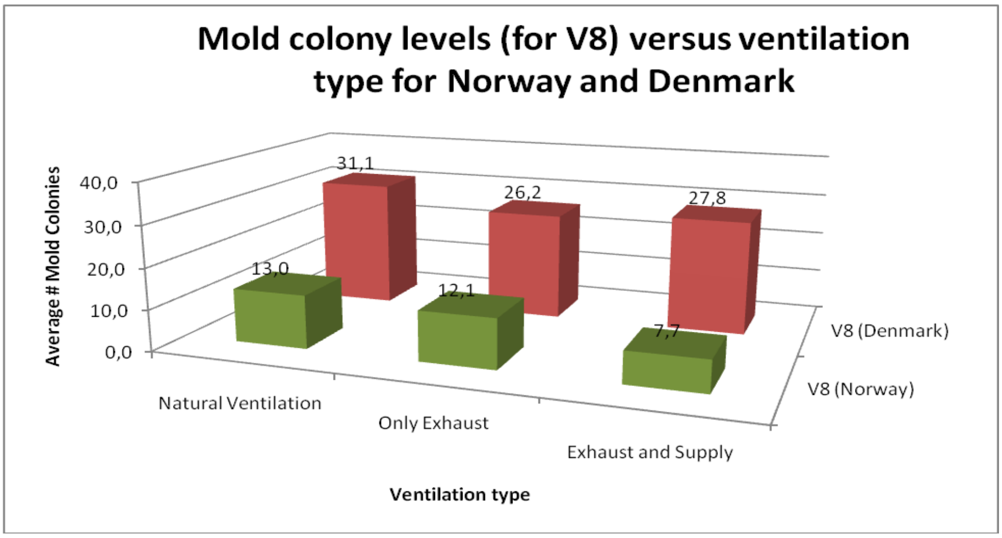


Figure 27: Average mold colony levels (for V8) versus ventilation types for Norway and Denmark.

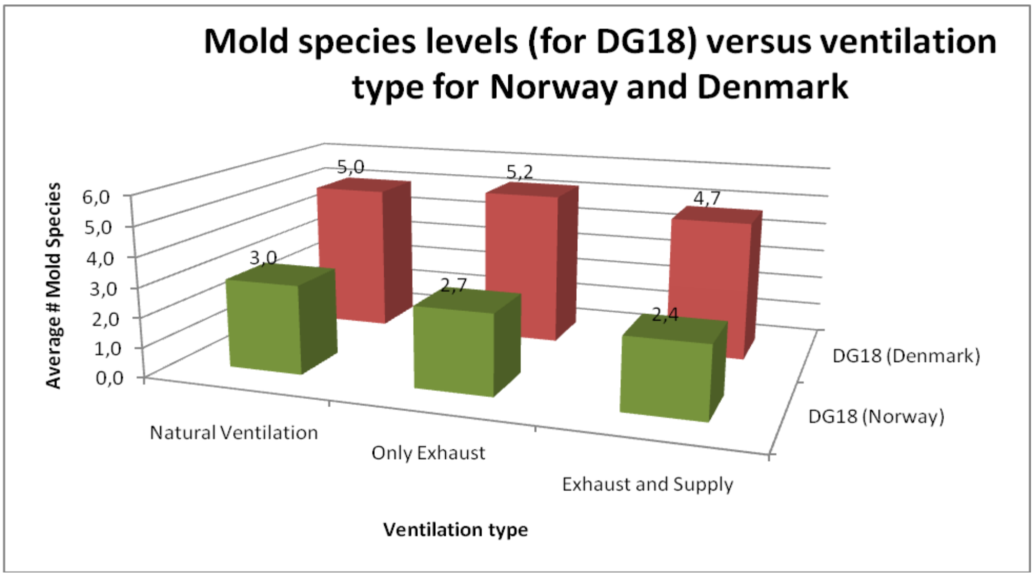


Figure 28: Average mold species levels (for DG18) versus ventilation types for Norway and Denmark.

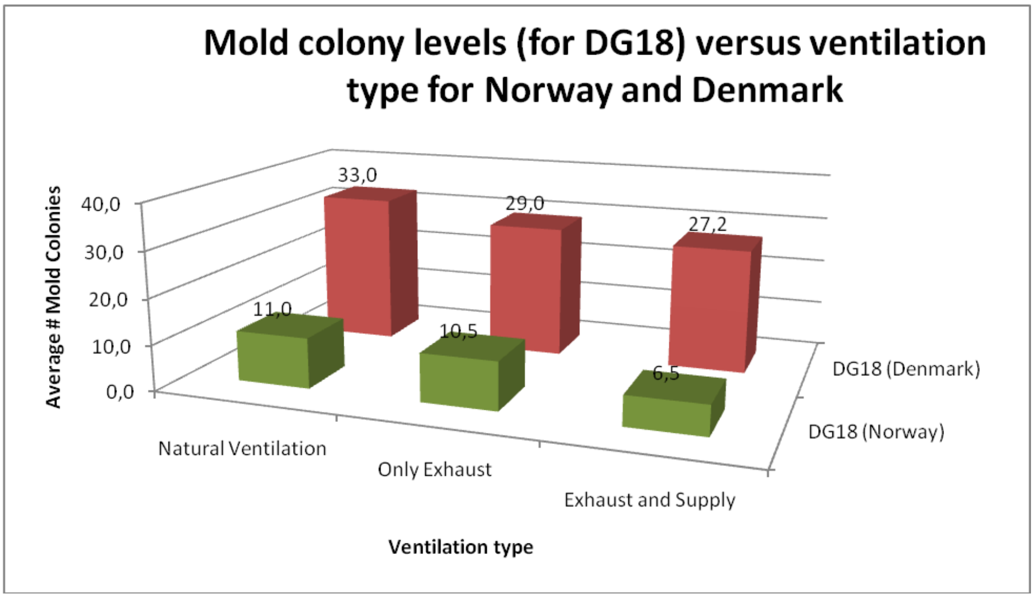


Figure 29: Average mold colony levels (for DG18) versus ventilation types for Norway and Denmark.

3.2.2 Mold Results Norway

The mold results for Norway are presented in four tables displaying the species and number of colonies for each species found through this part of the campaign; where these values are later compared to the other variables collected during the campaign. The most common mold species found were Cladosporium, Penicillium, and Asperigillus – each of these species occurring in about half of the petri dishes (Table 12), with an average of 1-3 colonies of each of these species per dish (Table 13). The V8 dishes were more successful at growing more species of Alternaria, Trichoderma, Eurotium, Yeast, and other molds (if they were first present)(Table 13). The overall number of colonies found per dish can be seen in Table 14, where about half of the dishes had between 1 and 5 colonies, and 75% contained less than 10 colonies. Approximately half of the dishes also contained between 0 and 2 mold species, where few of the dishes contained more than 4 species (Table 15).

Table 12: % of Petri dishes which contain the given mold species (DG18 and V8).

Dishes DG18		Dishes V8
Cladosporium	53%	52%
Penicillium	50%	55%
Aspergillus	46%	56%
Alternaria	23%	44%
Trichoderma	14%	16%
Eurotium	16%	15%
Yeast	34%	37%
Other molds	18%	20%

Table 13: Avg. number of colonies of each species per petri dish (DG18 and V8).

Colonies DG18 (avg)		Colonies V8 (avg)
Cladosporium	2.0	1.8
Penicillium	3.0	1.6
Aspergillus	1.1	1.6
Alternaria	0.8	1.4
Trichoderma	0.3	2.3
Eurotium	0.4	2.3
Yeast	1.2	3.2
Other molds	0.5	2.4

Table 14: % distribution of the number of colonies per petri dish (DG18 and V8).

# colonies	% Dishes DG18		% Dishes V8	
0	8.2%	(26)	6.3%	(20)
1-5	52.4%	(167)	45.3%	(145)
6-10	16.6%	(53)	25.0%	(80)
11-15	6.9%	(22)	7.8%	(25)
16-20	5.6%	(18)	5.6%	(18)
21-25	4.1%	(13)	2.2%	(7)
26-30	2.5%	(8)	1.6%	(5)
31-35	0.9%	(3)	2.2%	(7)
36-40	0.9%	(3)	1.6%	(5)
41-45	0.6%	(2)	0.3%	(1)
>50	0.3%	(1)	0.3%	(1)
>50	0.9%	(3)	1.9%	(6)

Table 15: % distribution of the number of species per petri dish (DG18 and V8).

# Species	% Dishes DG18		% Dishes V8	
0	8.2%	(26)	6.5%	(21)
1	31.3%	(100)	22.7%	(73)
2	23.8%	(76)	20.2%	(65)
3	16.0%	(51)	20.6%	(66)
4	5.3%	(17)	12.8%	(41)
5	3.1%	(10)	5.0%	(16)
6	0.9%	(3)	0.6%	(2)
7	4.4%	(14)	2.5%	(8)
8	6.9%	(22)	9.0%	(29)

It is expected that temperature and relative humidity should affect the concentration of mold growth, as mold thrives on warm humid surfaces. Figure 30 and Figure 31 however do not show any significant increase in mold colonies and species with increased temperatures.

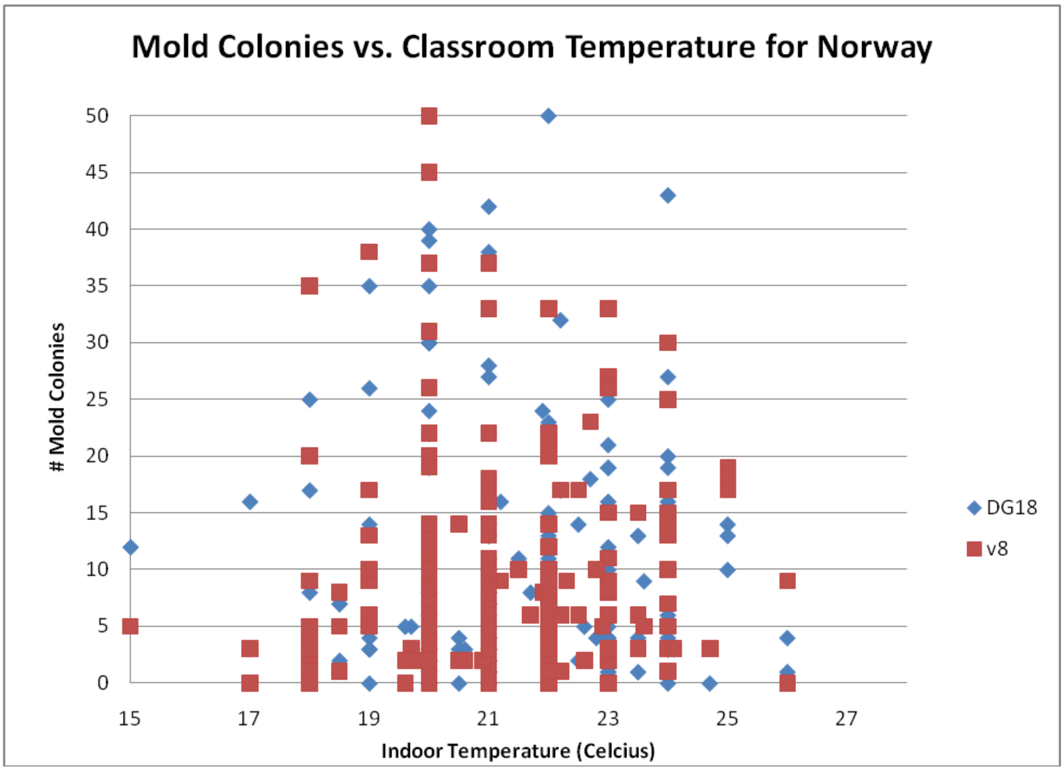


Figure 30: Number of mold colonies versus classroom temperature for Norway.

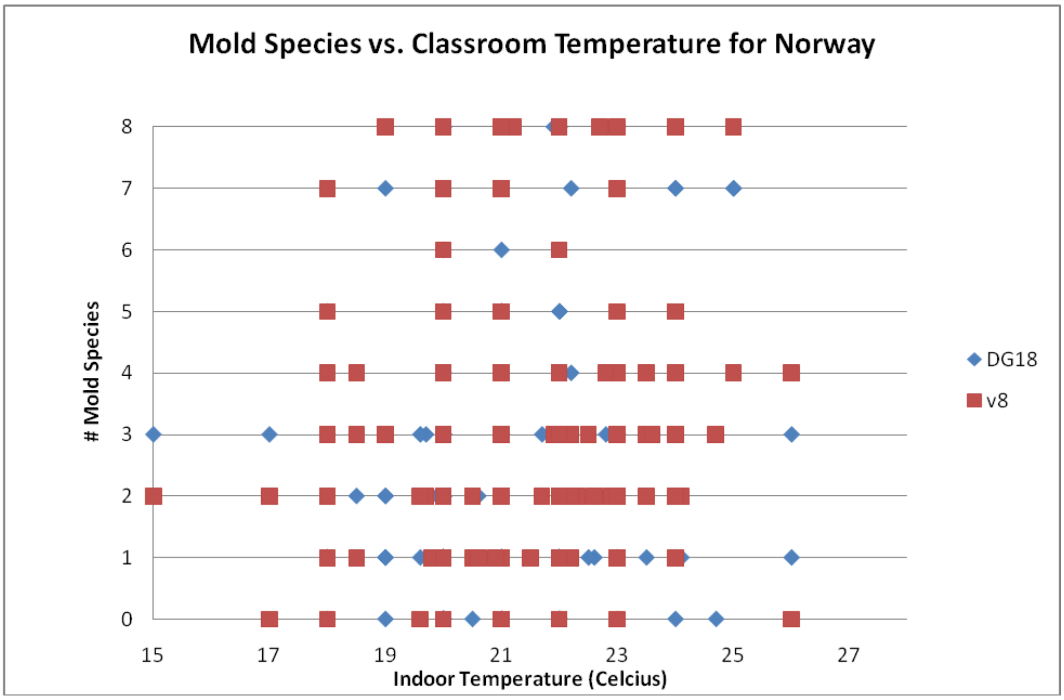


Figure 31: Number of mold species versus classroom temperature for Norway.

As expected, classroom density did not play a role in mold colony or mold species growth (Figure 32 and Figure 33). So, as the classroom density increased, there is no correlation between mold growths.

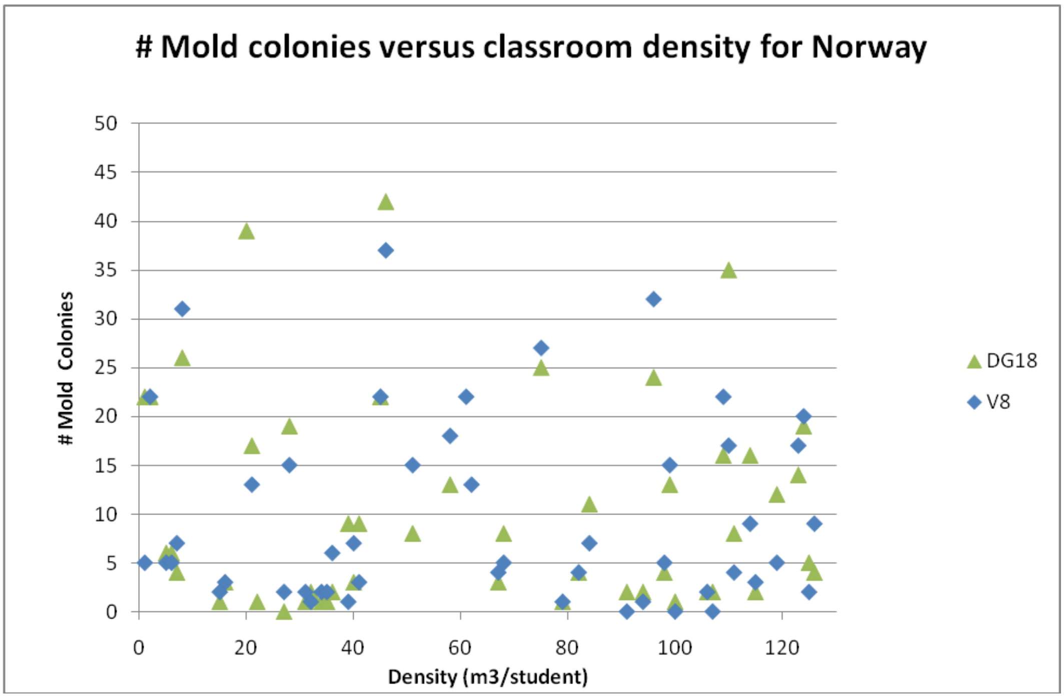


Figure 32: Number of mold colonies versus classroom density for Norway.

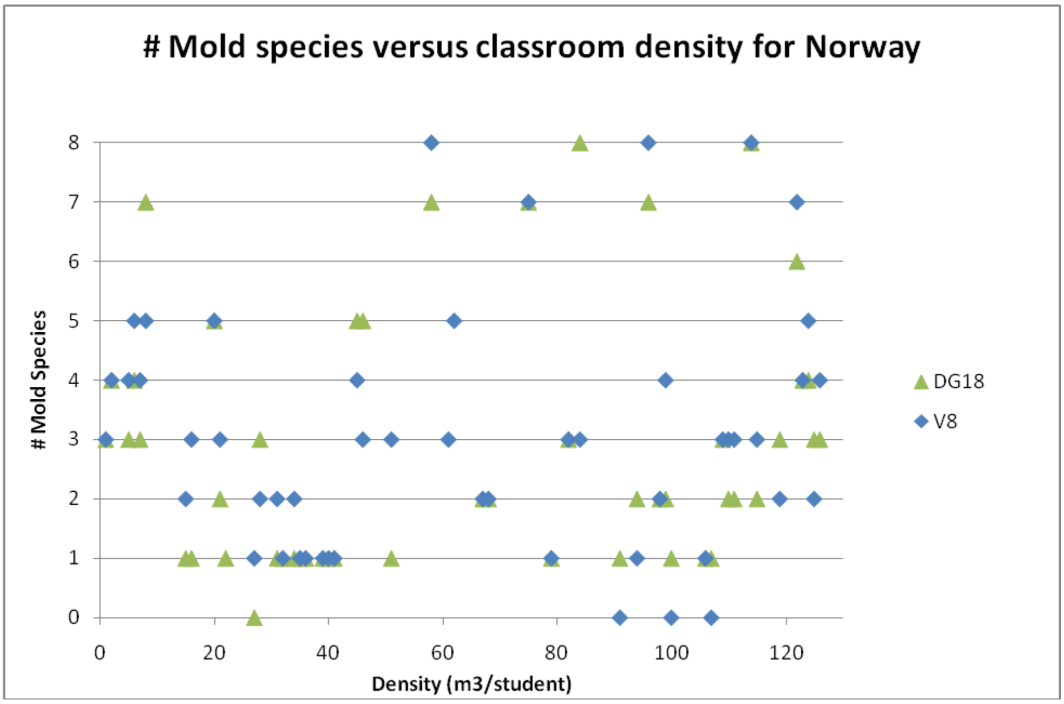


Figure 33: Number of mold species versus classroom density for Norway.

The age of the school building did not contribute to mold growth either. Figure 34 and Figure 35 present the number of mold colonies and species found for the variable of school age, where there is no obvious correlation.

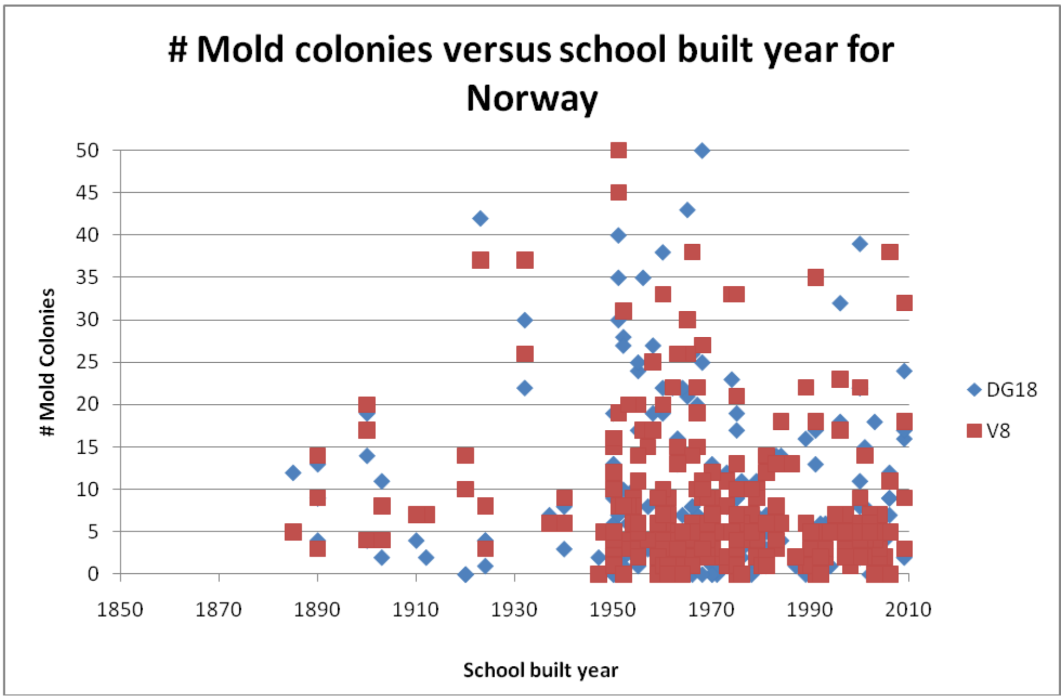


Figure 34: Number of mold colonies versus the school built year for Norway.

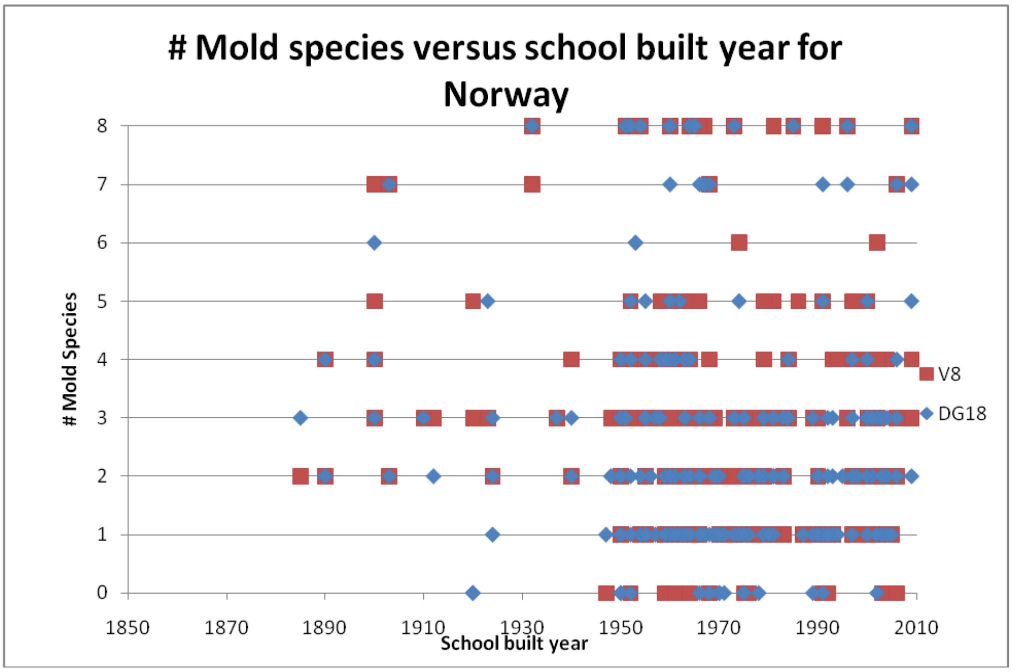


Figure 35: Number of mold species versus the school built year for Norway.

The presence of indoor mold traditionally carries with it particular musty smells. Of the classrooms that determined the room did not smell good, there was an average of 10-13 colonies present, in comparison to the rooms that did smell good, there was an average of 8-9 colonies (Figure 36). Similar trends were found for mold species as well (Figure 37), although these numbers are close together and beyond the standard deviations, making it difficult to conclude for certain if the students are able to sense increased mold growth.

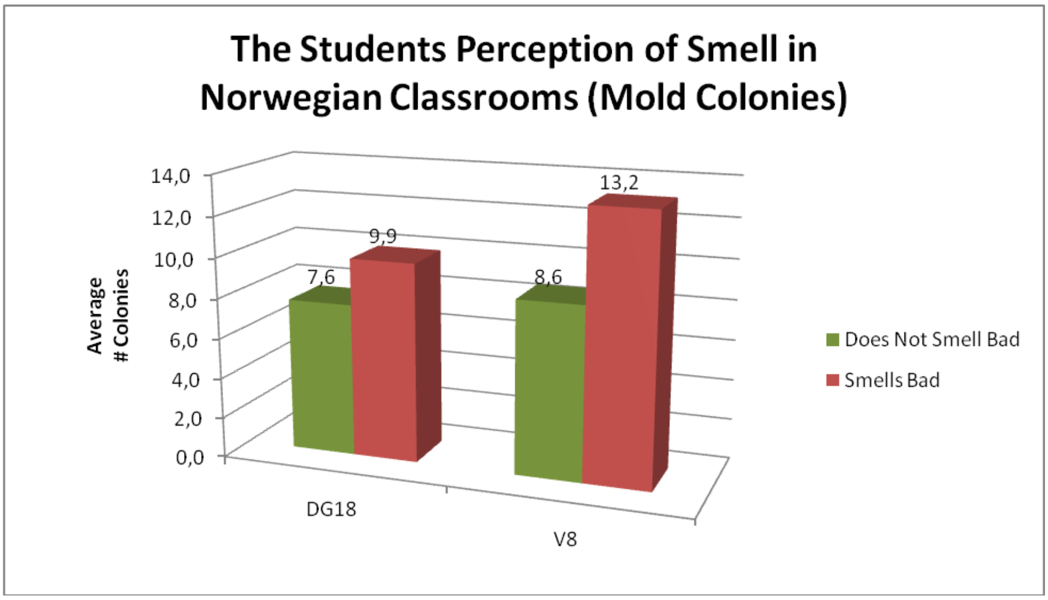


Figure 36: Students perception of smell in the Norwegian classrooms (mold colonies).

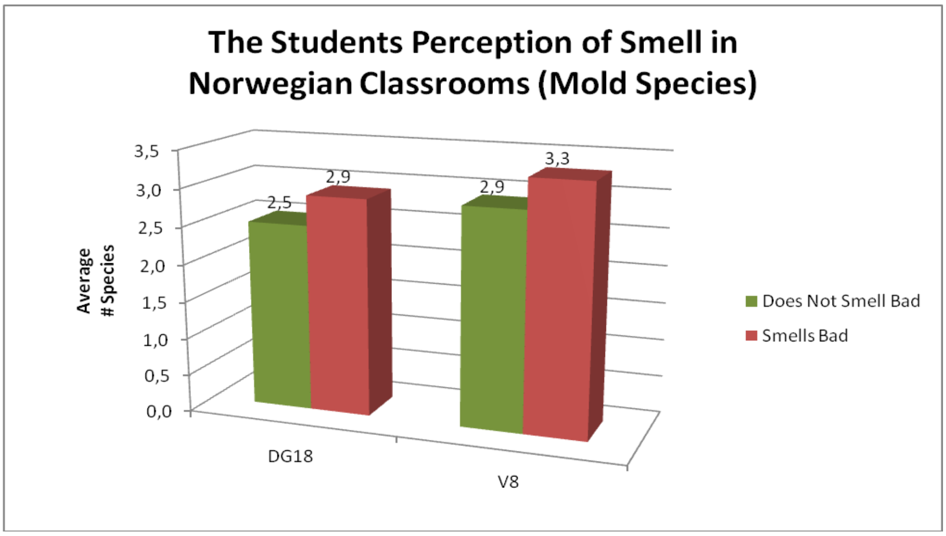


Figure 37: Students perception of smell in the Norwegian classrooms (mold species).

As demonstrated in Section 3.1, the ventilation type associated with the classroom plays an important role in determining the quality of the indoor air. The mold exercises can also be seen to support this point, where the data preliminarily suggests at the general level that the more advanced the ventilation type, the lower to mold growth. Figure 38 shows that "exhaust and supply" ventilation systems cut the mold colony growth in half, while having an "only exhaust" system only slightly reduces the mold colony growth. Figure 39 shows a slight reduction in mold species as the ventilation type advances. Many of the values in both of these figures are close to each other and contain a large standard deviation which lowers the confidence in these comparisons. So it can be suggested that "exhaust and supply" systems reduce the overall mold growth, but may potentially only slightly reduce the overall mold species found.

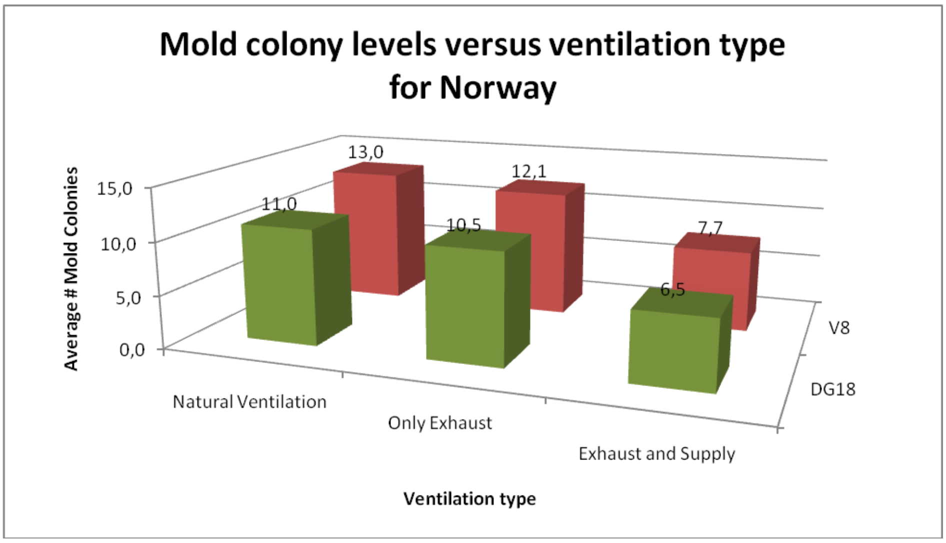


Figure 38: Mold colony levels versus ventilation type for Norway.

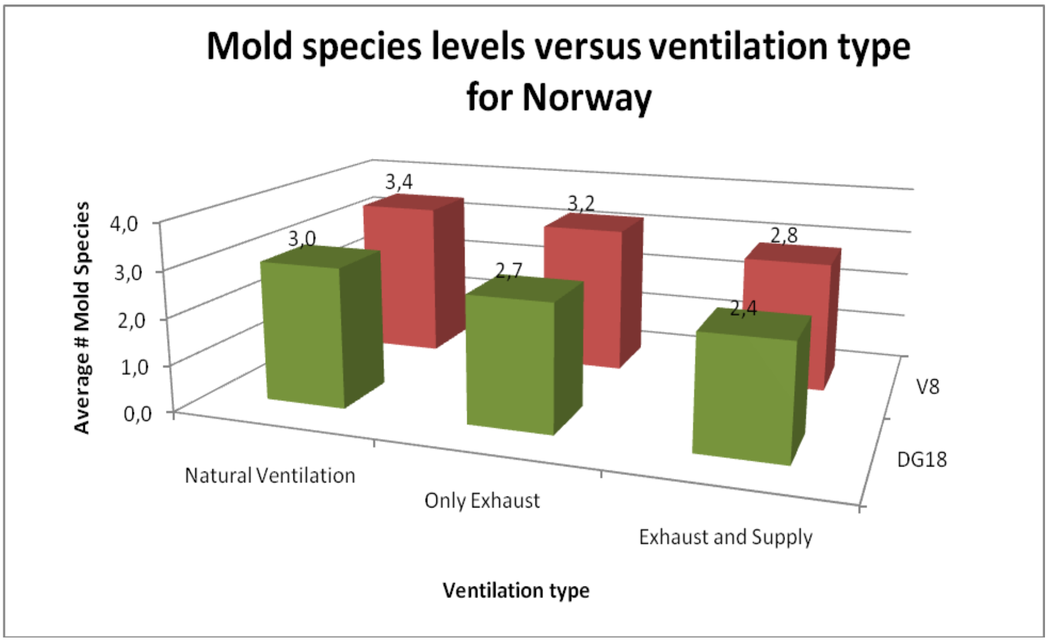


Figure 39: Mold species levels versus ventilation type for Norway.

Since both mold and CO_2 are seen as an indicators of air quality – it is expected that there is a correlation between mold and CO_2, thus as the CO_2 levels increase, there should be greater mold growth. Figure 40 and Figure 41 shows that there is no trend between CO_2 levels and mold (DG18 and V8). Even more interesting is that for all dishes with 20 or more colonies present, the CO_2 levels were actually less than 1000 ppm.

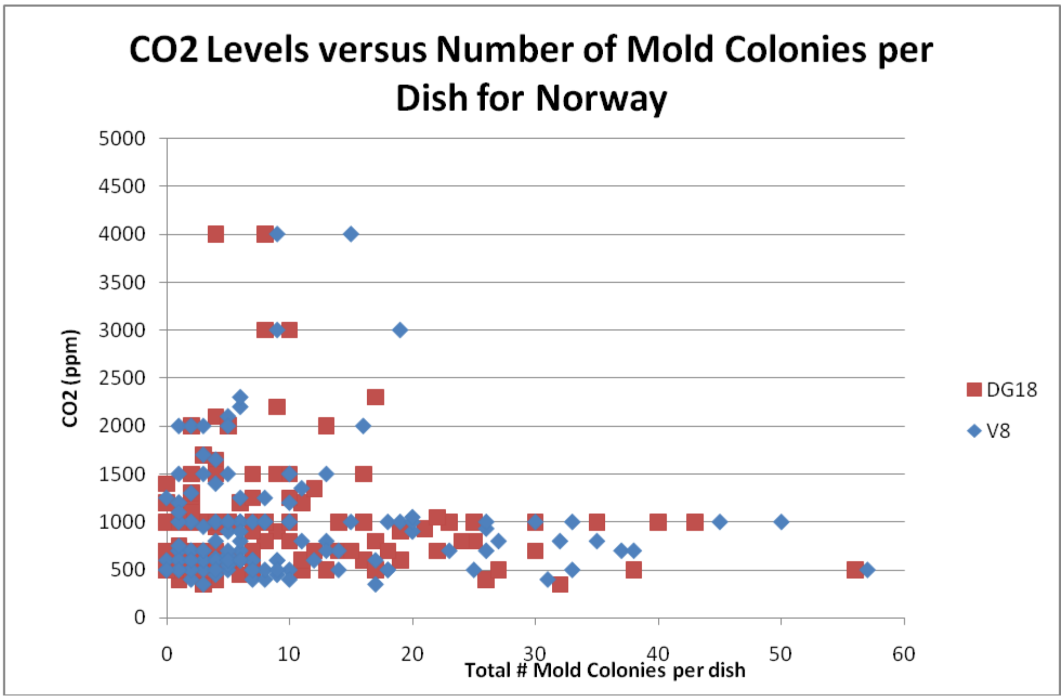


Figure 40: CO_2 levels versus number of mold colonies per dish.

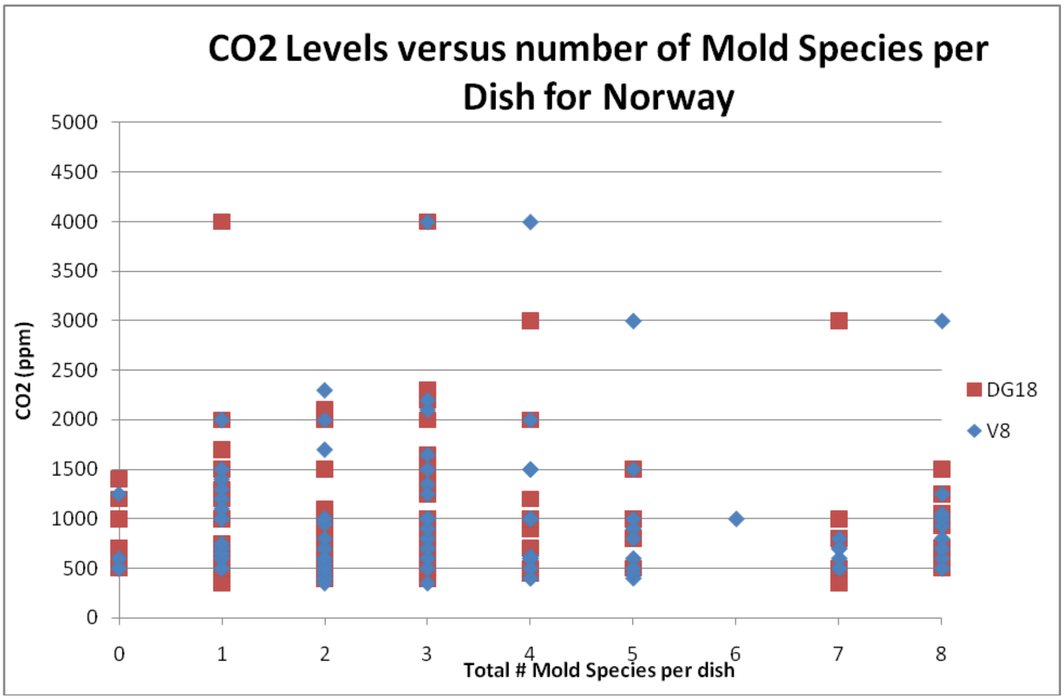


Figure 41: CO_2 levels versus number of mold species per dish.

4 Discussion and Conclusion

The CO_2 results for Norway show a general improvement over the 2003 campaign results, where almost 20% more classrooms are now below the 1000ppm threshold. The CO_2 results also demonstrate that Norwegian classrooms are in better conditions than their Danish counterparts, where 30% more classrooms in Denmark are over the 1000ppm threshold in comparison to Norway. The mold results for Norway do not show any alarming trends at the country level, and like the CO_2 results, these results are much better in comparison to Denmark – where Danish classrooms have on average approximately double the amount of mold species present, and four times as many mold colonies found. These differences between the Norwegian and Danish CO_2 and mold results can be attributed to the improved ventilation systems in Norwegian schools and/or manual ventilation routines. Other factors which may influence these findings are climatic variations, different building standards, and/or differences in cleaning routines.

Some of the additional factors and variables investigated during the campaign were attempted to be correlated to the CO_2 and/or mold results. Where some trends are visible, there were found no statistically significant correlations between variables, and in many cases there were large standard deviations to lend doubt to some potential trends as well.

- *Temperature*. Increased classroom temperatures could also potentially be increasing CO_2 values and mold species/colony growth for both Norway and Denmark. Similar results were also found for CO_2 in 2003 for Norway. Increased indoor temperatures during cooler months can indicate a ventilation and/or high density issue leading to increased CO_2 values; in addition, mold thrives better in warm conditions.
- *Density*. Is is expected that increased classroom student density should also increase CO_2 values. General trends indicated that this may be possible, but no distinct correlation was found for Norway or Denmark – similar results were found for Norway in 2003. High classroom density may lead to increased CO_2 values in poorly ventilated areas due to respiration, which in turn can also increase temperature.
- *School age*. It is expected that the older the school building, the more increased the CO_2 values and mold species/colony growth should be. This was a correlation reported for CO_2 in 2003 for Norway, but this year no correlation could be found. Older schools typically have degraded ventilation systems and infrastructure in comparison to new schools, in addition, older schools can have a higher potential for water damage, leading to optimal conditions for mold growth.
- *Smell*. The Norwegian student's perception of the classroom smell was slightly correlated to the CO_2 and mold results, where the classrooms reporting foul smells normally also had high CO_2 values and mold species/colony growth. Similar results were also found for CO_2 in 2003 for Norway. It is important that the students can identify problems in their own

environment, which enforces the point that student's complaints and recommendations should not be dismissed.

- *Ventilation*. Mechanical ventilation of exhaust and supply seemed to sdecrease the CO_2 values and mold colony/species growth in Norway and Denmark. CO_2 values were decreased by up to 40%, and mold growth reduced by up to 30% for classrooms which had exhaust and supply versus classes with mere manual ventilation. It is interesting however that classrooms with just exhaust ventilation did not show too much of an improvement in mold species/colony growth reduction, where in some cases the classes with this ventilation type show increased mold growth over classes with just manual ventilation. A possible reason for this case is that where the classroom air was effectively being removed from the room with the mechanical exhaust system, there was no fresh air available for replacement – thus lending to no improvement in the overall air quality of the room. Cases such as this should examine better manual ventilation routines in addition to their mechanical systems.

It should be again noted that **none** of the comparisons above proved to be statistically significant and many contained large standard deviations, so no concrete correlations can be presented. This is most likely due to the high number of unseen variables which exist between the different classrooms which are being compared to. It is also important to understand that some of these results may be skewed due to student error, deviation from methods, and/or country variations. However, the methods were closely replicated to the 2003 campaign, and were coordinated between all of the involved countries – which should limit error, and ensure confidence in the overall results. Some data analysis and comparisons were not performed due to low sample sizes as well. It must also be reiterated that CO_2 is an **indicator** for air quality, and does not concretely imply air quality problems; mold results should be given this same caution in that mold growth is only a concern when it gets to high levels.

At the country level for Norway, the overall results for indoor air quality in the classrooms are good, but at the individual classroom level, there are still many classrooms which indicate poor air quality. The classrooms with poor air quality indicators need remediation, where some advice for these classrooms is given in the next section entitled "Recommendations".

An important outcome of these results is the implication that the 2003 results may have had an effect on improving the actual school conditions in Norway through possible measures such as:

- Educating the students, teachers, parents and school system regarding the actual indoor air quality conditions, and the relation to health problems.
- This knowledge may have led to better manual ventilation routines in classrooms.
- This knowledge may have also led to improved or new ventilation systems in some schools.

This year's campaign can be seen as a success, as it was an excellent continuation of the annual campaign event in Norway, and a great web-based learning exercise for the students. It will be interesting to see if this year's campaign results have an impact on improving the indoor classroom conditions in Norway even further, and have an impact on making drastic initial changes in Denmark.

5 Recommendations

Based on the analysis of the campaign, recommendations are developed which include that the results and remediation opportunities should be disseminated to the students, teachers, and parents in a user-friendly manner. Schools should also be educated regarding better ventilation routines and they should have the opportunity to install devices in the classroom to warn of poor air quality spikes. The campaign should also be taken out of the Scandinavian context, and brought to the rest of Europe so other countries can learn from the campaign and have the opportunity to run the campaign themselves.

The following specific recommendations, in order of importance, can be made based on analysis of the campaign data for Norway, and the conclusions/discussion above. We hope that these recommendations are taken into serious consideration due to the potentiality that some individual classrooms in Norway have indicators for unacceptable air quality, and this may be detrimentally affecting student's health and well-being.

- **Continuous monitoring devices in classrooms**. A T8012 monitoring device (or similar, see Appendix J) is recommended to be installed at the approximate 100 classrooms that measured greater than 1000ppm CO_2 and/or the 30 classrooms with greater than 5 species mold and 20 colonies. These devices constantly measure the CO_2 value, and present the measurements in a user friendly manner of blue, green, yellow, and red indicator lights; so when the device lights yellow, or red, the classroom should be ventilated appropriately (by opening a window and/or door) – these devices also have the possibility to switch on an external device (a fan for example) when the CO_2 reaches a certain level. These devices are self-calibrating and have a lifetime of 10-15 years. These units can be purchased in bulk at a cost of approximately 1100kr each.
- **Ventilation systems and routines**. For schools with greater than 1000ppm CO_2 and 20 colonies/5 species mold, they should check their ventilation systems and ventilation routines.
    - Those with intake and exhaust ventilation systems, check system efficiency and consider professionally cleaning the system.
    - Those with just exhaust ventilation systems, also check system efficiency and consider cleaning, as well as consider adding intake.
    - Those with just natural ventilation, make sure that strict ventilation routines are adhered to, and consider installing an intake system, or combined intake and exhaust ventilation.
- **Mold remediation checklist**. While the most important measure to reduce mold in the classroom is to monitor and control the humidity level (through ventilation or other de-humidifying means), schools which measured high levels of mold or have the presence of visible mold in the classroom should complete the checklist found in Appendix K.

- **Results dissemination targeting students**. A campaign results pamphlet (based on this report) should be sent to all participating schools, notifying them of the results and how these results relate directly to the student - thus stressing the potential health effects of poor indoor air quality. The pamphlet should also notify the students of the potential remediation alternatives available, and the other recommendations listed here (specifically point 2 above). Students should in turn compare their collected results to the averages presented in the pamphlet and if able, also this report.
- **Publishing results at the European/International level**. It is recommended that results from the campaign, and further data analysis be published in an appropriate professional journal and be presented to the greater European scientific and educational community. The results from the campaign are valuable both at the scientific and educational levels, and other countries and institutions outside of Scandinavia would benefit from the results, methods, and outcomes of this project. It would also be valuable for other countries to be able to repeat the campaign in their own country as well.
- **Professional monitoring campaign**. In order to better quantify the amount of schools with poor air quality in Norway, it is recommended to initiate a professional monitoring campaign. A campaign of this nature should monitor specific components (such as Formaldehyde, Benzene, Naphtalene, Nitrous Oxide, Carbon Monoxide, Carbon Dioxide, Radon, Trichloroethylene, Tetrachloroethylene, PAH, Particulate Matter, and Ozone), and determine the types of schools based on structural characteristics which can be prone to poor indoor air quality. The campaign should then identify the vulnerable schools and verify the identified schools with extensive indoor measurements. Concrete action plans should then be developed to remediate the poor conditions at the verified schools.
- **Repeat campaign again.** It would be interesting to repeat this student campaign in Scandinavia/Norway again in 3-4 years for the students to experience the potential air quality trends which could be determined from repeating the campaign three times. If the first recommendation above is accepted (to install monitoring devices at problematic schools), it would also be valuable in this follow-up campaign for students to be able to measure the level of improvement to the indoor air quality (and perceived indoor air quality) from using such a monitoring/notification device.

6 References

Innset, B., Endregard, G., Arnesen, K., Bartonova, A. og Braathen, O.A. (2003). Undersøkelse av CO_2-konsentrasjon i norske klasserom. Elevbasert forskningskampanje som del av Forskningsdagene 2003. Kjeller (NILU OR 81/2003). URL: http://www.nilu.no/data/inc/leverfil.cfm?id=5925&type=6

United States Environmental Protection Agency (US-EPA) (2001). Mold remediation in schools and commercial buildings. Washington, DC. (EPA 402-K-01-001). URL: http://www.epa.gov/mold/pdfs/moldremediation.pdf

Appendix A

Student Guidance Document (CO_2)

(In Norwegian)

Formål

- Kartlegge luftkvaliteten i klasserommet ved å gjennomføre målinger av CO_2-konsentrasjonen i innelufta.
- Vurdere behovet for tiltak for å bedre luftkvaliteten.
- Lære om Opplæringslovens § 9a og kravene til det fysiske innemiljøet på skolen.

Aktuelle samarbeidspartnere

Skolens vaktmester eller driftsleder, helsesøster, kommunehelsetjenesten

Utstyr

- Rør for måling av CO_2 (CO_2-absorpsjonsrør med måleområde 400-5000 ppm).
- Håndpumpe (100 ml plastsprøyte) for å trekke luft gjennom CO_2-rør.
- Silikonslangebit til å sette mellom plastsprøyte og CO2-rør.
- Saks eller glassfil for å fjerne forseglingene i enden av CO2-rør slik at luft kan trekkes inn i røret.

CO2-målingsutstyr kan bestilles fra KPT Naturfag:

- CO_2-målerør (1 pk med 10 målerør, varenr: 60306): kr. 310,-
- 100 ml sprøyte for innsuging av luft i CO_2-målerør med 5 cm forbindelsesslange (varenr: 11647 og 14280): kr. 94,-

Moms er inkludert, fraktomkostninger kommer i tillegg. Bestilling: firmapost@kptnaturfag.no, tlf: 71 58 89 00.

Mindre pakke CO2-målerør fra Teknolab AS

Teknolab AS selger også pakker med 2 stk målerør til kr 175 inkl moms. Fraktomkostninger kommer i tillegg. Dette passer for skoler som ikke trenger så mange rør.

Bestilling: mail@teknolab.no / tlf 66 81 34 70

Dersom skolen har tilgang på en annen type manuell måler (Dräger-utstyr eller lignende) eller en kontinuerlig elektronisk CO2-måler, kan dette utstyret brukes i stedet. En del kommuner har en inneklimakoffert med måleutstyr fra Forum for miljø og helse (tidligere Teknisk-hygienisk forum) som en kan spørre om å få låne.

Se egen veiledning for bruk av kontinuerlig CO2-måler av type Telaire 7001 med HOBO datalogger.

Bakgrunn

Et av kravene til skolenes fysiske innemiljø i Opplæringslovens §9a er at luften skal være frisk og god å puste i og ikke inneholde skadelige stoffer eller gasser. Måling av karbondioksid (CO_2) er mye brukt for å kartlegge inneklimaet. Karbondioksid er i seg selv ikke direkte helseskadelig, men konsentrasjonen av denne gassen sier noe om hvor god luftkvaliteten er, og om det er behov for bedre frisklufttilførsel. Et høyt CO_2-nivå tyder på at luftskiftet er for dårlig i forhold til antall personer i rommet. Det kan innebære at innholdet av andre mer skadelige forurensninger i lufta også er høyt.

Gjennomføring

Gjennomfør målingene ved normal aktivitet og midt i klasserommet. For å få realistiske målinger er det viktig at rengjøring, eventuell utluftning og andre aktiviteter i klasserommet er som de pleier å være fram mot forsøket. Vinduene til klasseværelset skal være lukket fra start av forsøket og mens dere gjennomfører forsøket.

- **Enkeltmåling (Forskningskampanjen 2009)**

  2 CO_2-absorpsjonsrør, som kan brukes til en måling hver.

  Noter i tillegg:

  - Antall personer i klasserommet ved målingen.
  - Utetemperaturen ved tidspunktet for målingen.
  - Temperatur i klasserommet målt i samme høyde som CO_2
  - Lufterutiner: når skjer luftingen vanligvis? (Varighet i minutter og hvor mange vinduer som har vært åpne).

- **Enkeltmålinger**
  Mål CO_2-konsentrasjonen i klasserommet 1,1 m over golvet en gang pr. dag, for eksempel når elevene spiser matpakken. Utfør målingene før vinduene åpnes og elevene forlater rommet. Før måleresultatet inn i registreringsskjemaet.

  Noter i tillegg:

  - Antall personer i klasserommet ved målingene.
  - Utetemperaturen ved tidspunktet for målingene.
  - Lufterutiner: når skjer luftingen vanligvis? (Varighet i minutter og hvor mange vinduer som har vært åpne).

- **Kontinuerlige målinger**

  Dersom det benyttes en kontinuerlig CO_2-måler, skal denne plasseres i pustesonen 1,1 m over golvet.

Slik utføres målingene:

1. Bruk en saks evt. en glassfil for å klippe/file av endene på målerøret slik at luft kan trekkes gjennom røret:

- Saks:
  - Bruk briller og hold avstand
  -
  - Hold saksen og målerøret ned i et søppelspann slik at eventuelle glassplinter samles opp.
  - Hold på røret tett innpå der du klipper, slik at røret ikke knekker.
  - Klipp av endene like bak (ca 2 mm) de runde kulene. NB! Vær obs på at glassplinter kan fly når du klipper røret, så vær forsiktig.
- Glassfil:
  - Fil et hakk ved innsnevringen rett bak glasskulene i hver ende av absorpsjonsrøret. Bryt av glasskulene. Hold en papirbit mellom glasset og fingrene.

2. Sett slangebiten på sprøytespissen.

3. Stikk den enden på absorpsjonsrøret som ikke er markert med pil, ned i slangebiten på sprøyta. Hold sprøyta med absorpsjonsrøret vertikalt i ansiktshøyde, ca. 1,1 m over golvet og vekk fra kroppen under måling.

   NB! Dersom måleren holdes for nær kroppen eller noen puster direkte på den under målingen, blir måleresultatet usikkert.

4. Trekk sprøytestempelet sakte ut (bruk ca. 3,5 minutter) til underkanten av 100 ml-streken og hold det i denne posisjonen (minimum 30 sekunder) til hele sprøyta er fylt med luft. Stempelet skal ikke sprette tilbake på grunn av vakuum inne i sprøyta.

5. Les av CO_2-konsentrasjonen direkte på skalaen der fargen på absorpsjonsrøret går over fra lilla til hvitt. Noter verdien på registreringskjemaet (som finnes nederst på denne siden) sammen med dato og klokkeslett.

Legg inn data

Det er to registreringssider for CO_2 på internettsidene i miljolare.no, en for enkeltmålinger og en for kontinuerlige målinger. Når resultatene lastes opp til miljolare.no blir de automatisk publisert og presentert grafisk under Resultater.

Hvis dere bruker et kontinuerlig måleinstrument og ønsker å legge inn måleresultatene som enkeltmålinger, må dere beregne en gjennomsnittsverdi for de siste fem minuttene av timen for at resultatene skal være sammenlignbare med manuelle målinger.

Dersom det er utført kontinuerlige målinger med Telaire 7001 og HOBO datalogger overføres dataene som tekstfil til miljolare.no i henhold til beskrivelsen i egen veiledning.

Vurder resultatene
Sammenlign måleresultatene med anbefalte

faglige normer for CO_2 i inneklima. Dersom CO_2-konsentrasjonen i klasserommet ved noen av målingene er over Folkehelseinstituttets anbefaling, kan dette skyldes flere forhold. Vurder hva som kan være mulige årsaker, for eksempel:

- for dårlig lufting mellom timene
- elevene er inne i klasserommet i friminuttene
- for mange personer i rommet i forhold til hva ventilasjonsanlegget er dimensjonert for
- dobbelttimer uten ekstra lufting
- feil og mangler ved ventilasjonsanlegget
- feil ved målingene

Andre forslag til momenter som dere kan diskutere:

- Er måleresultatene slik at kravene til skolemiljøet i Opplæringsloven § 9a-2 og forskrift om miljørettet helsevern § 19 er oppfylt?
- Hva påvirker CO_2-konsentrasjonen i klasserommet?
- Hvordan er resultatene fra skolen sammenlignet med andre skoler?
- Hva kan gjøres for å redusere CO_2-konsentrasjonen i klasserommet?
- Bør det sendes en klage på inneklimaet til skolens ledelse?

Diskuter og foreslå tiltak som kan redusere CO_2-konsentrasjonen i klasserommet dersom CO_2-nivået er høyere enn den anbefalte normen. Fokuser på enkle tiltak som ikke koster penger, og prøv dem ut i praksis. Ta kontakt med fagfolk dersom slike tiltak ikke er tilstrekkelige. Lenkene i bakgrunnsstoffet peker til relevante aktører i denne sammenheng.

Finn eventuelt andre kilder til fakta. Last gjerne opp bilder og figurer når dere rapporterer resultatene.

Appendix B

Student Data Form (CO_2)

(In Norwegian)

Skjema for enkeltmålinger (Forskningskampanjen 2009)

Dato	
Klokkeslett	
CO_2 (ppm)	
Antall personer i klasserommet	
Hvor gammelt er klasserommet (byggeår)	
Romtype	
Takhøyd (cm)	
Gulvareal (m2)	
Romtemperatur (°C)	
Utetemperatur (°C)	

Skjema for dagmålinger

Klasserom nr:		

Tidspunkt		CO_2-kons.(ppm)	Antall personer i rommet	Utetemperatur (ºC)	Kommentarer *)
Dato	Klokke-slett				

*) Beskriv avvik fra det normale som dere tror innvirker på måleresultatene, for eksempel om det var ekstra mange personer i rommet, eller at dere glemte å lufte i friminuttet.

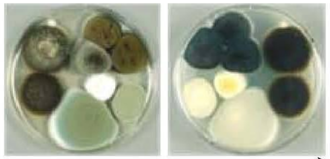
Appendix C

Mold Spore Identification Key

(In Norwegian)

GUIDE 1 - Muggsopp
Identifikasjon av de mest vanlige muggsoppene på DG18 (III)

HUSK!
Petriskålene flyttes og vendes forsiktig, slik at muggsoppens usynlige sporer ikke spres.



Velg en muggsopp i petriskålen din, start her og følg pilene.

Mørke- eller olivengrønne kolonier med **mørk** bakside →

- Lodne, løse kolonier. Bakside: brungrønn med trådet kant →

Alternaria L-muggsopp

- Fløyelsaktige, foldede, kompakte kolonier. Bakside: sortgrønn med hvit kant →

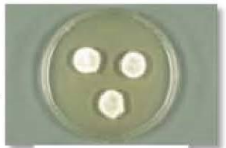
Cladosporium C-muggsopp

Blågrønne, grågrønne eller hvite kolonier med **lys** bakside →

- Store, flate, ofte kornete kolonier →

Penicillium P-muggsopp

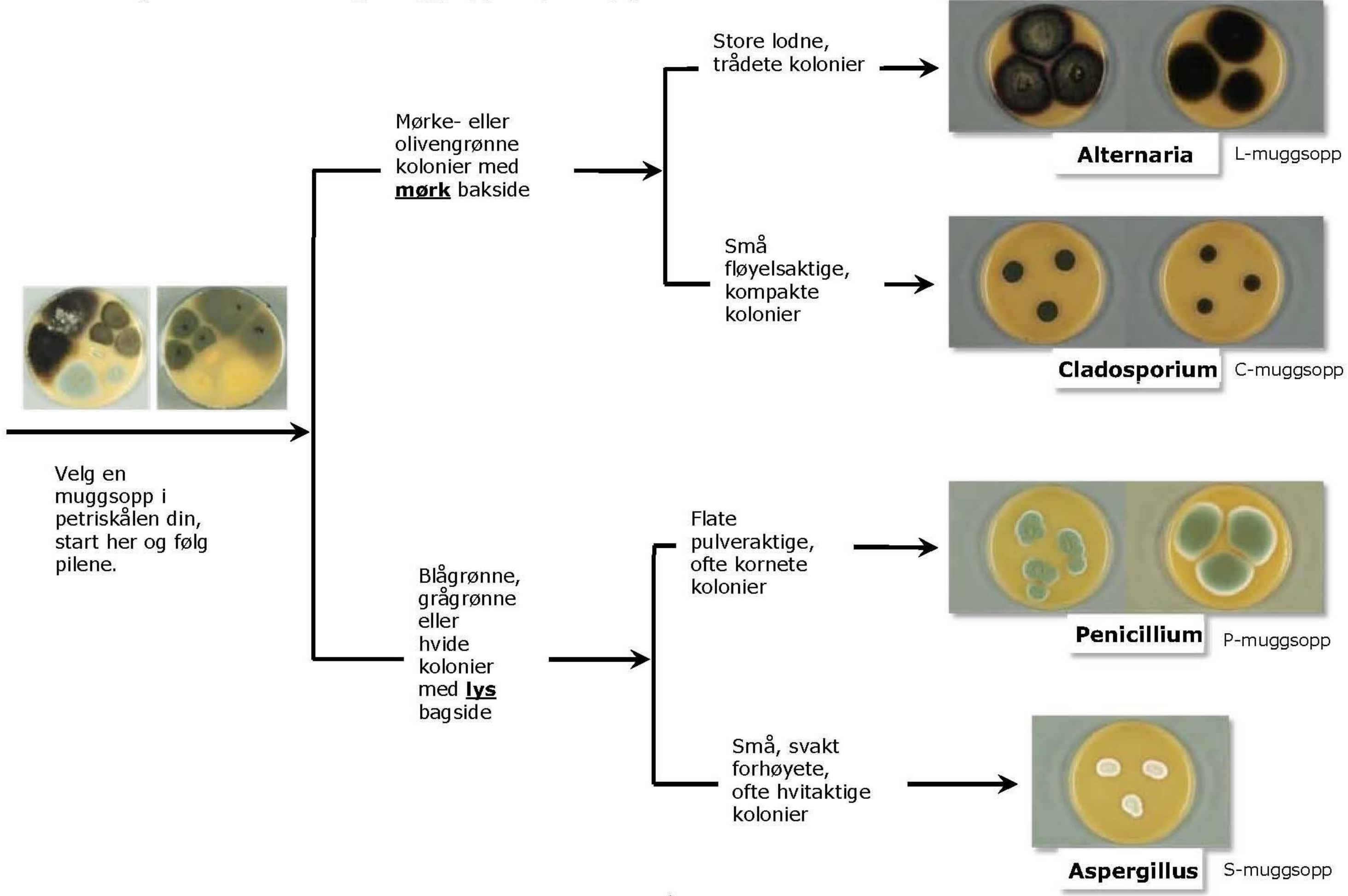
- Små, lett foldede, ofte hvitaktige kolonier →



Aspergillus S-muggsopp

OBS! Hvis du ikke finner muggsoppen via denne nøkkelen, gå videre til GUIDE 3.

GUIDE 2 - Muggsopp
Identifikasjon av de mest vanlige muggsoppene på V8 (II)



OBS! Hvis du ikke finner muggsoppen via denne nøkkelen, gå videre til GUIDE 3.

GUIDE 3 - Muggsopp
Identifikasjon av de mer sjeldne muggsoppene DG 18 (III) & V8 (II)

Start her →

- Små blanke, kulerunde kolonier som kan være hvite, orange eller røde → **Gjær** Fuktindikator (Gjærsopp)
- Meget store, løse og ujevne kolonier, som kan være gule og/eller grønne →
  - Blomkålsaktige kolonier med bare pletter og ujevn vekst fra opalgrønn i midten til hvit i kanten → **Trichoderma** Fuktindikator (T-muggsopp)
  - Bomullsaktige kolonier, kaktusgrønne med hvit kant, ofte gule i sentrum → **Eurotium** Fuktindikator (E-muggsopp)

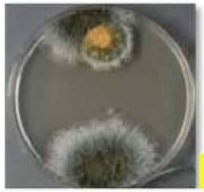
Gjær Fuktindikator

Gjærsopp

V8

Trichoderma Fuktindikator

T-muggsopp

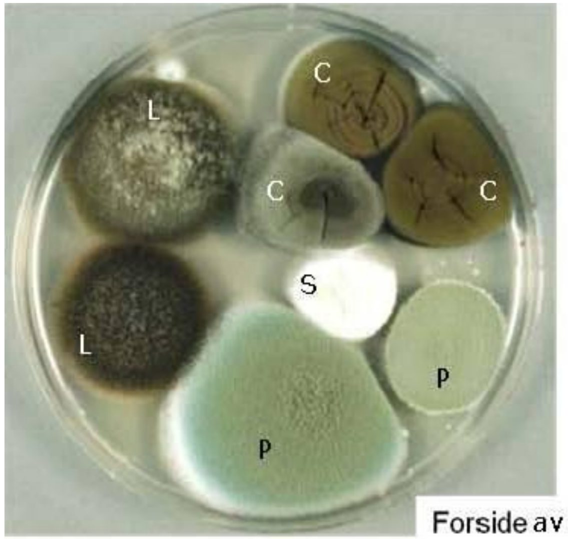


DG18

Eurotium Fuktindikator

E-muggsopp

OBS! Noter muggsoppen under "andre" hvis du ikke finner den i noen av nøklene.



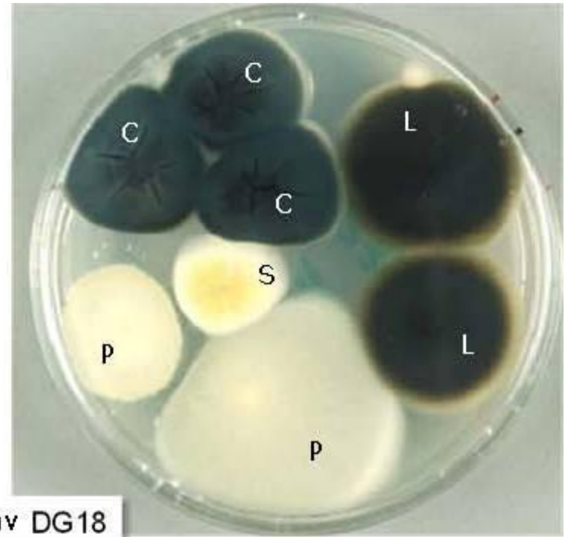
Forside av DG18

C = Cladosporium

L = Alternaria

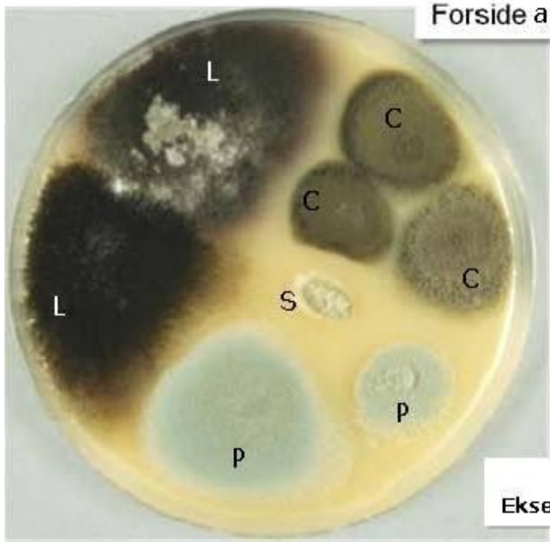
S = Aspergillus

P = Penicillium

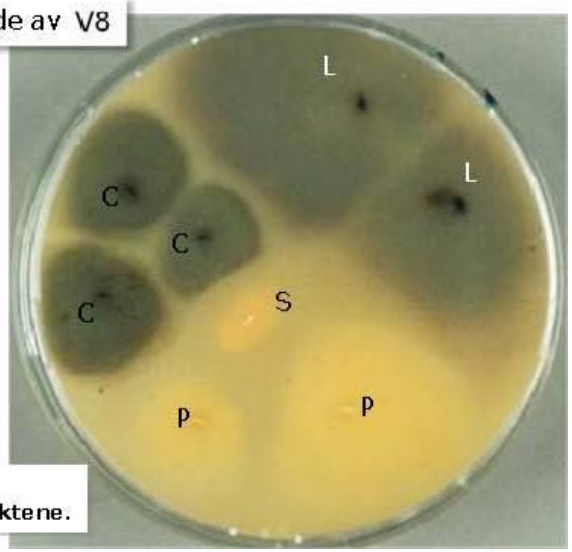


Bakside av DG18

Forside av V8



Bakside av V8



GUIDE 4 - Muggsopp
Eksempler på de fire mest vanlige slektene.

GUIDE 5 – Muggsopp
Beskrivelse av de mest vanlige muggsoppslektene og eksempel på vanlig dekningsgrad i skålen (i %).

	DG18 (III)	V8 (II)	Størrelse	Farge i midten av kolonien	Struktur	Overflate
C - Cladosporium	27 %	30 %	Liten/middels	Ensfarget: Mørkegrønn/brungrønn	Tett/kompakt	Fløyelsaktig
P - Penicillium	18 %	20 %	Middels/stor	Ensfarget: Lysegrøn/grønn/blågrønn	Tett/kompakt	Fløyelsaktig
S - Aspergillus	14 %	7 %	Stor	Ensfarget: Gyldengrønn/grønn/gressgrønn	Tynn/kornet	Hårete/bomullsaktig
E - Eurotium	5 %	1 %	Stor	Mangefarget: Gressgrønn/orangepepret grønn/gul	Tynn/kornet	Hårete/bomullsaktig
L - Alternaria	1 %	1 %	Middels/stor	Ensfarvet: Grønn/mørkegrønn	Tynn	Bomullsaktig/ru
T - Trichoderma	-	1 %	Stor	Ensfarget: Gressgrønn	Klumpete/lodden	
G - Gjær	10 %	12 %	Liten	Ensfarget: Hudfarget/gul/orange/rød	Tett/kompakt	Glatt/skinnende

De ulike muggsoppslektene kan ha arter som ser ganske forskjellige ut.

Appendix D

Student Guidance Document (Mold)

(In Norwegian)

Utstyr

Dag 1:

- 6 petriskåler med to typer agarvekstmedium spesifikt for muggsopp. 3 skåler har vekstmediet vi DG18, og 3 skåler har vekstmediet V8. Oppskrift og innholdsoversikt for DG18- og V8-agar.

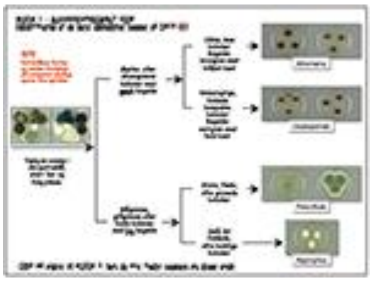
  Petriskåler med DG18 og V8 kan bestilles fra Veterinærinstituttet:

  - DG18: kr. 17,- per skål
  - V8: ca kr. 20,- per skål

  Moms er inkludert, fraktomkostninger kommer i tillegg. Minimumsbestilling er 6 skåler av hver type, kontakt: medieprod@vetinst.no / faksnr. 23 21 60 95.
- 3 plastposer med huller – til oppbevaring av petriskåler under forsøket
- 3 lynlåsposer/plastposer – til avfall
- Tape
- Blanke A4 ark
- Termometer

Dag 8:

- Nøkkel for bestemming av muggsopp
- Tape
- Sprit (minimum 70%) og rull med tørkepapir.
- Kamera
- Eventuelt et mikroskop



Bakgrunn

De fleste har hørt om muggsopp i bygninger, men hvem har sett muggsopp? Og hvordan ser de egentlig ut? Det finnes en mengde av forskjellige muggsoppsporer i luften. De fleste finnes naturlig utendørs, mens andre forekommer i hovedsak innendørs. Noen muggsopper kan være et problem for allergikere, andre er skadelige for mennesker generelt. Muggsopp er en vanlig årsak til dårlig inneklima, og for høye nivåer kan gi en rekke plager som utmattelse, allergiske responser, øye- og luftveisirritasjoner, hodepine, fordøyelsesproblemer, hoste, frysninger, muskel- og leddsmerter, hudirritasjoner, svimmelhet, m.m. (kilde: sykehuset.no).

Per i dag finnes det i følge Folkehelseinstituttet ikke noen gode grenseverdier for når nivåer av muggsopp blir helseskadelig (mer utfyllende rapport her), så undersøkelsene dere gjør her vil ikke direkte kunne gi et utvetydig svar på om dere har et muggsopproblem. Dere vil imidlertid få en pekepinn på forholdene i klasserommet og kunnskap om problemet. Hvis dere påviser et stort antall muggsoppkolonier, kan dere jo kanskje vurdere å la eksperter gjennomføre en mer eksakt undersøkelse. Senere års forskning viser at barn lærer vesentlig bedre i et godt inneklima, så luftkvalitet bør prioriteres høyt i skolene.

Les mer om muggsopp her.

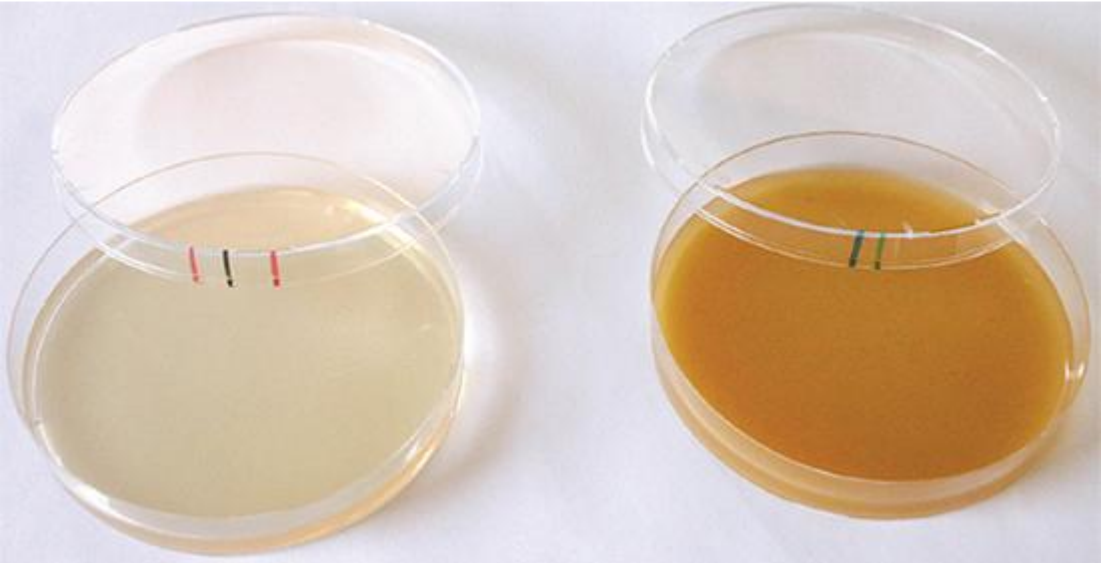
Veiledning

Les nøye gjennom veiledingen før eksperimentet gjennomføres, det er viktig at veiledningen følges nøye, og at alle i klassen gjør nøyaktig det samme.

For å få realistiske målinger er det viktig at rengjøring, eventuell utluftning og andre aktiviteter i klasserommet er som de pleier å være fram mot forsøket. Vinduene til klasseværelset skal være lukket fra start av forsøket og mens dere gjennomfører første del av forsøket (eksponering av petriskålene til luften i klasserommet).

Petriskålene

Petriskålene inneholder agar, et næringsmedium hvor soppsporene vil spire og danne kolonier. Ett sett med petriskåler består av to skåler med forskjellig agar, en med DG18 (Dichloran 18% Glycerol agar) spesielt god til å fange støvbårne sporer, og en med V8 (V8 er en forkortelse for en agar basert på grønnsaker) som egner seg godt til å fange sporer som liker fuktig miljø.



Petriskål DG18

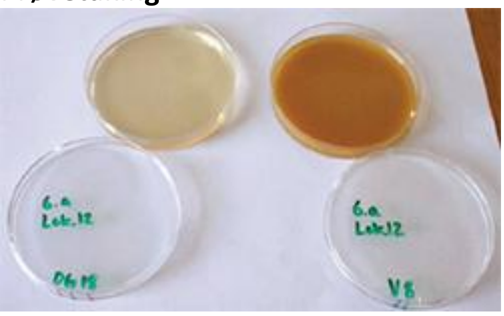
Strekkoden rød/svart/rød er forskernes symbol for en agarblanding (et vekstmedium) som kalles DG18. DG18 er en forkortelse for Dichloran 18% Glycerol agar. Glycerol senker vannaktiviteten, og egner seg derfor godt til å fange støvbårne muggsopper. NB! Hvis ikke strekkoden er brukt på skålene er de merket med DG18.

Petriskål V8

På samme måte er strekkoden blå/grønn forskernes symbol for en agarblanding (et vekstmedium), som kalles V8. V8 er forkortelsen for en grønnsak-agar som er god til å fange muggsopp i fuktige miljøer. NB! Hvis ikke strekkoden er brukt på skålene er de merket med V8.

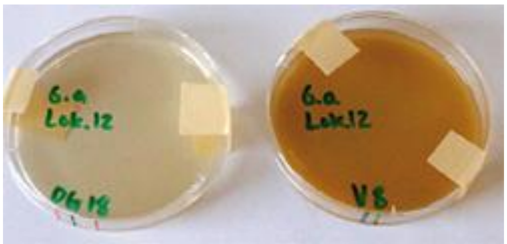
Gjennomføring

Prøvetaking



- Mål temperaturen i rommet
- Finn midten av rommet.
- Rydd dette området slik at det kan stå et bord her. En stol kan også brukes, men skålene står mer stabilt på et bord.
- Legg et rent A4 ark på bordet.

- Et sett med petriskåler pakkes ut og settes på et blankt A4 ark. Lokkene tas forsiktig av og legges ved siden av den skålen de ble tatt av. Lokket settes med oversiden opp (se bildene). Husk at petriskålene er sterile, så ikke rør dem på innsiden med fingrene.
- Petriskålene skal stå åpne i 60 minutter. Dette kalles "eksponering". Lokkene legges deretter tilbake på skålen de hørte til. Lokkene teipes fast med to små stykker med teip (se bildet), Ikke sett teip rundt hele kanten siden soppen må ha luft. Lokkene tas nå ikke av igjen før de skal avleses.
- Petriskålene settes oppå hverandre og pakkes inn i plastposen med huller (se bilder). Sett dem tørt og mørkt i et skap eller en skuff med vanlig romtemperatur (mellom 18 og 25 °C). Hvis skålene settes i sollys eller over varme, dannes det kondens i lokket. Lås gjerne skapet/skuffen. Skålene skal nå stå i fred i 7 døgn. Dette kalles "inkubering".



Avlesing av resultater etter 7 døgn i mørke

Husk at petriskålene bør håndteres forsiktig. Soppsporer spres normalt via lufttransport og klistrer seg veldig lett til lokkene.

Vi oppfordrer dere til å ta et foto av hver skål (både forside og bakside) og laste disse opp til miljolare.no når dere registrerer resultatene, så kan skoler sammenligne kolonivekstene. Hvis reflekser eller kondens i lokket gjør det vanskelig å få gode foto, kan læreren kortvarig fjerne lokket. Kondensen kan fjernes med et stykke tørkepapir.

Teip så lokket fast rundt hele omkretsen av skålen slik at sporene ikke spres.

Tell så soppkoloniene (enten direkte fra skålen eller fra foto) og finn totalt antall kolonier (CFU) for hver skål (CFU = Colony Forming Units = kolonidannende enheter). Før resultatene inn i skjemaet.

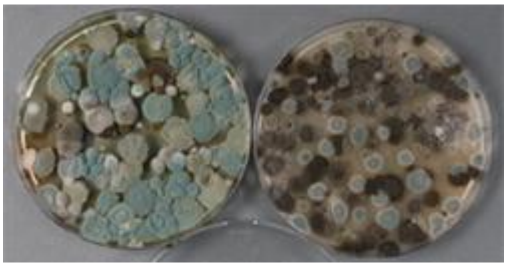
Bruk så fotoguiden for å identifisere koloniene. Guiden identifiserer syv slekter. De øvrige noteres under "andre" i skjemaet. Identifikasjon av muggsopp er ikke så veldig lett, men gjør så godt dere kan. Tell så antallet av kolonier dere finner fordelt på de ulike slektene.

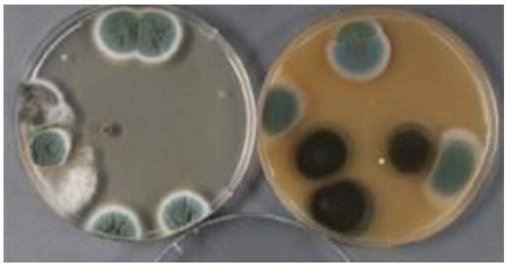
Petriskålene pakkes så inn i en plastpose som knyttes igjen/forsegles, og petriskålene kan så kastes som vanlig søppel.

Registrer så resultatene på miljolare.no

Eksempel på petriskåler som er klare til avlesning

Så forskjellige kan petriskålene se ut etter dette eksperimentet. Prøven under til venstre har mange Penicillium- og Cladosporium-kolonier. Det indikerer at det er fuktig i rommet. Prøven under til høyre er en mer normal prøve, med kun få Penicillium-og Cladosporium-kolonier.





SIKKERHET

Vær forsiktige når dere flytter petriskålene. Det er viktig å unngå å spre soppsporer. La derfor som en hovedregel lokket ligge på skålene, og flytt dem forsiktig.

Pakk petriskålene i plastpose med en gang dere er ferdige, forsegl posen og kast denne samme dag.

Hvis uhellet er ute, rens med sprit! Hvis dere mister en petriskål på gulvet eller bordet, rens med sprit. Fukt 3-4 tørkepapir med sprit og vask over området der dere mistet skålen. Hvis det ligger så mange soppsporer igjen på bordet eller gulvet at dere kan se et farget lag, heller dere en kopp sprit på området. Tørk så opp med tørkepapir. Den brukte tørkepapiret legges i en plastpose og kastes i det vanlige søppelet.

Appendix E

Student Data Form (Mold)

(In Norwegian)

Undersøk muggsopp i klasserommet

Skjema

Dette skjemaet kan du ta utskrift av og bruke når du jobber med aktiviteten. Når du er klar til å legge informasjonen inn i databasen, går du til

Registrer data

Registrer klasserommet

Romnavn	
Romtype	(Klasserom, garderobe, gymsal, heimkunnskapsrom, sløyd-/håndarbeidsrom, naturfagrom, bibliotek, pc-rom, musikkrom, lærerværelse, SFO, aula/ forelesningsrom, annet)
Hvor gammelt er klasserommet?	Byggeår
Gulvareal	m^2
Takhøyde	cm
Romvolum	m^3

Opplysninger om klasserommet

Lukter det vanligvis vondt/kjelleraktig/innestengt i klasserommet når dere kommer om morgenen?		Ja
		Nei
Blir det vanligvis luftet i klasserommet i friminuttene?		Ja
		Nei
Ligger skolen i eller like ved grøntområder?		Ja
		Nei

Hvilken type ventilasjon har klasserommet?		Ventilasjonsanlegg med både utsug og innblåsing
		Ventilasjonsanlegg med bare utsug
		Kun lufting gjennom vinduer eller ventiler

Opplysninger på prøvedagen (dag 1)

Hvor mange personer var det i klasserommet på prøvedagen?	

Hvordan var været de siste 24 timer før forsøket startet?		Sol		Vind
		Sol		Vind
		Sol		Vind

Når ble klasserommet sist rengjort?	Dato/klokkeslett	
Når ble det sist luftet i klasserommet?		

Måletidspunkt

Starttidsspunkt for petriskålforsøket	Dato/klokkeslett	
Tidspunkt for lukking av petriskåler		
Tidspunkt for telling av mugsoppkolonier		

Temperatur i klasserommet (kun dag 1)

Temperatur ved start av petriskålforsøket		°C
Temperatur ved lukking petriskåler		°C

Muggsopp identifisert ved hjelp av nøkkelen/guiden

	Antall kolonier på DG18	**Antall kolonier på V8**
C-muggsopp = *Cladosporium*		
P-muggsopp = *Penicillium*		
S-muggsopp = *Aspergillus*		
L-muggsopp = *Alternaria*		
T-muggsopp = *Trichoderma*		
E-muggsopp = *Eurotium*		
G-sopp		
Andre muggsopp		

Kommentarer til forsøket

Kommentarer:

Appendix F

Participating Norwegian Schools

(sorted by region alphabetically)

(In Norwegian)

Deltaker	deltaker_id	Fylke	Kommune	Bygning	Rom	Utført av
Drøbak skole	1031	Akershus	Frogn	Drøbak skole	7 trinn	Johanna Hulbach
Brønnerud Skole	2041	Akershus	Ås	skolebygning	Klasse E	Klasse E
Ski ungdomsskole	3583	Akershus	Ski	hovedbygningen	rom 12	Edel Eikesdal
Ås skole	2281	Akershus	Eidsvoll	Skolebygg	5.trinn	Ingrid Rønsen
Vevelstadåsen skole	2331	Akershus	Ski	Skolebygg	Nr 5	6c
Eikeli skole	3722	Akershus	Bærum	Eikeli Skole	10	6.trinn
Skedsmo videregående skole	2613	Akershus	Skedsmo	Skedsmo videregående skole	6201	Biologi2
Vilberg skole	2736	Akershus	Eidsvoll	Vilberg skole	Jupiter	Vilberg skole
Hosletoppen Skole	3184	Akershus	Bærum	Hosletoppen Skole	208	elisabeth raabe og ann larsen
Østerås skole	3126	Akershus	Bærum	Østerås skole	208	Oddvin
Tæruddalen skole	7149	Akershus	Skedsmo	Tæruddalen skole	9 F	9 F v / Unni Kjus Aahlin
Nesbru videregående skole	13080	Akershus	Asker	Nesbru videregående skole	N-356	tof 1
Skui skole	7944	Akershus	Bærum	Skui skole	a	7.klasse
Vilberg ungdomsskole	2686	Akershus	Eidsvoll	Vilberg ungdomsskole	22	10 b
Gullhaug skole	3498	Akershus	Bærum	skolebygning	klasserom	Mette Munthe-Kaas
Bøleråsen Skole	2096	Akershus	Ski	klasserom 3 stk.	129	Elever på 7.trinn
Søndeled skole	3134	Aust-Agder	Risør	Søndeled skole	5. klasserom	Kathrin Kveim Flåta
Valle skule	1824	Aust-Agder	Valle	Barneskulefløy	5.kl	Tor Brokke
Gol Skule	3186	Buskerud	Gol	Gol Skule	D1	Kontakt.l. Aslaug
Hol Ungdomsskole	1858	Buskerud	Hol	Hol Ungdomsskole	8A	Stian Ripe Daviknes
Flå Skole	3190	Buskerud	Flå	Flå skole	10.klasse	9.trinn
Strømsø skole	405	Buskerud	Drammen	Strømsø Skole	24	Gruppe 8 AB 3
Sylling Skole	1967	Buskerud	Lier	Sylling skole		8. klasse v/Signor Ellingsen
Bøkfjord skole	1610	Finnmark	Sør-Varanger	Jakobsnes Oppvekstsenter	SFOrom	3. trinn

Tårnet skole	831	Finnmark	Sør-Varanger	Tårnet skole	3-4 klasse	gruppe 3
Alta videregående skole	3079	Finnmark	Alta	Alta videregående skole	N203	tof2
Alta ungdomsskole	660	Finnmark	Alta	Skoleplassen	101	klasse 9B
Kunes skole	1342	Finnmark	Lebesby	Kunes Skole	Klasserom	Stine og Inge
Gjesvær skole	2689	Finnmark	Nordkapp	Gjesvær skole	Klasserom mellomtrinn	5. - 7. klasse
Sentrum skole	2559	Finnmark	Vadsø	Sentrum Skole	datarom	
Saga skole	3072	Finnmark	Alta	Saga skole	147	4. trinn
Tynset ungdomsskole	2472	Hedmark	Tynset	Skolebygg	K 1	Irene Siksjø
Hernes skole	2703	Hedmark	Elverum	Kirkeby Skole	129	Stig Evensen
Grue barne- og ungdomsskole	3767	Hedmark	Grue	Grue barne- og ungdomsskole	9A rom 212	Aina PAulsrud
Finnskogen Montessoriskole Ba	9551	Hedmark	Kongsvinger	Finnskogen Montessoriskole	Gruppe 2	Kaja Græsberg
Lillemoen Skole	2437	Hedmark	Elverum	Skolebygg	5.klasserom	Trinn 5
Os skole	1830	Hedmark	Os	Os skole	Rom 14	Ellen Gullbrekken og 9B
Prestrud Skole	1714	Hedmark	Hamar	Prestrud skole	6c	6c
Solør Montessoriskole	13069	Hedmark	Åsnes	Solør Montessoriskole	klasserom	gruppe 3
Romedal ungdomsskole	2884	Hedmark	Stange	Romedal ungdomsskole	402	Rita Korsbakken Olsen
Tertnes Skole	2022	Hordaland	Bergen	Hovedbygg	308/309	Bjørg Irene Hagen
Lægreid skule	2526	Hordaland	Eidfjord	Lægreid skule	6.kl	6. og 7.klasse
Enge skule	856	Hordaland	Etne	fylkesvegen ved Etne samf.hus	120	6.klasse
Hjellestad skole	1278	Hordaland	Bergen	Hjellestad skole	109, grønt rom	6. trinn, rom 109
Skånevik skule	729	Hordaland	Etne	Skånevik skule	8	9.klasse v/ Reidar leknes
Espevær skule	490	Hordaland	Bømlo	Espevær Skule	223	5.-7.trinn på Espevær skule
Christi Krybbe Skoler	2070	Hordaland	Bergen	Klasserom 103	2	Elisabeth Hunsrød
Ekerhovd Oppveksttun skule	13078	Hordaland	Fjell	Ekerhovd Oppveksttun skule	musikkrom/klasserom	Sigrid B. Kvam
Osterøy ungdomsskule	2956	Hordaland	Osterøy	Osterøy ungdomsskule	8 klasse gang	Osterøy ungdomsskule 10ab

Bjorøy Oppveksttun skule	5625	Hordaland	Fjell	Bjorøy skole	Kjeller	Tom Klippenberg
Olsvikåsen videregående skole	3499	Hordaland	Bergen	Olsvikåsen videregående skole	Stasjon 2	Amir
Loddefjord skole	2511	Hordaland	Bergen	Skolebygg	5.trinn	Nils-Einar Johansen / 5.trinn ved Loddefjord skole
Erdal skole	321	Hordaland	Askøy	Hovedbygning	101	Hallvard Enoksen
Jondal skule	4374	Hordaland	Jondal	Jondal skule	10. klasse	Jondal skule 10. klasse
Øystese gymnas	223	Hordaland	Kvam	Øystese gymnas	129	Klasse 1STA
St Paul Skole	1611	Hordaland	Bergen	St. Paul skole	6. klasse	6. klasse, Truls Hopsdal
Flaktveit skole	2501	Hordaland	Bergen	Våningen (hovedbygning)	Arbeidsrom, rom 8	Linda Mork-Knudsen og Randi Kvalem
Selbjørn skule	2199	Hordaland	Austevoll	Selbjørn skule	klasserom	Selbjørn skule 7. trinn
Damsgård skole	3237	Hordaland	Bergen	Damsgård skole	208	Kristin Skage
Pollen skule	265	Hordaland	Sund	Pollen skule	klasserom 7.klasse	Liv Marit
Rå skole	3076	Hordaland	Bergen	Rå ungdomsskole	nr 10	9A
Bønes skole	2498	Hordaland	Bergen	Bønes skole gymsal	Gymsal	Anita Kobbeltvedt
Storebø skule	682	Hordaland	Austevoll	Skolebygg	C 201	Klasse 7a-b
Nordbyen skole	3275	Møre og Romsdal	Molde	Hovedbygningen	7	Hans Terje Møller
Molvær skule	2974	Møre og Romsdal	Sula	Molvær skule	2. klasse	2. klasse
Valderøy ungdomsskule	380	Møre og Romsdal	Giske	Valderøy ungdomsskule	201	klasse 10B
Geiranger skule	935	Møre og Romsdal	Stranda	Geiranger Skule	2	Terje Drege Rusten
Tresfjord skule	1170	Møre og Romsdal	Vestnes	Tresfjord skule	klasserom for 10.	10. klasse
Bigset skule	666	Møre og Romsdal	Hareid	Bigset skule	204	Hanne Sofie Urke
Tomrefjord skule	2565	Møre og Romsdal	Vestnes	Tomrefjord skule	Nr. 276	Marina Djupvik
Aure skule	5578	Møre og Romsdal	Sykkylven	Aure skule	Klasserom	6.klasse Aure skule
Atlanten videregående skole	2660	Møre og Romsdal	Kristiansund	Atlanten videregående skole	103	
Frei skole	906	Møre og Romsdal	Frei	Frei skole	7. klasse	Stig Kåre Håholm

Terje Nygård	8127	Møre og Romsdal	Molde	Terje Nygård	Klasserom- gruppe2	Trinn 8
Onøy/Lurøy skole	392	Nordland	Lurøy	Onøy/Lurøy skole	Skolekjøkken	8-10 klasse
Alsvåg skole	858	Nordland	Øksnes	Nyskolen	6 klasse	Geir Arne Haughom
Midtbygda skole	2989	Nordland	Dønna	Gammelbygget på Midtbygda	3	7.klasse
KRISTEN VIDEREGÅENDE SKOLE - NORDLAND	3259	Nordland	Nesna	Nesna	I	1ST
Røkland Skole	1887	Nordland	Saltdal	Røkland Skole	Nordnes	6.klasse med lærere
Stokmarknes skole	907	Nordland	Hadsel	Stokmarknes skole	7B	Åge Lind
Kongsvik Skole	3016	Nordland	Tjeldsund	Kongsvik skole	rom 4	5 - 7 klasse
Digermulen Skole	2443	Nordland	Vågan	Skolebygg	Mellomtrinnet	Mellomtrinnet
Bodø videregående skole	2794	Nordland	Bodø	BODØ VIDEREGÅENDE SKOLE	TG	STBi1 Åse Alvestad
Bodøsjøen skole	10061	Nordland	Bodø	Bodøsjøen skole	Fembøringen	Heidi Heimlund
Gruben Barneskole	2448	Nordland	Rana	Fløy B	B-16	Klasse 5c
Liland skole	1169	Nordland	Evenes	Skolebygg	rom 2	5.klasse liland skole
Fleinvær skole	13051	Nordland	Gildeskål	Fleinvær skole	Klasserom	Stig-Are Melby
Vest-Lofoten videregående skole	215	Nordland	Vestvågøy	Ved Vest Lofoten vgs, avd Gravdal	204	Vg1A Studiespesialiserende
Reipå Skole	1920	Nordland	Meløy	Hovedbygg	6	
Meløy videregående skole - avd. Ørnes	121	Nordland	Meløy	Meløy videregående skole - avd. Ørnes	F	Vg1 studiespesialisering
Risøyhamn Barne og ungdomsskole	6868	Nordland	Andøy	Risehamn sentrum	10.kl	Lærer
Mindland Skole	1892	Nordland	Alstahaug	Skolebygg	Storklassen	5. - 7. klasse
Rødøy skole	9417	Nordland	Rødøy	Rødøy skole	7	8.-10.kl.
Ballstad skole	3141	Nordland	Vestvågøy	Ballstad skole	9. klasserom	9. klasse 2009/10
Testmann Minne skole	3970	Nord-Trøndelag	Leksvik	Testmann Minne skole	Rom 14	Tor A. Dale
Vålen skole	3277	Nord-Trøndelag	Steinkjer	skolebygning	Klasserom 1	6.- og 7. klasse
Lø skole	1608	Nord-Trøndelag	Steinkjer	klasserom	Rom 5	

Kolvereid Skole	1642	Nord-Trøndelag	Nærøy	Kolvereid Skole	2.klasse	Nan Engnes
Malm skole	333	Nord-Trøndelag	Verran	Barneskolen Malm	202	6. klasse
Folla skole	319	Nord-Trøndelag	Verran	Folla skole	9.klasse	
Nesset ungdomsskole	1331	Nord-Trøndelag	Levanger	Skole	Klasserom 9	Klasse 9B v/Ulf Thyrhaug
Marlo Skule	2997	Oppland	Skjåk	Marlo Skule	7. klasserom	Jarleif Ellingbø
Sanne Skole	2394	Oppland	Gran	Gamleksolen	6.klasserom	6.trinn
Grymyr Skole	1929	Oppland	Gran	Skolebygg	Aktivitetsrommet (5. kl)	5.-7. trinn
Forset skole	2828	Oppland	Gausdal	Forset skole	Rom 5	Kjetil Pedersen
Lunner ungdomsskole	7563	Oppland	Lunner	Frøystad	u2	Lasse
Gjøvik skole	13081	Oppland	Gjøvik	Gjøvik skole	6.kl.rom	J.Richenberg
Dokka videregående skole	13071	Oppland	Nordre Land	Dokka videregående skole	102	3STB
Solvang skole i Gran	1472	Oppland	Gran	Solvang -	klasserom	7. klasse
Nord-Aurdal ungdomsskole	13096	Oppland	Nord-Aurdal	Nord-Aurdal ungdomsskole	8	Marit Trøen
Jørstadmoen skole	2400	Oppland	Lillehammer	Jørstadmoen skole	Personalrom	Erland Sorgendal
Kastellet skole	9982	Oslo	Oslo	Kastellet skole	naturfagsal	9a og 9b
Ullevål skole	13060	Oslo	Oslo	Ullevål skole	Naturfagrommet	5. trinn
Lilleaker skole	2252	Oslo	Oslo	A-Bygget	6	Klasse 6b
Munkerud Skole	2259	Oslo	Oslo	hovedbygget	nr. 16	5 d/Else Kolflaath
Lakkegata skole	2151	Oslo	Oslo	Gamlebyen skole	B220	5b
Bøler skole	2145	Oslo	Oslo	utmarkveien 4	Rom 19	Morten Saksgård
Bekkelaget skole	2579	Oslo	Oslo	Bekkelaget skole	Naturfagsrom	Sindre Utstrand
Den Franske skolen	2743	Oslo	Oslo	Den Franske skolen	205	Sophie Cordon
Abildsø skole	2237	Oslo	Oslo	Bygg2, klokkebygget nede	2-102	Klasse 10b
St. Sunniva skole	2268	Oslo	Oslo	Hovedbygg	A6	10. trinn
Hauketo skole	1281	Oslo	Oslo	Hauketo skole	rom 3 oppe og nede	Ragnhild Martinsen og Lene Holmen

Skeisvang videregående skole	3252	Rogaland	Haugesund	Skeisvang vg skole	A003	1STC
Sund skole	10069	Rogaland	Karmøy	Sund skole	2	7.klasse
Solås skole	3713	Rogaland	Gjesdal	Solås Skole	6. klasserom dobbelt	6. Klasse
Bokn skule	1132	Rogaland	Bokn	Bokn skule	7.klasserom	7.klasse, Sigrunn Hole Hosaas
Storevarden skole	352	Rogaland	Sola	Storevarden skole	6A	6A Storevarden skole
Jørpeland ungdomsskole	504	Rogaland	Strand	Jørpeland ungdomsskole	GrC1	Mari K. Granerud
Sevland skole	782	Rogaland	Karmøy	Sevland skole	104	Sevland skole
Vålandshaugen barnehage, naturgruppa	3533	Rogaland	Stavanger	Vålandshaugen barnehage, naturgruppa	avdeling	eirik
Lura skole	13068	Rogaland	Sandnes	Lura skole	203	7. kl Lura skole
Bærland skole	3656	Rogaland	Gjesdal	Bærland skole	klasserom U3	Wigdis Stangeland
Harestad skole v/ Thor Atle Andresen	658	Rogaland	Randaberg	Harestad skole v/ Thor Atle Andresen	B216	Thor Atle Andresen
Soma skole	3099	Rogaland	Sandnes	skolebygning	auditorium	5., 6. og 7. klasse
Bjørheimsbygd skule	3707	Rogaland	Strand	Bjørheimsbygd skule	5-7 klasserom	5-7 trinn
Tveit vidaregåande skole	207	Rogaland	Tysvær	Tveit vidaregåande skole	Trapperommet	VG3 NF
Fjelltun skole	7921	Rogaland	Strand	Skolegården	1	
Ombo Oppvekstsenter	13063	Rogaland	Finnøy	Ombo Oppvekstsenter	mellomtrinn	Ombo oppvekstsenter
Jostedal skule	2970	Sogn og Fjordane	Luster	Jostedal skule	storeklasseromet	5-7 klasse gr.1
Dalen skule	3089	Sogn og Fjordane	Naustdal	Dalen skule	6.klasserom	6.klasse
Holvik skule	13061	Sogn og Fjordane	Vågsøy	Holvik skule	Klasserom 2	Bente Eikrem
Gloppen ungdomsskule	1093	Sogn og Fjordane	Gloppen	Gloppen ungdomsskule	8	8C
Leikanger barneskule	596	Sogn og Fjordane	Leikanger	Leikanger barneskule	Klasserom 7/8	6. klasse v/Monica Wathne Tufte
Skram skole	616	Sogn og Fjordane	Vågsøy	Skram skole	207	Kristian Andal
Oppstryn skule	3940	Sogn og Fjordane	Stryn	Oppstryn skule	Rom 3	
Lilleby Dagskole	13090	Sør-Trøndelag	Trondheim	Lilleby Dagskole	Tekstilrom	SB

Steinerskolen på Fosen	13070	Sør-Trøndelag	Ørland	Steinerskolen på Fosen	9.-10. kl	Sandra Scwabe
Orkanger Barneskole	1993	Sør-Trøndelag	Orkdal	1985 - fløy	7.nord	Thomas Nordahl Pedersen
Brundalen skole	2575	Sør-Trøndelag	Trondheim	Brundalen barneskole	7.trinn landskap	7.trinn Kari Øverås
Dalgård skole - Trondheim kommune	3239	Sør-Trøndelag	Trondheim	Dalgård	klasserom	4a+d
Orkdal vidaregåande skole	174	Sør-Trøndelag	Orkdal	Orkdal vidaregåande skole	C-26	
Grefstad Skole	1913	Sør-Trøndelag	Meldal	Grefstad Skole	Rom 6	Jonas Landrø
Hommelvik ungdomsskole	2113	Sør-Trøndelag	Malvik	Vestfløy	Klasserom 4	Klasse 9a
Hovet skole	2687	Telemark	Porsgrunn	Hovet ring 7, 5-7 klasse	2	7.klasse
International School Telemark	6097	Telemark	Porsgrunn	MYP Herøyahuset	HH1	MYP D
Rugtvedt skole i Bamble	3954	Telemark	Bamble	Rugtvedt skole i Bamble	6	10AB
Kragerø videregående skole	7886	Telemark	Kragerø	Kragerø videregående skole	131	2REA
Bø skule	3859	Telemark	Drangedal	Bø skule	blå rom	5 til 7 klasse
Sannidal skole	2288	Telemark	Kragerø	Sannidal skole	Rom 6	Else-Liv Thorsen
Skien videregående skole	10057	Telemark	Skien	Skien videregående skole	Kantina	TOF2
Kviteseid Skule	1981	Telemark	Kviteseid	nærområdet	9A	klasse 9A
Åmot skule	3400	Telemark	Vinje	Åmot skule, hovudbygningen	10.klasse-rom	10. klasse
Miland skole	3003	Telemark	Tinn	Miland skole	SFO	5-7 klasse
Heddal ungdomsskole	2903	Telemark	Notodden	Heddal ungdomsskole	Naturfagsal	Kari Tho
Hamnvåg Montessoriskole	5889	Troms	Balsfjord	Hamnvåg	klasserom oppe	elevene i 5.-6. klasse
Ramfjord skole	13072	Troms	Tromsø	Ramfjord skole	120 klasserom	8.kl og lærer Knut
Voksenopplæringen i Tromsø	13055	Troms	Tromsø	Voksenopplæringen i Tromsø	208	GS1
Reinen skole	3608	Troms	Tromsø	Reienen	Planet	Roar Albrigtsen
Vågsfjord videregående skole skolested Heggen	3339	Troms	Harstad	HEGGEN VIDEREGÅENDE SKOLE	211	Klasse 1D
Vågsfjord videregående skole, Skånland	975	Troms	Skånland	Skånland videregående skole	8	Klasse 3b

Skjervøy skole i Skjervøy	1197	Troms	Skjervøy	Skjervøy barneskole-mellomfløy	rom10	5a
Ekrehagen skole	13066	Troms	Tromsø	Ekrehagen skole	Klasserom F	Mona Lockertsen og elever
Breivika videregående skole	13049	Troms	Tromsø	Breivika videregående skole	A2.021	13MKA/13PÅC
Kvaløysletta ungdomsskole	228	Troms	Tromsø	Kvaløysletta skole	rom 5	8b
Lyngsdalen skole	2631	Troms	Lyngen	Lyngsdalen oppvekstsenter	Klasserom 2	5.,6. og 7.kl
Brensholmen skole	372	Troms	Tromsø	Brensholmen skole	MT-rommet	MT ved Brensholmen skole
Bjarkøy Barne- Og Ungdomsskole	3570	Troms	Bjarkøy	Nergårdshamn	himmelen	8. og 9. klasse
Steinerskolen i Tromsø	13101	Troms	Tromsø	Steinerskolen i Tromsø	9. klasse rommet	May-Britt Norberg
Stonglandet skole	535	Troms	Tranøy	stonglandet skole	7	8.og 9.klasse
Skjelnan Skole	1999	Troms	Tromsø	Skjelnan skole - Rom E105	E 105	Klass e 7B
Øvergård Montessoriskole	2490	Troms	Målselv	Gammel del	C klasseroomet	Ewa Anna Øvergård
Lista Ungdomsskole	2338	Vest-Agder	Farsund	Lista ungdomsskole	208	Jan Andersen
Samfundets skole, avd. Søgne	386	Vest-Agder	Søgne	Samfundets skole	Trilingan	Geir Helleland
Farsund barne- og ungdomsskole	2325	Vest-Agder	Farsund	Brakka	1	Elever på 7 trinn.
Karuss skole	3123	Vest-Agder	Kristiansand	springvann Karuss skole	9b	9b
Austerdalen skole	1825	Vest-Agder	Kvinesdal	Austerdalen skole	klasserom	Astrid aldal
Holum Skole	2332	Vest-Agder	Mandal	Mellomtrinnet	6. klasse	Bente Tronstad
Andebu ungdomsskole	13058	Vestfold	Andebu	Andebu ungdomsskole	5	Kl.8b Andebu ungdomsskole
Moe Skole	2677	Vestfold	Sandefjord	Moe skole	B2	Fredrik Døvik
Langestrand skole	3138	Vestfold	Larvik	Langestrand skole 5.kl	5.klasse	5.klasse
Brunla ungdomsskole	764	Vestfold	Larvik	Rom 9	Rom 9	Anne Øfstedal Nilsen og 8c
Skagerak Primary And Middle School	3943	Vestfold	Sandefjord	Skagerak Primary And Middle School	Naturfag lab	Irena Rinkeviciene
Jordet skole, Larvik	273	Vestfold	Larvik	Jordet skole	Klasserommet til 6b	6b
Korsgård skole	1107	Østfold	Askim	C bygningen på Korsgård skole	5.trinns klasserom	Jorunn Dyrbekk + elever på 5.trinn

Gimle skole	13079	Østfold	Halden	Gimle skole	60	6. trinn
Folkvang Skole	1677	Østfold	Halden	Folkvang Skole	9	Hege Machulla
Hurrød Skole	3742	Østfold	Fredrikstad	Hurrød skole	8 3etg.	7. trinn
Trosvik skole	10080	Østfold	Fredrikstad	Trosvik skole	brakke	Anita Tangen
Hafslundsøy skole	3932	Østfold	Sarpsborg	Hafslundsøy skole,hovedbygning	klasserom 5	Kari Røberg
Grøtvedt skole	1110	Østfold	Askim	Grøtvedt skole	3	8c

Appendix G

Schools which participated in 2003 and 2009

Schools which participated in both the 2003 and 2009 campaign

Abildsø skole
Alsvåg skole
Breivika videregående skole
Brunla ungdomsskole
Bønes skole
Digermulen Skole
Drøbak skole
Erdal skole
Espevær skule
Farsund barne- og ungdomsskole
Flaktveit skole
Gol Skule
Gruben Barneskole
Grymyr Skole
Hafslundsøy skole
Holum Skole
Hommelvik ungdomsskole
Hovet skole
Jordet skole, Larvik
Jørstadmoen skole
Kongsvik Skole
KRISTEN VIDEREGÅENDE SKOLE - NORDLAND
Kviteseid Skule
Liland skole
Lilleaker skole
Lillemoen Skole
Lista Ungdomsskole
Loddefjord skole
Lyngsdalen skole
Lægreid skule
Malm skole
Midtbygda skole
Mindland Skole
Nord-Aurdal ungdomsskole
Oppstryn skule
Orkanger Barneskole
Os skole
Osterøy ungdomsskule
Prestrud Skole
Reipå Skole
Samfundets skole, avd. Søgne
Sentrum skole
Ski ungdomsskole
Skjelnan Skole
Skjervøy skole i Skjervøy
Solvang skole i Gran
St. Sunniva skole
Stonglandet skole
Storebø skule
Tertnes Skole
Tomrefjord skule
Tynset ungdomsskole
Tårnet skole
Valderøy ungdomsskule
Valle skule
Vevelstadåsen skole
Voksenopplæringen i Tromsø
Ås skole

Appendix H

CO_2 and Temperature Results for Denmark

(In Norwegian)

CO_2 values distributed for Denmark:

Fordeling av målingene

101-200 ppm	1%	5
201-300 ppm	1%	6
301-400 ppm	2%	16
401-500 ppm	3%	24
501-600 ppm	10%	76
601-700 ppm	4%	30
701-800 ppm	6%	48
801-900 ppm	3%	21
901-1000 ppm	16%	124
1001-1100 ppm	2%	12
1101-1200 ppm	6%	43
1201-1300 ppm	1%	11
1301-1400 ppm	5%	40
1401-1500 ppm	2%	13
1501-1600 ppm	5%	38
1601-1700 ppm	2%	12
1701-1800 ppm	4%	32
1801-1900 ppm	1%	7
1901-2000 ppm	8%	62
2001-2100 ppm	0%	1
2101-2200 ppm	2%	17
2201-2300 ppm	0%	2
2301-2400 ppm	6%	47
2501-2600 ppm	1%	11
2601-2700 ppm	0%	1
2701-2800 ppm	2%	17
2801-2900 ppm	0%	2
2901-3000 ppm	1%	5
3101-3200 ppm	2%	19
3201-3300 ppm	0%	1
3301-3400 ppm	1%	5
3501-3600 ppm	1%	7
3701-3800 ppm	1%	4
3901-4000 ppm	0%	3
4001-4100 ppm	1%	4
4701-4800 ppm	0%	1

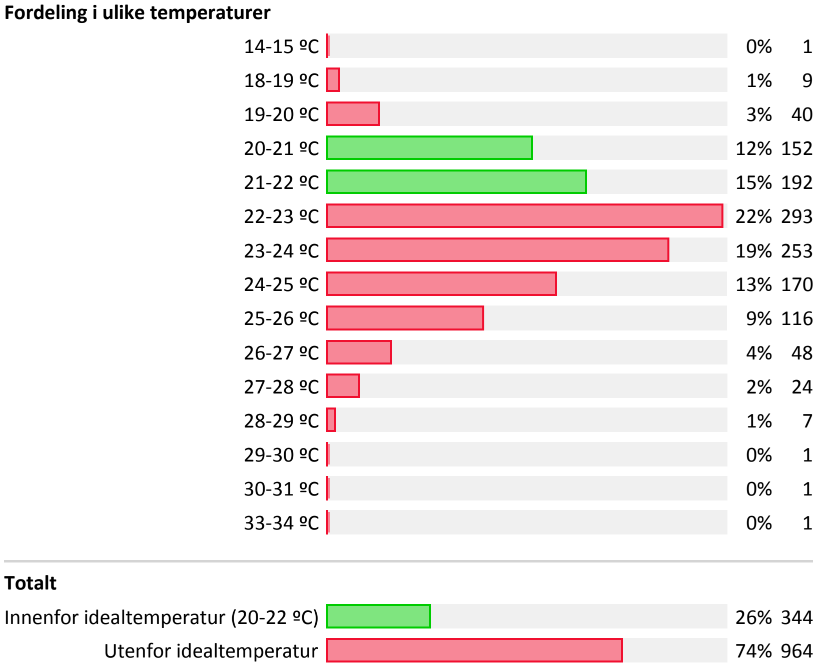
Totalt

Andel <=1000 ppm	46%	350
Andel >1000 ppm	54%	417

CO_2 results for Denmark divided by region:

Fylke	Skoler	Målinger	Rom	<1000 ppm	> 1000 ppm	Andel over/under 1000 pm
Hovedstaden	100	267	256	46%	54%	
Midtjylland	64	168	150	44%	56%	
Nordjylland	27	64	62	34%	66%	
Sjælland	54	125	116	53%	47%	
Syddanmark	80	164	151	44%	56%	

Temperature results distributed for Denmark:



Appendix I

CO_2 and Temperature Results for Sweden

(In Norwegian)

CO_2 values distributed for Sweden:

Fordeling av målingene

101-200 ppm	0%	1
201-300 ppm	0%	1
301-400 ppm	5%	12
401-500 ppm	3%	7
501-600 ppm	22%	51
601-700 ppm	6%	15
701-800 ppm	19%	44
801-900 ppm	6%	14
901-1000 ppm	21%	50
1001-1100 ppm	1%	3
1101-1200 ppm	5%	12
1301-1400 ppm	3%	7
1401-1500 ppm	0%	1
1501-1600 ppm	2%	5
1701-1800 ppm	0%	1
1801-1900 ppm	0%	1
1901-2000 ppm	2%	5
2101-2200 ppm	0%	1
2501-2600 ppm	0%	1
2701-2800 ppm	1%	2

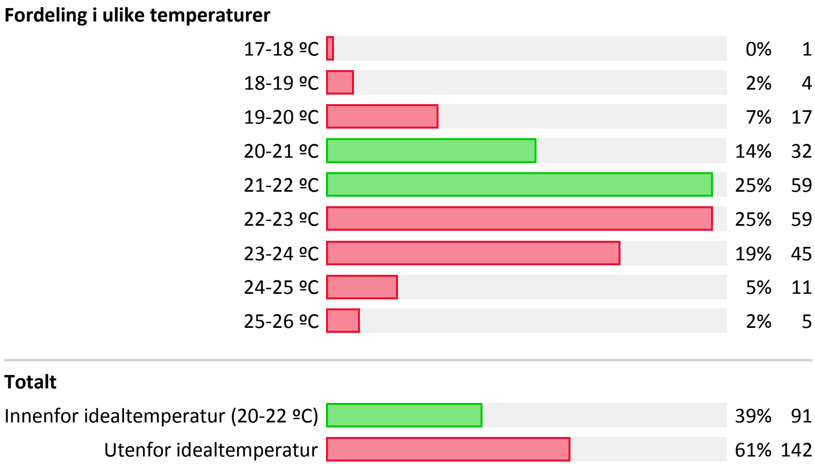
Totalt

Andel <=1000 ppm	83%	195
Andel >1000 ppm	17%	39

CO_2 results for Sweden divided by region:

Fylke	Skoler	Målinger	Rom	<1000 ppm	> 1000 ppm	Andel over/under 1000 pm
	1	1	1	100%	0%	
Hallands län	13	21	15	86%	14%	
Kalmar län	10	17	15	100%	0%	
Norrbottens län	12	20	19	90%	10%	
Stockholms län	4	15	13	93%	7%	
Södermanlands län	4	7	7	100%	0%	
Uppsala län	4	6	6	83%	17%	
Västerbottens län	4	7	6	100%	0%	
Västra Götalands län	70	126	116	78%	22%	
Örebro län	9	16	15	88%	13%	

Temperature results distributed for Sweden:



Appendix J

Continuous Monitoring Devices Recommended for Schools

GE

Sensing & Inspection Technologies

T8012 Telaire® CO² Switch

Wall-Mounted Switch for Ventilation Control

Features:

- Reliable (15 years of low-cost infrared sensor manufacturing)
- Intuitive Light display (VLI)
- 115/230 Vac power supply
- 230 V 8A rated output relay
- Pre-calibrated
- Maintenance free (calibration maintained with patented ABC Logic)
- User selectable output switch point
- RoHS and WEEE compliant

The Telaire® T8012 series CO_2 switch is a low-cost wall mounted sensing solution for ventilation control. The 8012 provides an intuitive VLI (Visual Level Indicator) display for CO_2 thresholds, to maintain air quality in enclosed spaces (i.e., school classrooms, offices, gymnasiums, theatres, etc. . .)

The simple LED array indicates increased CO_2 concentrations based on predetermined thresholds. The LED smoothly transitions between blue, green, yellow and red as the CO_2 concentration increases. Unlike scientific displays, training to understand PPM values is not prerequisite with this innovative product. Indication shows under ventilation (red) or over ventilation (blue), which translates to low air quality (red) or too much energy being used to heat or cool unnecessary outside air (blue). In a heating only application the blue should be ignored if windows are opened to provide cooling.

ABC Logic™ (Automatic Background Calibration)

The Telaire product line offers patented ABC Logic™ software for self-correction of drift to better than ±20 ppm per year. The system is virtually free of maintenance, and typically has a lifetime of more than 10 years.

Specifications

Sampling Method
Non-dispersive infrared (NDIR), gold plated optics, (with Telaire's patented ABC Logic self calibration algorithm). Diffusion sampling.

Measurement Range
600-2,000 ppm factory calibrated.

Temperature Dependence
0.2% FS per °C

Stability
<2% of FS over life of sensor (15 year typical)

Non Linearity
<1% of FS

Pressure Dependence
0.135 of reading per mm Hg

Calibration Interval
Not required

Response Time
<2 minutes for 90% step change typical

Signal Update
Every 4 seconds

Warm Up Time
- <2 minutes (operational)
- 10 minutes (maximum accuracy)

Operating Conditions
- 32°F to 122°F (0°C to 50°C)
- 0 to 95% RH, non condensing

Storage Conditions
-40°F to 158°F (-40°C to 70°C)

Output
SPDT Switch 230 V 8A resistive

Display Colored LEDs
- <600 Single Blue
- <800 Double Blue
- <1000 Green
- <1500 Yellow
- <2000 Single Red
- >2000 Double Red

Connections
Screw terminals for 18 to 28 AWG.
1. Line Input
2. Neutral Output
3. Output Switch Common
4. Output Switch High Value (ON)
5. Output Switch Low Value (OFF)

Output Switch Levels
User selectable at 1000 ppm (default) or 1500 ppm with hysterisis of 300ppm

Auto-On-Off Manual Switch
Auto - Relay operated by CO_2, LEDs indicate CO_2 concentration

On - Relay is in the powered "on" state, all LEDs lit continuously

Off -Relay is in the powered "off" state, all LEDs are off

Anti-recycle Time
Minimum ON or OFF period: 10 minutes (in Auto)

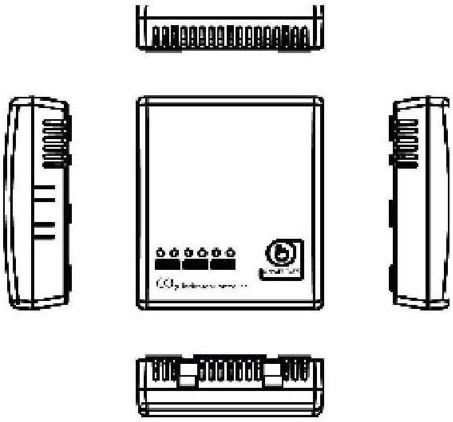
Power Supply Requirements
85 VAC to 265 VAC

Power Consumption
<1.5 W average

Dimensions
100 mm x 80 mm x 28 mm (h x w x d)

Agency/Certifications
FCC Part 15 Class B, CE, ROHS, WEEE

Warranty Term
18 months



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920-459-2

Appendix K

Mold Remediation Checklist

CHECKLIST FOR MOLD REMEDIATION

Investigate and evaluate moisture and mold problems

☐Assess size of moldy area (square feet)

☐Consider the possibility of hidden mold

☐Clean up small mold problems and fix moisture problems before they become large problems

☐Select remediation manager for medium or large size mold problem

☐Investigate areas associated with occupant complaints

☐Identify source(s) or cause of water or moisture problem(s)

☐Note type of water-damaged materials (wallboard, carpet, etc.)

☐Check inside air ducts and air handling unit

☐Throughout process, consult qualified professional if necessary or desired

Communicate with building occupants at all stages of process, as appropriate

☐Designate contact person for questions and comments about medium or large scale remediation as needed

Plan remediation

☐Adapt or modify remediation guidelines to fit your situation; use professional judgment

☐Plan to dry wet, non-moldy materials within 48 hours to prevent mold growth (see Table 1 and text)

☐Select cleanup methods for moldy items (see Table 2 and text)

☐Select Personal Protection Equipment – protect remediators (see Table 2 and text)

☐Select containment equipment – protect building occupants (see Table 2 and text)

☐Select remediation personnel who have the experience and training needed to implement the remediation plan and use Personal Protection Equipment and containment as appropriate

Remediate moisture and mold problems

☐Fix moisture problem, implement repair plan and/or maintenance plan

☐Dry wet, non-moldy materials within 48 hours to prevent mold growth

☐Clean and dry moldy materials (see Table 2 and text)

☐Discard moldy porous items that can't be cleaned (see Table 2 and text)

Source: (US-EPA, 2001).

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		CONTRACT REF. Emmy Gram Lauvanger	

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0131 Oslo

ABSTRACT
Student research campaigns (forskningskampanjer) have been an annual event in connection to Science Days (Forskningsdagene) since 2003 in Norway. The campaigns invite students from all over the country to participate in a common scientific research event, always connected to a special environmentally related theme – for example Air Quality in the Classroom (2003), Pollution along Roads (2004), Bacteria in Drinking Water (2005), and The Rain Check (2006). This year's campaign repeated the 2003 Indoor Air Quality campaign, while in addition including schools in Denmark and Sweden as well.

The campaign included the hands-on activity of collecting CO_2 and mold data from the students classrooms. This data was then assembled on the campaign website at miljolare.no. The results from the Norwegian campaign show that Norwegian classrooms show improved indictors in comparison to the 2003 CO_2 results, and that overall the mold results are not too alarming. Norwegian classrooms show much better indicators than their Danish counterparts when analysing the CO2 and mold results. Norwegian classrooms most likely show improved conditions due to advanced ventilation systems and ventilation routines, where improving ventilation is the single best method to improving the indoor air quality.

NORWEGIAN TITLE
Inneklima i Norske klasserom: Elevbasert forskningskampanje som del av Forskningsdagene 2009

KEYWORDS		
CO2	Mold	Indoor Air Quality Schools

ABSTRACT (in Norwegian)

* Classification		
	A	*Unclassified (can be ordered from NILU)*
	B	*Restricted distribution*
	C	*Classified (not to be distributed)*

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NILU Norsk institutt for luftforskning
Norwegian Institute for Air Research