Relation between ventilation and the learning skills of pupils in classrooms.

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SUMMARY

Goal of the study was to investigate the relation between the level of ventilation and the performance of school children in classrooms
In one school in two classrooms the same ventilation system was installed. The two classrooms were located at the same façade. The system had a possibility of supplying full outside air to the classroom or the position with full recirculation of air. The temperature in the classroom was kept as constant as possible.
The performance of two groups in the age of about 12 years was studied.
The pupils had to carry out four different tests:
• comparing symbols
• the position of the legs of the clock
• spelling language
• calculation
The weeks before the real test the pupils already had carried out the same type of test to overcome the effect of adaptation to these type of tests.
The average CO_2 concentration at the beginning of the tests was approximately:
• conditioned classroom 738 ppm
• unconditioned classroom 1267 ppm
The average CO_2 concentration at the end of the tests was approximately:
• conditioned classroom 747 ppm
• unconditioned classroom 1870 ppm
The results of the tests are roughly that no significant effect was found for the more visual related tests such as comparing symbols and the legs of the clock. For the more cognitive tasks such as spelling and calculation significant effects were found. The improvement in relative score for the tests made under CO_2 controlled conditions was in the order of about 15%.

1. INTRODUCTION

The indoor environment in classrooms is often not very good. The ventilation is in most cases insufficient. This leads to high pollutant loads in classrooms. Every person who have visited classrooms in schools have the experience that if you enter a classroom it does not smell fresh. There is a saying that in classrooms you may lean against the air. Measurements carried out in classrooms by many different investigators show that at the end of a few lessons the CO_2 concentrations in schools frequently go beyond 3000 ppm. On itself CO_2 is not a relevant pollutant for the indoor air, because it is an inert gas. CO_2 however is often used as a marker for so called bio-effluents. These are secretion products produced from for instance respiration (breathing) and evaporation (sweating) of persons.
The negative relation between a stuffy atmosphere in classrooms and learning skills and attention deficit is regularly mentioned in publications and lectures. Just a few relevant papers can confirm this hypothesis. The main aim of this study was to investigate the relation between the level of ventilation and the performance of school children in classrooms.

2 DESIGN OF THE EXPERIMENT

2.1 General

In a school in two adjacent classrooms the same ventilation system was installed. The two classrooms were located at the same façade. The system had a possibility of supplying full outside air to the classroom or the position with full recirculation of air. The temperature in the classroom was kept as constant as possible..
The performance of two groups, each about 25 pupils in the age of about 12 years, was studied.
The pupils had to carry out four different tests:
• comparing symbols
• the position of the legs of the clock
• spelling language
• calculation

Table 1 Design of the experiment

Group	**CO_2 controlled ventilation**	**No purpose provided ventilation**
8A	Day 1	Day 2
8B	Day 2	Day 1

The idea was to carry out the four tests at the beginning of the morning or afternoon lessons and repeat the same type of tests at the and of the morning or afternoon lessons. Each test series of four tests should not take more time than about 30 minutes.

2.2 Pilot study

A pilot study was carried out before the final and real test series. The reason for the pilot study was to check whether or not the types of tests ware usable and not too much time consuming. The pilot study was carried out in two other schools than where the final tests took place. From the results of the pilot study we determined a real learning effect by repeating these types of tests. Therefore during the final real test series the weeks before the real test took place, pupils already had to carry out the same type of tests to overcome the learning effect of adaptation to these types of tests.

3. TYPE OF TESTS

3.1 General

The tests were set up after consulting some specialists from universities and other TNO institutes.
The four different tests consist of:

- comparing symbols
- the position of the legs of the clock
- spelling language
- calculation

The first two tests were more visual oriented, while the last two tests more cognitive skills require.
Examples of the different tests will be given in the next paragraphs.

3.2 Comparing symbols

In the test with comparing symbols pupils had to check whether or not two of the same symbols occurred in one line of 7 symbols. The test consists of 45 lines with randomly produced symbols. The pupils got about 5 minutes to carry out the test.

Example:
Instruction
Observe the symbols on **one line.**. Deteremine The essence is to determine **the same symbols in one line**.

Ξ	≅	⊆	∫	⊆	⊗	⊇	ja ●	nee 0

In this line the same symbol occur twice.. Your answer is yes (ja in Dutch).'

∀	Ψ	⊄	⊃	∫	⇓	⊂	ja 0	nee ●

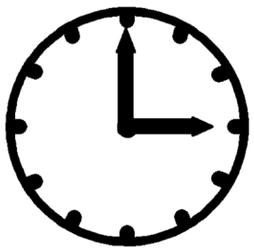
In this line the same symbol does't occur . Your answer is no (nee in Dutch).'

3.3 The position of the legs of a clock

For this test the pupils got 3 minutes. In these three minutes they had to draw six times the legs of the clock. in the clock face.

Example:

Three o' clock



De large leg is pointing to 12 while the small leg is pointing to three. This example is easy, but for instance forty minutes past seven is less easy.

3.4 Spelling language

The test with spelling consists of 8 lines with each about 8 words. There were on average about two spelling errors in each line. There were lines with 0 to maximum 5 spelling errors.
The pupils were asked to give the number of wrong spelled words
The example given here is from the original report and so in Dutch.
Example:
Het is hier op school erg luek sind juf Maartje op school is gekome.

0	1	2	3	4	5 or more errors
			X		

Het is hier op school erg l***eu***k sind***s*** juf Maartje op school is gekome***n***
There are three wrong spelled words in this sentence.
Translation to English:
It is here on school very pleasant since teacher Marian has started.
Examples of errors in English
It is here on school very plaesant sinse teacher Marian has startet.
So also in this sentence in English there are three wrong spelled words.

3.5 Calculation

The letters **a** to **g** were given a numerical value, a = 1 and g =7. Pupils got 8 sums within about 8 minutes in which they should add or subtract. The answer was always a name of a child, such as **ada** or **eef**.. It was allowed to use paper and pencil.
Example:
a =1 b=2 c=3 d=4 e=5 f=6 g=7
Adding:
ad = 14
ab = 12
---- +
The right answer is = 26
The calculation test was the most difficult cognitive task