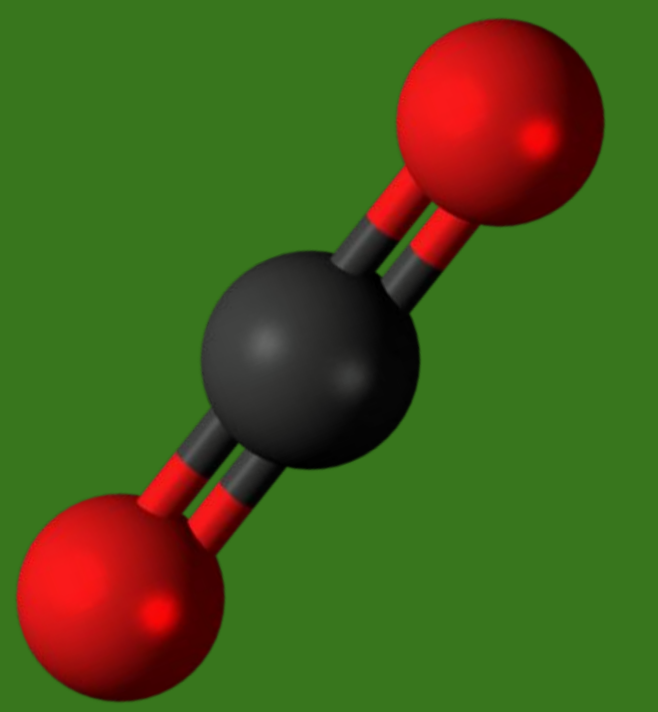


# Classroom CO<sub>2</sub> levels and their Effect on Student Cognitive Performance



## Statistical Analysis-

### Part A: Monitoring of rooms:

We found that out of all classrooms we tested, an astonishing 60% of classrooms exceeded 2000 ppm CO<sub>2</sub> with vents and windows closed. The recommended limit is 1200 ppm. Whilst not in breach of any health guidelines this is definitely an unhealthy environment for teachers and students to spend the majority of their days.

### Part B: Teacher Survey:

From our teacher survey we found that only 3.7% of teachers thought their students were most alert in the afternoon, 10.7% of teachers found themselves most alert at this time also, correlating with our findings from our classroom tests with CO<sub>2</sub> levels increasing over the duration of the day.

Only 37% of teachers knew that vents were installed in classrooms with only 32% actually using them meaning that 88% of teachers do NOT use vents provided.

### Part C: Effect of the use of vents on CO<sub>2</sub> levels:

With vents open, a maximum CO<sub>2</sub> reading of 2389 ppm in the single ventilated room and 1839 ppm in the cross ventilated room was obtained. This shows that vents alone are NOT capable of reaching the recommended target of 1200 ppm CO<sub>2</sub> in fully occupied rooms, without opening windows, which is not practical in winter.

We found that vents open can reduce CO<sub>2</sub> levels by up to 39% compared to when they are closed. However, we found that in some cases having blinds closed over the vents rendered them useless.

From our temperature sensors we found that there was no significant difference in temperature levels between blinds open and blinds closed.

### Part D: Testing Cognitive Performance:

For the cognitive ability test we found that group 1 improved by 11%, group 2 improved by 8% and group 3 improved by 7% in a low CO<sub>2</sub> environment.

For the memory test, we found that group 1 improved by 30%, group 2 improved by 20% and group 3 improved by 18% in a low CO<sub>2</sub> environment. From these results it is evident that high CO<sub>2</sub> had a negative impact on both cognitive ability and memory. However, its effect on memory is much more significant than its effect on cognitive ability. This is a worrying result for us the students, as so much of what we are examined on is memory dependant and exams are taken in very high occupancy exam halls.

## Summary-

The objective of our project was to determine what the CO<sub>2</sub> levels within the classrooms are and to use these values as a surrogate for determining if the rooms are adequately ventilated. We also wished to find out if these CO<sub>2</sub> levels are affecting student's cognitive and memory abilities. Our school, despite being a new build (2014), does not have a mechanical ventilation system, instead, it has vents on the windows which have levers to manually open or close them. We wished to uncover if the current ventilation system within the building is providing adequate ventilation to the classrooms and if they were being used correctly. Our school is occupied by 1200 students and 90 employees, these figures towering over other schools around the country. To maintain a healthy environment our school must also be able provide adequate ventilation whilst achieving maximum energy efficiency over the winter months. Our background research informed us that some schools which did not contain a mechanical ventilation system had levels of CO<sub>2</sub> reaching up to 7000 ppm. Other research outlined the ill effects of CO<sub>2</sub> concentrations between 2000-5000 ppm as "Headaches, sleepiness and stagnant, stale, stuffy air.

Poor concentration, loss of attention, increased heart rate and slight nausea may also be present". We could not find any studies conducted in Irish schools and were eager to contribute some research in this area.



## Results-

CO2 Vent Test, Ventilated one side only (LGF-01)

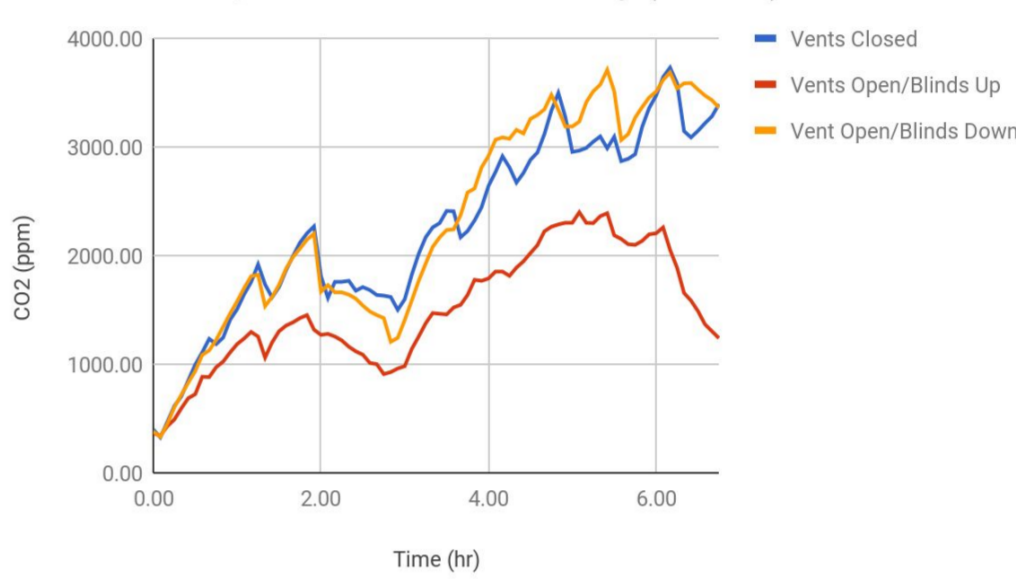


Fig 5

LGF01 Temperature level with vents opened and vents closed

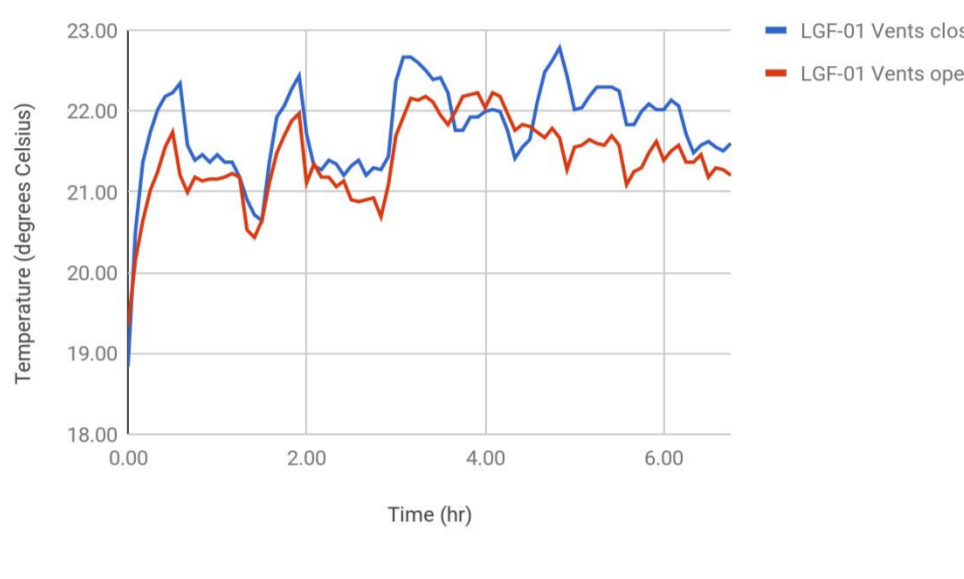


Fig.6

Group 1-CAT Test

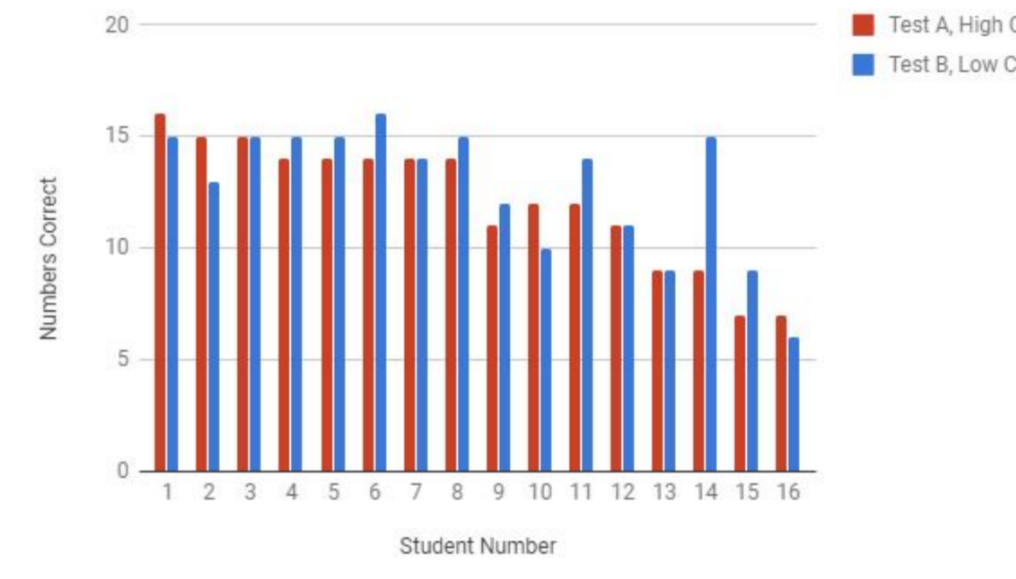


Fig.7

Group 1-Memory Test

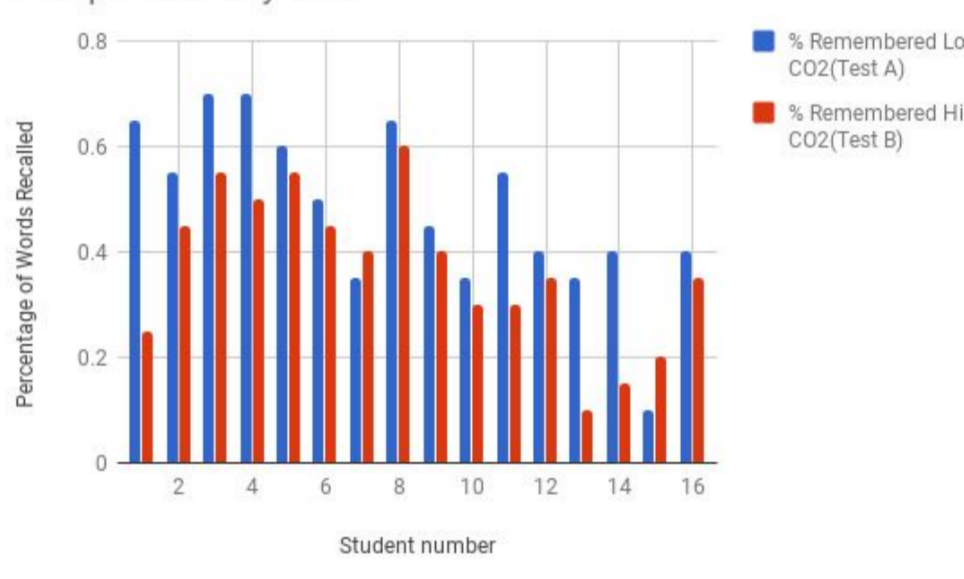


Fig.8

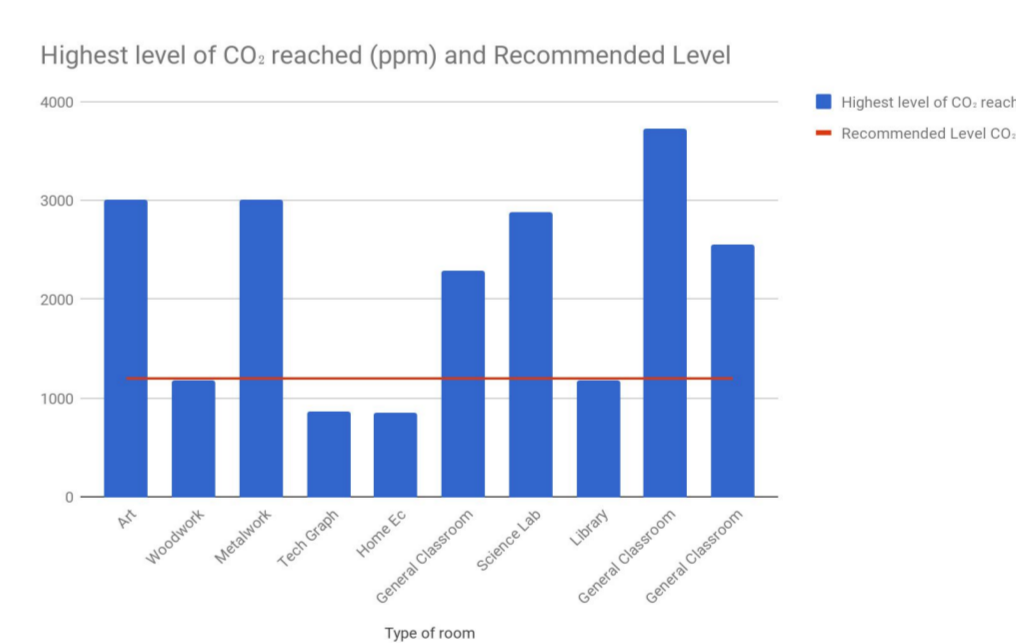


Fig.9

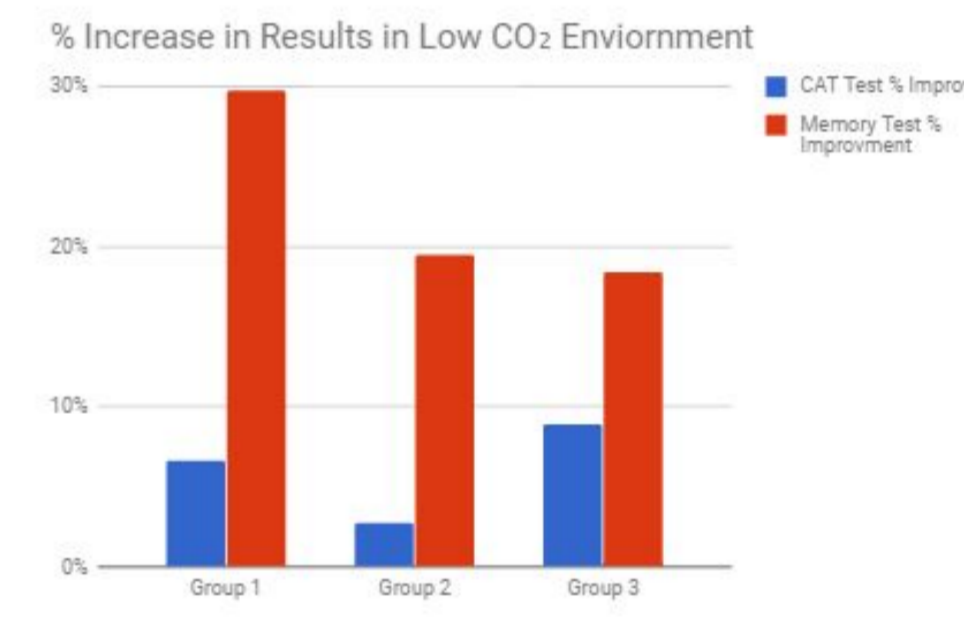


Fig.10

## Teacher Survey-

Are you aware that there are vents on the windows in your classroom?

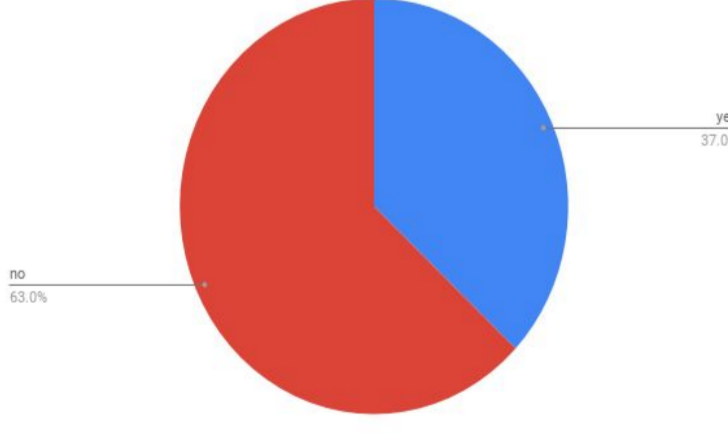


Fig.1

If yes, do you use the vents to ventilate your classroom?

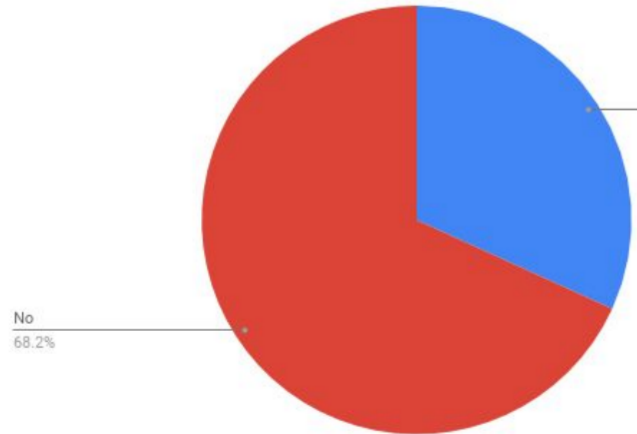


Fig.2

When do you feel your students are most alert?

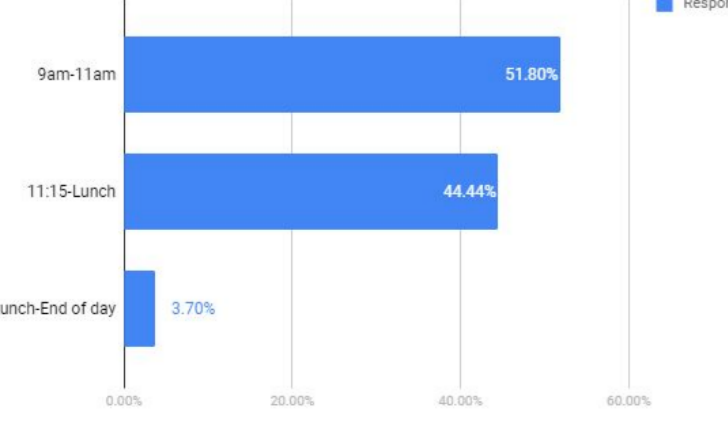


Fig.3

When do you feel that you are most alert?

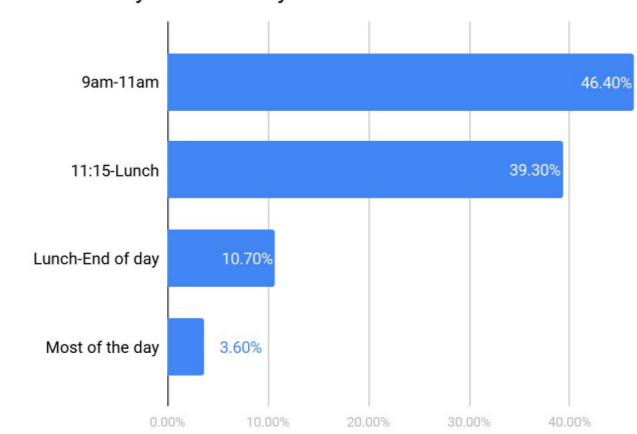


Fig.4

## Experimental Methods-

### A) Monitoring of rooms:

Using Vernier CO<sub>2</sub> and temp. sensors and data loggers we determined the levels of CO<sub>2</sub> reached in a typical school day in various classroom types, under normal occupancy, leaving windows and vents closed.

### C) Vents Tests:

We measured CO<sub>2</sub> concentrations to determine the effects of leaving vents open in rooms that were cross ventilated versus rooms with ventilation on one side only. It also determined if having blinds closed over vents had any effect on ventilation within the room.

### B) Teacher Survey:

Using Google Forms we developed a survey to determine how teachers ventilate their classrooms. We also wished to uncover if there were particular times of the day that students and teachers were most alert.

### D) Effects of CO<sub>2</sub> on cognitive performance and memory:

The aim of this section was to determine using CAT 4 test questions and a memory test, the effect of CO<sub>2</sub> on cognitive performance and memory, for three different TY classes.

## Recommendations-

1. We would like to encourage the Irish Government to view our project and from here to form acceptable guidelines for the adequate ventilation of schools. We believe that while DoES guidelines exist in relation to ventilation, their primary objective is to control heat during the summer months. Whilst the figure of 8/l/s/person is outlined in technical guidance documents, this corresponds to a CO<sub>2</sub> level of 1200 ppm, we have shown that this figure cannot be obtained in many cases by fixed wall vents alone, under full occupancy and requires ventilation from the windows, which is not practical in the winter months.
2. It is not economically viable to retrofit a mechanical ventilation system to existing school buildings. We do however recommend installing a Heat Recovery Ventilation System (HRV) to new school buildings. This would preheat the fresh air supply and is likely to be the most energy efficient solution for schools in particular during the winter months.
3. Teachers should be informed about the levels of CO<sub>2</sub> in their classrooms and the negative effects these levels of CO<sub>2</sub> can have on students and teachers alike. Teachers should be made aware of the vents in their classrooms and should be informed on how they are correctly used to give maximum ventilation.
4. A possible economically viable retrofit for existing buildings, would be to link the wall vents to a CO<sub>2</sub> sensor which would mechanically open or close the vents based on the CO<sub>2</sub> reading.
5. Ventilation should be made a priority in schools, after all a school is made for teachers to teach and for students to learn, so if something is giving them a lesser chance of them achieving 100% in class, then it is a major problem and needs to be reviewed in schools across the country.