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Effects of Classroom Environment on Learning

Andrew Blaker*

【Abstract】

This paper introduces research around carbon dioxide, temperature and their effects on student learning in the classroom. It is shown that carbon dioxide has a negative effect on students' cognitive performance, but that increasing the rate of ventilation ameliorates these effects. The negative effect on student motivation of high temperatures in the classroom is also introduced. The paper concludes that an investigation into student learning environments of each campus should be undergone to establish the possible effects that these issues may be having on students.

【Key Words】

CO2, carbon dioxide, ventilation, classroom, temperature, performance

1. Introduction

As teachers, we must consider the effects of the physical environment on our students. In summer Japanese students complain it is too hot, and in winter they complain it is too cold. It is often joked about that there is about one week in the spring and one week in the autumn when students are comfortable. There is an increasing awareness of the effect of the classroom environment on student concentration and learning. Carbon dioxide (CO2) levels and room temperature are important elements of creating an environment that is conducive to learning (Haverinen-Shaughnessy & Shaughnessy, 2015; Satish et al, 2011; Kameda et al., 2007; Ito et al., 2006; Wargocki et al., 2005). Even when not in the classroom, students in Japan spend a lot of time in climate-controlled environments, so the effects on the students of these environments should be understood. Universities should strive to create a physical environment that is conducive to effective learning, and

* Hirao School of Management, Konan University

to that end this paper reviews research on the effects of CO2 in the classroom, the use of ventilation in managing CO2 levels and how they affect learning in the classroom.

2. Carbon dioxide levels

CO2 is present in the outside air at a level of around 400 parts per million (ppm) (Satish et al, 2011). It is also a byproduct of respiration, and without ventilation can increase in concentration in enclosed spaces such as a classroom. The Japanese Ministry of Health, Labor, and Welfare (MHLW, 2020) states that air conditioning and ventilation systems should work to ensure indoor concentrations of CO2 be below 1,000ppm. A study of classrooms in the UK showed that once occupied, classrooms can quickly exceed the recommended level, with levels of 3,000ppm not uncommon, and in some cases can exceed 5,000ppm (Bakó-Biró et al, 2012). Levels of CO2 are correlated with students' work performance, measured by short-term computer-based testing (Daisey et al, 2003; Myhrvold & Olsen, 1997). Levels over 2,500ppm affect decision making skills, and can even make people dysfunctional (Satish et al, 2011).

3. Ventilation

Each of these studies states that the solution to reducing CO2 levels is to increase the level of ventilation. Ventilation usually refers to the process of forcing filtered outdoor air into the room. This is done for the purposes of removing water vapor caused by perspiration and respiration and also to reduce the buildup of contaminants such as unpleasant smells and of course CO2. It is measured in relation to the size of the space, or the number of people in the room, in which case it is measured in cubic meters of air per hour per person (m3/h/person) (Bakó-Biró et al, 2012). Increasing the ventilation rate in classrooms can improve student concentration and productivity (Myhrvold et al, 1997; Wargocki et al, 2006). Ito and Murakami (2010) quantified the level of academic improvement correlated with increased ventilation: When ventilation rates were increased from 10 to 30 m3/h/person, academic performance was assessed as improving by 4%. In the case where ventilation was increased from 10 to 60 m3/h/person, academic performance was assessed as improving by 6.4%. Low ventilation rates are also associated with lowered attention span, affecting concentration of both students and teachers (Bakó-Biró et al, 2012). Finally, a negative physical environment can be indicated by increased student absenteeism. Low environmental quality such as increased CO2 levels due to low ventilation rates is correlated with increased student absences (Shendell et al, 2004). Increased CO2 levels have a measurable negative impact on students and learning. CO2 beyond recommended levels results in poor cognitive performance, low attention span, and even an increase in school absences. Increased

ventilation rates are a possible solution to these undesirable outcomes.

4. Temperature

The temperature of a classroom is another important factor in student learning environments (Haverinen-Shaughnessy & Shaughnessy, 2015; Wargocki & Wyon, 2006; Kameda et al, 2007). An investigation into accuracy of cognitive tasks such as mental arithmetic showed a negative result when room temperatures were raised from 20–22°C to 24–26°C (Toftum & Wyon, 2005). Another study quantified this negative effect as a 2% decrease in performance for each 1°C increase in temperature beyond 25°C (Smolander et al, 2003). While results may vary for students from different cultures and environments, a generalization may be made about Japanese students. Kameda et al (2007) found that a warm environment decreased motivation of Japanese university students for learning during lectures and drew a direct correlation between motivation during lectures and test scores. Most studies show a similar decrease in performance with temperature increase, but Lan et al (2011) suggests that it is not simply high temperatures, but thermal discomfort. If people are not within their zone of thermal comfort, they do not perform optimally. Even in the case of thermal discomfort, subjects' rate of work is lower at higher temperatures, indicating that lower temperatures are more desirable (ibid).

5. Conclusion

There are many aspects of students' learning experiences that are out of control of the educational institution, but maintaining adequate ventilation and air conditioning are simple to manage and can produce measurable and significant effects. Increasing cognitive performance and attention span, reducing student absences, and increasing student motivation are significant goals to achieve by meeting simple ventilation and temperature targets. Further investigation is required in each campus to ensure these targets are being met.

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