Research project: Creating healthier classrooms for NZ primary school students

SUMMARY SENTENCE

While children are often resilient, many New Zealand primary aged school children struggle through the winter months with respiratory and infectious illnesses, causing them to be absent more often from school, less able to concentrate on their studies and struggling to achieve – the future knock-on effects of which could extend into later life.

MAIN ARTICLE

During the cold season, people spend up to 90 per cent of their time inside. If the air quality is poor, it's known to cause or exacerbate seasonal illness, and asthma, which affects 25 per cent of New Zealand children.

Many New Zealand's classrooms are housed in older buildings, constructed with poor insulation, lacking adequate heating and ventilation. Classroom upgrades are prohibitively expensive, leaving some schools unable to provide healthy learning environments for children. Compounding the need for more efficient heating is the Ministry of Education's cap on energy spending fixed at 2010 levels. Typically, 30 per cent of energy consumed by schools is used outside of school hours, requiring changes to the way schools manage their resources to keep costs under control.

Of key concern is poor indoor air quality resulting from lack of ventilation. Most New Zealand schools depend on open windows for ventilation. However, during April to October, classroom windows and doors tend to stay shut, and some are permanently closed for security reasons. A 2015 study conducted by Massey University in 40 schools across Auckland found that only 40 per cent of teachers open windows. Without fresh air flow, children are exposed to avoidably high levels of respirable pathogens, pollutants, carbon dioxide and humidity.

The sustainable and healthy building expert team from Massey University, GNS Science, BRANZ, Mid Central DHB and University of Otago's Public Health Department, led by Dr Mikael Boulic, sought to find out whether improving the air quality in classrooms would have a positive impact on student health and absenteeism.

They conducted an interventional study in 12 low decile primary school classrooms in Palmerston North over two school terms for two winters in 2013-2014, to investigate the impacts of a low-cost solar-heated ventilation system on air quality and student health. This study was funded by a Health Research Council of NZ Emerging Researcher Grant and Lottery Health Research Grant

In the first monitoring period, six classrooms were ventilated and six were kept under normal conditions for the school (control classroom). A low-cost commercially available ventilation system provided fresh, clean air warmed by the sun in a roof-mounted air heater.

During winter, the average temperature of the air coming into the classroom was above 30 degrees Celcius for 80 per cent of the time and at times up to 55 degrees Celcius. This heated fresh air dispersed through the classroom to raise the background temperature by one or two degrees.

Environmental and health parameters were measured in the classrooms. Health measures included monthly throat swabs for streptococci (conducted and supported by Mid Central District Health Board), total airborne bacteria (analysis supported by NZ Genomics Ltd), room temperature, carbon dioxide, relative humidity and energy used for heating.

The results of the research are greatly anticipated as few studies have been conducted in New Zealand on air quality in schools. Data analysis from the study is expected to be completed by the end of 2016 (Yu Wang's PhD project). The researchers are hoping to see a correlation between increased ventilation, reduction in respiratory infections, fewer sick days and a lower level of chemical pollutants. Early anecdotal feedback from teachers was positive and significant energy savings were made as a result of the not needing to use heaters as much.

Whilst waiting for the results to come in, the researchers have embarked on a more extensive healthy air in schools project in Auckland and Wellington. Industry and government partners are on board and plans are underway to set up a research and demonstration lab in both cities in existing prefab classrooms.

In each city, one classroom (1970s era) will be the control classroom (standard design), and another will be the 'treatment classroom' where everything will be cost-effectively upgraded to try and get the environment (humidity, temperature and CO_2 levels) up to World Health Organisation standards.

The retrofit will include a special flooring that will make cleaning more efficient and reduce Particulate $Matter_{10}$ (PM) by a factor of 1.5. Preliminary results on particulate matter (PM) (monitoring and analysis funded by GNS Science) showed a high level of PM_{10} (up to 10 microns in diameter). The higher indoor PM concentrations were identified as soil that had been tracked into the classrooms by children's footwear and re-suspended into the air by the children's activities.

'Smart' windows developed in partnership with APL Ltd and a team of Massey University mechatronics students led by Dr Khalid Arif will also be installed and tested. A sensor measuring CO_2 levels, temperature and relative humidity will control the opening and closing of window vents via an 'actuator' (a type of motor) using a Bluetooth signal.

David Waters of APL Ltd says, "APL's approach to the design of windows and doors has largely centred around the structural and weather tightness performance with little thought given to indoor air quality and the important role that windows play in maintaining a healthy indoor environment. As building standards improve and its focus on airtightness increases, we can no longer rely on air leakage as a mechanism for ventilation within the building envelope. Operable windows can provide fresh air and natural ventilation, however studies have shown that they are rarely used to maximise natural ventilation, especially in the colder months.

“The research being carried out by Mikael and his colleagues at Massey University has had an enormous impact on APL’s approach to future window and door development, specifically around the area of passive ventilation,” he adds.

Upon completion of the upgrade, the classrooms will be monitored for a year, then in the second year, students will use the classrooms.

In September 2016, a workshop is planned with schools, industry and government partners to establish a task force and develop the research plan for healthier classrooms for New Zealand’s future.

The Research team is also developing a laboratory classroom on Massey’s Wellington campus, to demonstrate pre- and post-intervention health effects.

The learnings from the Palmerston North, Wellington and Auckland studies will be used to develop guidelines for the Ministry of Education and school designers.

QUOTATION
Indoor air pollution is among the top five environmental risks to public health. (United States Environmental Protection Agency)

FACT BOX
Dates: 2012-2015
Funders: Health Research Council of NZ
Funding programme:
Partner organisations: Ministry of Education, Building Research Association of New Zealand, APL Ltd, Housing Research Group, GNS Science, University of Otago

ACADEMIC PROFILES
Name: Mikael Boulic
Introductory sentence: Dr Mikael Boulic is a lecturer in the School of Engineering and Advanced Technology at Massey University.
Biography: Mikael started his research career in 2005 undertaking his PhD studies on the New Zealand Housing, Heating and Health Study/He Kainga Oranga. For his doctoral project, supported by a Building Research Association of New Zealand (BRANZ) PhD scholarship, Mikael investigated the relationship between domestic heaters and the indoor environment of families with a child with doctor-diagnosed asthma.

As a Research Officer at Massey University, from 2008 to 2011, Mikael was engaged in a project on environmental benefits from a positive pressure heat recovery ventilation system and he conducted part of the BRANZ funded study of new homes as part of the Weather-tightness, Air quality and Ventilation Engineering programme.
Areas of expertise: Indoor air quality

Name: Robyn Phipps
Introductory sentence: Robyn Phipps is Professor in Construction at the School of Engineering and Advanced Technology, the Academic Director of construction programmes, and leader of the Built Environment staff at Massey University.

Biography: Professor Phipps has expertise in the design and management of healthy buildings, including fungi and bacteria in buildings, indoor air quality, heating and ventilation.

Her research is focused on validating effective and practical means to improve indoor environments in homes, school and workplaces.

Robyn Phipps started her career in Architectural practice, where she completed a wide variety of residential, commercial and industrial projects. She moved to Massey University to fulfil a passion for research on healthy and sustainable buildings. She has been an active member of the Clean Air Society of Australia and New Zealand and been chair or deputy chair of the special interest group for Indoor Air Quality for many years. She is also a member of the International Society for Indoor Air Quality and Climate. She is a Co-Director of the Healthy Housing Research Group and Sustainable Cities Research consortium and member of NERI National Energy Research Institute.
Areas of expertise: Energy efficient, sustainable buildings

Name: Chris Cunningham
Introductory sentence: Chris Cunningham is Professor in the Research Centre for Maori Health and Development at Massey University.
Biography: Professor Cunningham, of Ngati Toa and Ngati Raukawa iwi (tribes) is a senior Māori health researcher. He currently Chairs on the Lottery Health Distribution Committee, The Hepatitis Foundation of NZ and the Quit Group Trust. He is co-director of He Kainga Oranga – Housing and Health Research Programme - which won the Prime Minister's Science Prize in 2014.
Areas of expertise: Maori health, public health

Name: Dr Khalid Arif
Introductory sentence: Dr Khalid Arif is a lecturer in mechatronics and robotics at Massey University's School of Engineering and Advanced Technology.
Biography:
Areas of expertise: Mechatronics, robotics

Name: Dr Patrick Biggs
Introductory sentence: Dr Patrick Biggs is a senior lecturer in computational biology in the Institute of Veterinary, Animal and Biomedical Sciences (IVABS) at Massey University, currently the national Bioinformatics Team Leader at New Zealand Genomics Ltd.
Biography: Dr Biggs has a PhD from the University of London, UK. Since arriving in New Zealand in 2007, he has been involved in many aspects of biological research involving so-called Next Generation Sequencing technologies. He has collaborated widely on a variety of projects, including many looking at metagenomics in various environments. Within IVABS he is the head of bioinformatics within the Molecular Epidemiology group, where his research focusses on metagenomics and the genomics of foodborne pathogens.
Areas of expertise: computational biology and bioinformatics, including metagenomic studies

Name: David Waters
Introductory sentence: David Waters heads up Market Sector Development at Architectural Profiles Ltd, New Zealand's largest window and door systems company.
Biography: After twenty years practical experience in the building industry, David joined Architectural Profiles in 1994 to forge relationships in various sectors – NZ Institute of Architects, Architectural Designers N Z, Master Builders and Certified Builders. He established a sales and marketing program for the APL Fabricators Brands – Vantage, First and Altherm Windows and Doors. David worked through the late 1990 and early 2000's helping to establish the Vantage Brand in Australia. David, through his company, Intext Architectural Systems, was involved in many high end, award winning projects. He re-joined APL in 2014 where he heads up their market sector development – looking specifically at developing products targeting the education, aged care and social housing markets.

Name: Bill Trompetter
Introductory sentence: Dr Bill Trompetter is a senior scientist as GNS Science.
Biography: Bill is a physicist with the Ion Beam Analysis Group at GNS Science, Lower Hutt. His involvement in air particulate matter research started with an ongoing United Nations Development Program using nuclear techniques to study air particulates. This capability is used to determine composition and contributions of the particulate matter to study source apportionment, transport, deposition, and is now being applied to indoor air quality through this collaborative group. Bill has recently taken on the leadership of the CASANZ indoor air quality special interest group to help develop this topic more widely.
Areas of expertise: Materials science, air quality