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WHITEPAPER

Healthy Heating in Schools

4 Trends to Watch

jaga CLIMATE DESIGNERS

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**How the right heating and cooling system can reduce costs,
improve academic outcomes and contribute to a healthy,
sustainable learning environment**

INTRODUCTION

As pioneers settled across North America in the late 19th and early 20th centuries, one-room school houses were common. Children of all ages would take their places on long benches according to grade-level facing toward a teacher who would provide their instruction. A wood-burning fireplace sat somewhere inside the room, belching out heat (and ash!) on cold winter days.

Until recently, you could see this design influence in most classrooms. Desks replaced benches, boiler rooms replaced fireplaces and single classrooms multiplied into many all housed within a new larger school building. Despite these enhancements, many issues remained—particularly with the schools heating systems.

In most schools, classrooms never seemed to be the right temperature. You may even remember hearing loud radiators clanking to life as class started each morning. Eventually, the room grew warm, and on a warm day, uncomfortably so. Inevitably, teachers would open a window to provide some relief—and to keep students from falling asleep.

Modern designs have fortunately shifted away from this traditional classroom layout. We have recognized that learning outcomes improve when there's more collaboration, freedom to move, and increased exposure to nature and the outdoors.

With these improvements, designers have opened up traditional classrooms to focus on larger spaces. These flexible spaces and “biophilic” elements have become commonplace in new school building designs.

Ultimately, there's a growing consensus that teaching and instruction is only part of the equation when it comes to student learning and performance. We have realized that how the building is constructed, and the materials used will also have a major impact on student health, and performance.

“...interior architecture and internal features of learning spaces can help students focus their attention on studying or prevent them from giving full attention to learning,”
(Yeung, Craven, & Kaur, 2014).

In this white paper, we will look at four new design trends creating healthy heating, and cooling systems in modern schools.

Using several examples, we'll show how several new school buildings and others retrofits reflect these new trends to create healthier, safer and higher-performing environments for teachers and students.

A young boy with blonde hair, wearing a grey t-shirt and black shorts, is balancing on a blue beam in a gymnasium. He has his arms outstretched and is looking to the left. In the background, two other children are watching: a girl in a white long-sleeved shirt and a boy in a red t-shirt and blue shorts. The gymnasium has large windows and wooden beams.

Trend #1 Reducing Energy Consumption

Reducing Energy Consumption

Recognizing the value that green buildings and construction techniques have on building occupants, school districts and municipalities are adopting more sustainable building requirements for new, and existing educational buildings.

For districts operating on shoestring budgets, sustainable initiatives can generate significant savings when it comes to energy conservation. Some estimates show that green schools can use up to 70 percent less energy than schools of a similar size. [↗](#)

Engineers are reducing energy consumption through the design of low-temperature heating and cooling loops. In these mechanical systems, energy generated through high-efficiency condensing boilers or renewable energy systems such as solar and geothermal heat have proven to substantially reduce consumption and costs.

Winston Churchill Public School (WCPS) is a single-story school building located in the heart of Kingston, Ontario. Built in the 1960s, it serves 268 students in kindergarten through eighth grade. Always ahead of the curve when it comes to sustainable systems, the school wanted to find a faster and more efficient way of heating this building.

In 2008, the school board approved a complete overhaul of the school's heating system with the focus of reducing energy consumption. David W. Downey Engineering, Ltd., was hired to design a new system that would not only provide a sustainable solution, but one that was also cost-effective, and safe for students.



To replace the original condensing boiler system, Downey installed five high-efficiency, natural gas-fired condensing boilers. Each unit serves as a fully modulating condensing boiler. Solar panels mounted on the roof provide an offloaded energy source from the new boiler plant.

To maximize the low temperatures and energy-efficiency of the condensing boilers, Downey replaced the finned-tube convectors located throughout the school with 107 low-temperature convectors from Jaga. Unlike the original units, the new convectors operate at lower water temperatures of 130 degrees Fahrenheit and 20°F dT. This resulted in a firing rate reduction of the boiler by 30 percent, ultimately reducing the total amount of energy required to heat the building.

“The new system substantially reduces the firing rates for each of the boilers,” said Downey. “In fact, it is not uncommon for all five boilers to be operating in condensing mode during peak times. During the spring or fall, only one or two boilers may be operating. This has resulted in substantially less natural gas consumption—as much as 25 to 30 percent over what was previously used.”

These energy savings have continued to drive the installation of more low-temperature heating systems in both new build, and retrofit applications. In many cases, they have been shown to provide an energy savings of up to 30 to 40 percent above ASHRAE 90.1 and an ROI of less than five years compared to traditional systems.



Lowtemperature convector

A photograph of three students in a laboratory or classroom setting. The student in the center is wearing a yellow sleeveless top and blue safety goggles, smiling. The student on the right is wearing a plaid shirt and is focused on a black and yellow robotic arm mounted on a table. The student on the left is partially visible, wearing a red long-sleeved shirt and safety goggles. The background shows a typical classroom or lab environment with tables, equipment, and fluorescent lighting.

Trend #2
Improving
Temperature
Controls

Improving Temperature Controls

While HVAC systems can contribute to greater energy savings, they can also have substantial impacts on student health, and performance. In the book, [Healthy Buildings: How Indoor Spaces Drive Performance and Productivity](#) ^[7], authors cite a Harvard study that looked at temperature fluctuations in student dormitories and their subsequent impact on students' performance on simple cognitive functions, finding that for every 2°F variation from the optimal temperature, there was a single percentage reduction in performance.

One study, completed at Lawrence Berkeley National Laboratory, “found a 10 percent relative reduction in performance when the temperature fell out of this narrow optimal range.”

In an office spaces, researchers note that a 2 percent throughput (resulting from a temperature beyond what's deemed “optimal”) can equate to a 9 percent decline in the bottom line of the business.

So what does this mean when developing indoor climate systems for schools?



New Westminister Secondary School (NWSS) Looks for Better Comfort

A central benefit to low-temperature convection units is a quick reaction time. In WCPS, rather than starting the heating system early in the morning before students arrive, teachers are able to turn on units as heat is needed just minutes before student's arrival. Similarly, when temperatures become too warm, convection units will stop radiating heat almost immediately when turned off.

This control was important in the design of the New Westminister Secondary School (NWSS) in southern British Columbia. The second largest secondary school in BC, NWSS is the new educational home for approximately 2,000 students in grades 9 through 12.

The mechanical system at NWSS uses three large 3.500 MBTU high-efficiency condensing boilers to heat the 16,390-square-metre school.

All classrooms have with low-temperature convectors mounted along the perimeter within an attractive casing. These perimeter units include covers so that there is not exposed piping, reducing exposure and matching the contemporary design elements.

In addition to reducing energy consumption, the units also react quickly to internal heat loads. So, when students arrive in the morning, the units can produce enough heat until the desired temperatures are reached.

Eunice Doroteo, senior engineer with Integral Vancouver, designed the mechanical system using a low-temperature heating water loop. This allowed them to achieve their energy efficiency goals with the ultimate goal of achieving LEED-Gold certification.

“ This job is very important to our team. The children and families of New Westminister have been waiting for it for a long time and we're excited to provide them with a building that serves the whole New Westminister community.”

Eunice Doroteo, senior engineer with Integral Vancouver

A young girl with dark hair in a ponytail, secured with a pink hair tie and a white bow, is seen from behind. She is wearing a white t-shirt and a tan backpack. The background is a blurred classroom with desks and windows. The text "Trend #3 Quieter Heating and Cooling" is overlaid on the left side of the image.

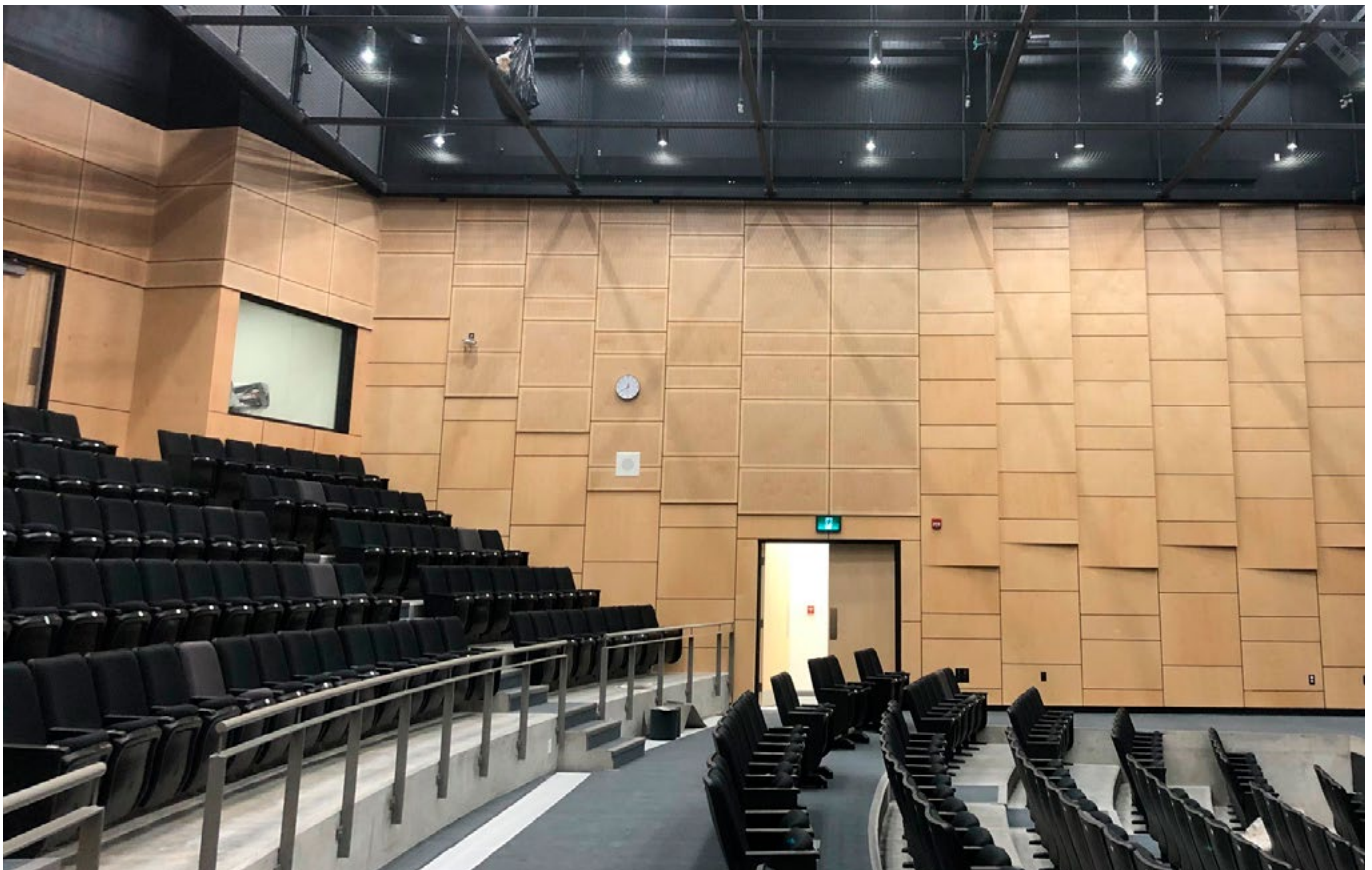
Trend #3
Quieter Heating
and Cooling

Quieter Heating and Cooling

When it comes to rooms with high ceilings such as shops and theaters, you should not have to sacrifice aesthetics for sustainability and sound. At NWSS, engineers specified unique ultra-quiet ECM unit heaters that can also operate on the existing low-temperature heating water loop.

“For shop and maintenance areas, we wanted a product that fits in a space with extremely high headroom. The challenge was finding a heater that had enough capacity to make sure that occupants at lower levels would be comfortable,” said Doroteo.

“ We also wanted something with a nice finish.”





Unit heater

Jaga's unit heater features technology that generates powerful airflow with even temperature distribution. By reducing the return temperature, the unit heaters are able to reduce stratification and the amount of cold air build-up at the ground level. This means shorter operational times and greater energy savings.

The use of EC motors in the unit heaters means there is very little fan noise along with 90 percent less electrical consumption compared to traditional AC motors.

Acoustics, and low sound level were important considerations, as louder HVAC systems can also have a substantial impact on student performance.

A study of 500 school children in France revealed that standardized test scores were 5.5 points lower for every 10 dB increase in noise over the average benchmark of 50dB¹.

This is largely due to the background noise that the teachers have to speak over. Students closer to the front of the classroom will have less trouble hearing than those in the back of the class.

"The unit heaters installed are the quietest I've ever seen in my career," said Doroteo.

“ Even though they are shops, they are still teaching spaces. That means when they're not doing any activity, the teacher is still providing instruction. Having a quiet mechanical system reduces the background noise to facilitate better learning.”

¹ S. Pujol et al., "Association between Ambient Noise Exposure and School Performance of Children Living in an Urban Area: A Cross-Sectional Population-Based Study," *Journal of Urban Health* 91, no. 2 (2013). [Read more](#)



Trend #4
Bringing
the Outside
in through
Daylighting and
Biophilic Design

Bringing the Outside in through Daylighting and Biophilic Design

The term “biophilia” describes the human tendency to interact or be closely associated with other forms of life in nature. It’s that gravitational pull we have to the outdoors.

In schools, biophilic design can take the form of increased glazing to bring in daylight, larger glass doors to connect to with outdoor green spaces.

With a building design that incorporates natural daylight through extensive glazing (and offering a gorgeous view of the nearby Wasatch Mountains), Shoreline Junior High in Layton, UT, needed a heating system that would quickly adjust to internal energy loads. On cloudy winter days, more heat might be needed compared to sunny weather.





To maintain optimal temperatures, engineers selected Jaga's Mini-Canal freestanding units in classrooms. In larger spaces designated as "learning suites," engineers integrated perimeter trench convection units built into the floor. By using trench units within the floor designers were able to eliminate any obstruction so both students and teachers can see through the full length of the glazing. Built-in units also allow for students and staff to easily move items around, including chairs, tables or other classroom furniture.

In areas where there's extensive glazing, trench heating systems also help prevent condensation and offset cold radiation from the glass. These units are powerful enough to be used as a stand-alone heating system or supplemental. This keeps students comfortable regardless of where they sit, maximizing the space for both collaboration, and learning.

The Future of Design in Academia

As researchers learn more about the impact of buildings on the health and wellness of building occupants, we'll continue to see this evolution in systems and strategies that allow people to perform at peak levels. Design with consideration to temperature control, acoustic and sustainability were once "nice to have," but are now becoming increasingly essential in new build and retrofit projects.

Nowhere are these design considerations more essential than within our schools. New technology is evident throughout classrooms, from the instructional tools used by teachers to the climate control systems resting behind the walls.

In addition to saving money, studies routinely identify the impact of green building on student health, performance and in some cases, behavior. [↗](#)

When designers can integrate better acoustics, thermal comfort, improved indoor air quality and a connection with the outside environment, everyone wins.

At Jaga, we are committed to building more comfortable indoor environments while limiting our impact on the natural environment. This focus is core to everything we imagine, design and build.

From sustainable heating, cooling and ventilation products, our solutions are designed to work with environmentally friendly technology such as heat pumps and solar energy. Operating on the lowest water temperatures, our award-winning radiators not only provide outstanding heating and cooling, they enhance the space with while maximizing comfort.

For more information on Jaga's climate designs for schools, please go to [jaga-canada.com](https://www.jaga-canada.com)