



White Paper:

IMPACT OF FLOORING SELECTION IN THE BUILT-ENVIRONMENT ON 21ST CENTURY LEARNING

How premium rubber flooring positively impacts student health, performance and success.

By Sandra Soraci, *EDAC, LEED AP, NCIDQ,*
Marketing Leader, Healthcare & Education Solutions, nora systems, Inc.

nora systems, Inc.
PR Contact: Tasha.hughes@nora.com
800-332-NORA
www.nora.com/us

nora[®]
by **Interface**[®]

Young, developing minds require an educational environment that is both safe and healthy. Unfortunately, many schools fall short of providing spaces that allow students to optimize their learning potential. A 2017 Infrastructure Report Card published by The American Society of Civil Engineers (ASCE) found that 24 percent of public schools were rated as being in fair or poor condition. In addition, 52 percent of public schools needed to make repairs and/or renovations to be considered in “good” condition.¹

In 2015, a new education law titled the “Every Student Succeeds Act” was established to ensure investments were made in low-performing schools to reduce chronic absenteeism and ensure equal opportunity for success in all pre-K through 12 schools. These performance drivers included the condition of aging schools and its impact on a child’s ability to learn and thrive.²

Often referred to as the “third teacher,”³ the environment in which students learn can have a positive or negative effect on performance and outcomes. For this reason, capital investments must take into account the impact on the built-environment, which can influence student health, wellness and - ultimately - academic performance. Flooring can have a significant impact on student success. More than a design driver, flooring specification is a decision that affects both health and wellness.

The condition of our nation’s schools

Roughly a quarter of the nation’s population spends the majority of their day in a school or educational facility. Upon graduating,



high school students will have spent up to 15,000-plus hours in school. Regrettably, many aging schools are in dire need of repairs or replacements.⁴ With many states reducing public school funding, steps must be taken to ensure allocated dollars are put towards fostering a healthier educational environment since young adults are more susceptible to environmental exposures.⁵

Studies have shown the quality of a school building can have an impact on student health and learning, and older buildings may contain inferior, interior finish materials known to cause health implications.⁶ The physical learning environment can affect many areas of student success, including speech intelligibility, lung health (from poor indoor air quality) and vision (from increased glare and reflectance). Combined, these factors can diminish a student’s ability to learn and can contribute to chronic absenteeism.

Legislators are beginning to recognize the need to improve school facilities with healthy, green design. According to McGraw Hill Construction’s Green Outlook Report (2011),⁷ green schools accounted for over a third of new education construction in 2010. However, more investments are needed to ensure all schools provide a safe and healthy place for children to learn and thrive.

Education in a safe and healthy environment

Though often an overlooked performance characteristic, flooring plays a key role in the health and well-being of students, teachers and administrators. Observational studies have demonstrated the link between the condition of school facilities and student outcomes. One study looked at a school district in Connecticut and found that after school renovations were completed, student test scores across all schools went up considerably (Neilson and Zimmerman 2011).⁸

One way to achieve these goals can be accomplished using Evidence-based Design (EBD), which is “the process of basing decisions about the built-environment on credible research to achieve the best possible outcomes.”⁹ EBD drivers contribute to the health, safety and wellness of students by enhancing Indoor Air Quality (IAQ), improving speech intelligibility, fostering safety and helping to reduce absenteeism.

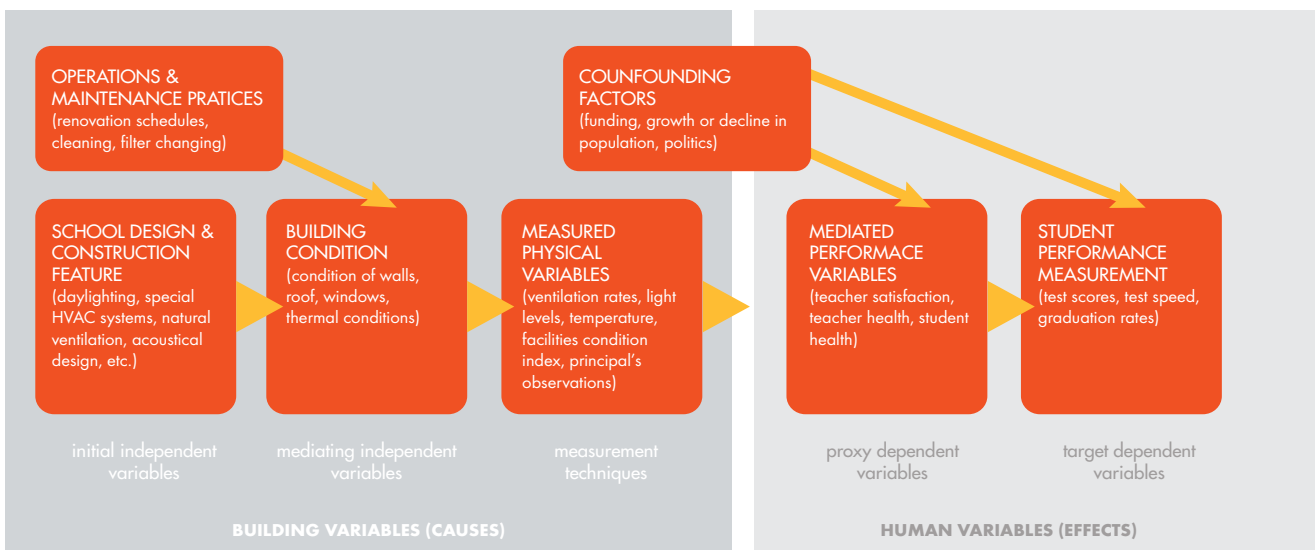
According to the Healthy Buildings Teams at Harvard, there are fundamental building factors that influence health and performance in schools. The nine foundations of a healthy building include: ventilation, air quality, thermal health, moisture, dust and pests, safety and security, water quality, noise, lighting and views and ventilation. Those specific to resilient flooring include indoor air quality, moisture in the floor, safety issues and noise mitigation.¹⁰



With many K-12 schools constructed more than 50 years ago, administrators must adopt a more proactive approach to new construction and renovation with the proper use of interior finish materials that foster student achievement, faculty retention and improved district rankings.

Facility impact on health and wellness

According to the Center for Green Schools, the cause and effect issue is one of the largest challenges faced when attempting to define the influence of building design decisions on health.



When we look at Building Variables, we know that ease of renovation and ability to clean affect operations and maintenance. That design features are about health and wellness, in addition to aesthetics and life-cycle cost. It is the condition of a building that affects physical variables of: absenteeism, asthma and allergy and return on investment. This is how “Human Variables” are affected in faculty retention, student test scores, health and wellness. Flooring is often overlooked for the performance characteristics it brings to the learning environment. It supports learning, health and comfort from the littlest learners in daycare and pre-K spaces, to higher-education facilities and technical and career spaces for lifetime learning.

Virtually every aspect of the built-environment can impact health, including:

- Construction features such as daylighting, natural ventilation and acoustics.
- The building conditions of walls, roofs, flooring and windows.
- Physical conditions such as ventilation rates, temperature and lighting.

Premium rubber flooring can have a positive influence on many areas of a student’s ability to learn and give teachers the comfort they need to effectively manage their classrooms.

The importance of IAQ

Studies have found correlation between building conditions and student achievement. Schools built before the 1980s may contain hazardous building materials within the interior finishes that can negate basic health and safety needs in developing young adults.

According to Dr. Greg Norris, Harvard School for Public Health, the volatile organic compounds (VOCs) released from a single waxing of a floor is comparable to the number of VOCs emitted from the flooring over its lifespan.¹¹ Many resilient floors require frequent stripping and recoating, and this maintenance protocol can be detrimental to human health and IAQ.

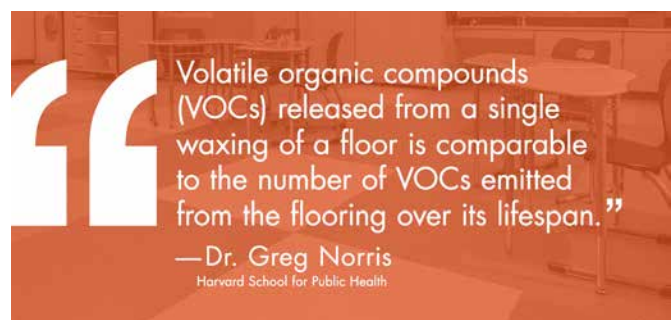
Knowledge expands daily about the potential hazards of unknown chemical.¹² VOCs are emitted by a wide array of products numbering in the thousands and indoor concentrations can be ten times higher than outdoors. Considering 1:13 children and 1:12 adults have asthma (a lung disease), VOCs and poor IAQ are a leading cause of absenteeism in schools. Additionally, mold in a classroom can contribute to asthma and allergies, making it crucial to source products that prohibit growth of bacteria and fungi. Be mindful that you do not want a resilient flooring product that contains antimicrobials, which means the product contains chemicals and pesticides.

The use of low VOC certified flooring is critical to maintaining healthy IAQ in schools. When it comes to flooring, GREENGUARD® Gold Certification is one of the most stringent and rigorous IAQ certification programs available. Specification of a resilient floor with this certification will best support human health and wellness.

Hygiene

What defines a hygienic floor? The floor has to be dimensionally stable – something a floor containing PVC struggles to achieve – and nonporous with a surface that’s easy to clean. Plasticizers in PVC floors can migrate and cause the floor to shrink, allowing for cracks and crevices that can harbor dirt and bacteria. Some PVC-based resilient floors – in particular low-cost options like VCT – will require a maintenance protocol of coating, stripping and refinishing, which is a detriment to IAQ, operational costs and total cost of ownership (TCO).

Premium rubber floorings have extremely dense, closed surfaces that are inherently dirt-repellent due to a special production process that ensures optimum material cross-linking.



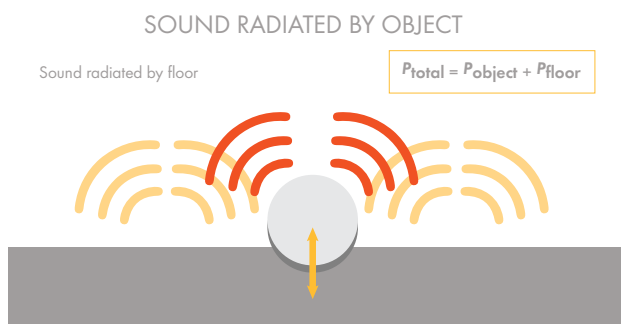
Advantages of greater surface density include:

- Reduced susceptibility to soiling
- Improved hygiene properties
- Lower outlay for maintenance
- Improved IAQ for students, teachers and staff
- No exposure to cleaning chemicals

Acoustics and learning

The ability to hear and be heard clearly is an integral part of the learning process. The Acoustical Society of America recommends background noise exposure levels of 35dB for unoccupied core-learning spaces. Up to 60 percent of classroom activities involve speech. A growing body of research links acoustics to student learning and achievement.

There is an industry misconception that carpet is the only solution to noise when it comes to floorcovering. Premium rubber flooring can reduce the amount of sound being generated - helping to control unwanted ambient noise. A third-party acoustics study conducted by the University of Salford, Manchester, UK, is pending publication in the Journal of Applied Acoustics on "In-Room Impact Noise Reduction" shows a significant degree of acoustical separation between ten different floor coverings.¹³



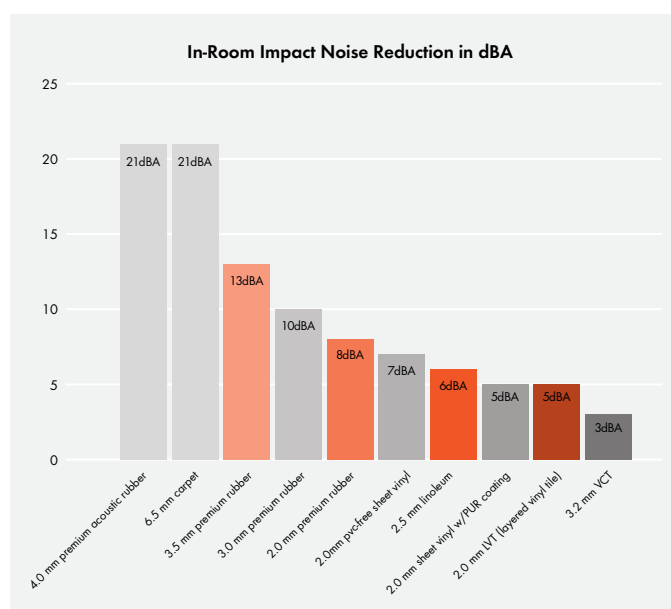
The research evidenced that premium rubber floorcovering reduces the amount of sound being generated, helping to control unwanted ambient noise. Testing showed that the 4mm acoustic rubber floor provides 21dBA "in-room" impact noise reduction,

the same as the 6.5mm carpet and 4x quieter than VCT. In most cases, the 4mm rubber flooring provides at least twice as much impact noise reduction than the other resilient types tested.

Table 1: Subjective Effects of Changes in Sound Levels

(Reynolds, 1981) (Long, 2006)

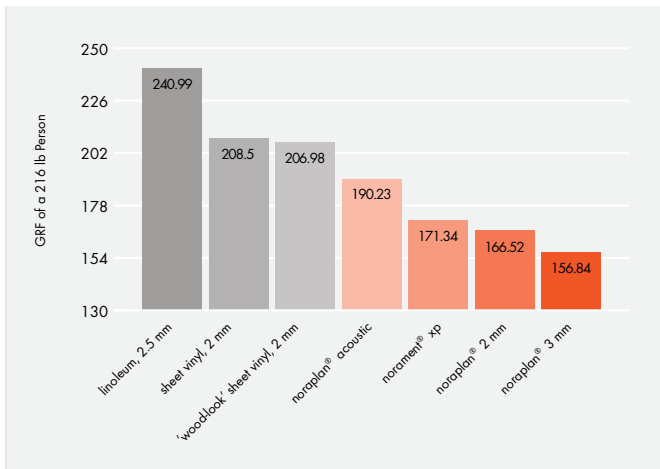
Change in Sound Level	Change in Apparent Loudness
3 dBA	Just perceptible
5 dBA	Clearly noticeable
10 dBA	Twice or half as loud
20 dBA	Four times louder or quieter



Comfort and concentration

Musculoskeletal disorders are the leading cause of workplace injuries. An independent test was done by a Senior Clinical Research Consultant for measuring psi (pounds per square inch) on the metatarsus (between the ankle and toes on the foot). It showed that the peak pressure on premium rubber was

2.8 kg/cm², better than the result on carpet for 3.5 kg/cm², a notable ergonomic advantage in the premium rubber. This research furthered the Ground Reaction Force (GRF) research done by Dr. Redfern with The University of Pittsburgh Bioengineering Department.



In Redfern’s research, each floor covering was tested for 50 cycles and the average GRF measured at the foot was calculated for each. Average GRF is calculated over one entire cycle of walking, from the time the heel first hits the floor through to when the foot is lifted from the floor. The force of a 216 lb person’s foot impacting the floor will be greater than the 216 lb weight of the person due to the acceleration of the foot during walking. For instance, the impact of a 216 lb. person on 2.5 mm linoleum was 240.99 pounds, whereas the impact of a 216 lb. person on 3mm premium rubber was 156.84 pounds, which is significantly less in support of musculoskeletal health.

We shared that while a coated floor impacts IAQ and operational costs, it also plays a role in visual discomfort in the form of fatigue, such as eyestrain and headaches. An uncoated or never-coated floor best supports visual comfort and safety when there is little to no glare from the floor surface, visual acuity is not compromised. For further information, the light reflective value (LRV) of surfaces is now referenced in LEED (Leadership in Energy and Environmental Design) v4 for educational facilities.

Premium rubber flooring has superior acoustical properties that reduces unwanted noise to lessen distraction and provide greater speech intelligibility for both students and teachers. Its non-coated,

dense surface is inherently non-slip. A non- or never-coated, chemical-free cleaning and maintenance protocol contributes to a healthier IAQ, making it a more sustainable product with a lower TCO. Premium rubber also offers enhanced ergonomic properties to lessen the fatigue placed on teachers who stand on their feet day in and day out.

Life-cycle costs

Lifespan and TCO are critical components to consider when it comes to resilient flooring selection and specification. A Life-cycle Cost Analysis (LCCA) allows specifiers to compare the economic impact of alternative materials over the Reference Service Life (RSL) of a product or building system, the Whole Building Design Guide (WBDG) states a building life is 50 years.¹⁴ Factors impacting LCCA include the cost to purchase, install (including labor, material, adhesive and prep) and clean and maintain the floor (including man-hours, labor rate, material, equipment size, cleaning frequency and cost of chemicals).

In the EPD (Environmental Product Declarations) section provided by The Resilient Floor Covering Institute (RFCI), it states that rubber

Product	Square Footage	TCO Yrs. 1-35 RSL (Sum*)	Total LCC p/sf Yrs. 1-35 (TCO YRS÷sf)	%O&M of Total LCC p/sf	Total LCC to Maintain Annually p/sf
CASE 1					
Coated VCT (RSL 25)	29,753	\$837,307	\$28.14	84.30%	\$0.80
If non-coated premium rubber was used (RSL 35)	29,753	\$539,716	\$18.14	47.60%	\$0.52
CASE 2					
Coated VCT (RSL 25)	2,478	\$83,676	\$33.77	76.95%	\$0.96
If non-coated premium rubber was used (RSL 35)	2,478	\$40,019	\$16.15	41.15%	\$0.46

This data was collected from a major k-12 school district in the southeast. It is a representative snapshot of their “real-time” cleaning protocol provided by the Lead Custodial Supervisor.

flooring has a reference service life (RSL) of 35 years, so it would need to be replaced only once over the course of a building life of 50 years.¹⁵

Professionals who practice EBD can incorporate LCCA as another means for stakeholders to make an informed decision in their selection process, since flooring is a long-term facility and capital investment. Research shows that premium rubber flooring is sustainable and can last decades while still maintaining its inherent performance characteristics. Flooring decisions can have a far-reaching effect on budgets, safety, absenteeism and aesthetics. It has an extremely low LCCA and percent of Operations and Maintenance (O&M) compared to other coated resilient flooring alternatives because it is a never-coated product.

Closer look at VCT & premium rubber flooring materials

The flooring industry does not categorize the diversity of resilient flooring materials in terms of initial and long-term costs based on level of maintenance required. The Resilient Floor Covering Institute (RFCI) defines resilient flooring as “flooring that is firm yet has give,”¹⁶ It occupies a middle ground between soft floors (carpeting) and hard floors (stone or ceramic) and includes rubber, vinyl composition tile (VCT), solid vinyl tile (SVT), sheet vinyl, linoleum, cork and luxury vinyl tile (LVT).

In many K-12 schools, VCT is often chosen for first-cost. Premium rubber is one of the few resilient flooring systems with a never-wax protocol over its sustainable life, resulting in a lower outlay for maintenance – eliminating the need for harsh cleaning chemicals. Many resilient floors offer a factory-applied coating that initially suggests a non-wax protocol. Based on location, foot traffic and maintenance protocol, at some point during the useful life of the floor, the factory-applied coating will no longer sustain. At that point it becomes a “coated floor” and now risks compromising IAQ and increasing O&M by over thirty percent as evidenced in the “real-time” maintenance protocol data provided.

As a result, there can be significant operational cost savings to the district given premium rubber cleans with little more than water. This contributes to healthier IAQ for building occupants.

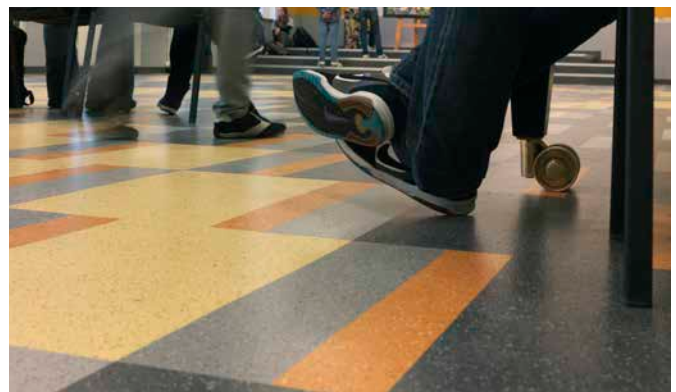
Be mindful that, not all rubber floors are created equal. Specifiers should verify that the manufacturing process ensures optimal cross-linking with enhanced surface density, and that maintenance instructions confirm the need for a never-coated maintenance protocol, especially in cleaning guidelines for high-traffic areas.

The multitude of options can make choosing the right resilient floor a daunting task, so it becomes important for a project team to align flooring selections/specifications with the basis of design (BOD) to ensure informed decisions are made for stakeholders.

Role of color in learning

Classrooms are used for a variety of purposes, but the main intent is to stimulate learning. In recent years, there has been a growing focus on the need to better prepare students for higher education and equip them with the skills and knowledge necessary to be successful innovators in the 21st century workforce. By engaging students around the subjects of Science, Technology, Engineering, Arts and Math (STEAM), educators aim to spark an interest and lifelong love of the arts and sciences in children from an early age.¹⁷

To further enhance STEAM learning, color can be used to influence how students respond to their environment and develop cognitively. In fact, we have known for decades that color has a direct impact on cognitive thinking. In 1958, U.S. scientist Dr. Robert Gerard conducted a study which claimed that the color red stimulates and makes us anxious, while blue promotes calm. He also showed that color could affect appetite, blood pressure and aggression.¹⁸



The use of color in the built-environment cannot be viewed as a passive approach to impact educational outcomes. According to Ohio-based interior designer Elizabeth Stout, color in school room design is rarely a consideration, except for its relation to functionality. Typically, a school will have a neutral wall color and use the school's colors as an occasional accent.¹⁹

Color is an important element when it comes to human-centered design and should be a consideration in the classroom environment to maximize information retention and stimulate participation. The flexibility of premium rubber flooring allows for precision cutting to create inlays that stimulate young minds and further encourage creative thinking in a fun way that is educational.

A sustainable solution

Flooring plays an important role in human-centered and evidence-based design. The human-centered approach to product selection must address economics, cost of ownership, operational outcomes, health and safety impacts and environmental considerations. EBD takes into consideration the comprehensive and holistic influence buildings have on their occupants. Both human-centered and EBD incorporate several factors that emphasize wellness for the building occupants since product selection can impact 80 to 90 percent of the O&M budget.

The composition of flooring should also meet stringent sustainable standards. GREENGUARD® Gold Certification is one of the most stringent and rigorous IAQ certification programs in the world. All GREENGUARD® Gold Certified products exceed California's Department of Public Health Services Standard Practice for Specification Section 01350, which tests for an additional 330 chemicals and total volatile organic content (TVOC). Green cleaning protocol improves IAQ and can contribute to LEED/USGBC Green Building rating system credits.



In 2005, [Grand Valley Local School District](#) in Orwell, OH, embarked on a construction project that consolidated three elementary schools, one middle school and one high school into a single 244,000-square-foot pre-K through 12 facility. The school board selected nora® premium rubber flooring, which covers classrooms, corridors, locker and weight rooms, stairwells and the cafeteria.

The performance characteristics of nora had a significant impact on sound attenuation properties and reduced the level of noise in high-traffic areas, including hallways with slamming lockers during classroom changes. The school also saw an improvement in IAQ using the nora pro clean® system and combining the product with microfiber use. This helped reduce the number of air particles and allowed students to breath cleaner, healthier air.

In addition, the simpler maintenance regimen reduced exposure to harsh chemicals as well as lowered operational costs and allowed workers to focus on other tasks. The underfoot comfort of nora flooring also reduced musculoskeletal injuries for maintenance workers and teachers who stood on their feet for the majority of the workday.

More than ten years after the installation of nora flooring at the Grand Valley School District, administrators reported that the flooring looked just as new as the day of installation, calling the decision to choose nora flooring a “no-brainer.”

K-12 Applications Ideal for Premium Rubber



Auditorium/Theatre – Capturing and maintaining the attention of students in large common areas can be challenging. Premium rubber flooring’s dense, closed surface helps reduce unwanted sound while providing superior acoustics for ideal speech intelligibility.

Cafeterias – The role of the cafeteria can pose hazards such as trips and falls from wet floors. The surface density of premium rubber flooring offers a higher Coefficient of Friction (COF) for additional traction to prevent slipping. The non-coated surface of premium rubber helps reduce glare and the perception of slipperiness, while its acoustical properties reduce noise in these high-volume spaces.

Classrooms – Are filled with distractions, so it is important to have flooring that best supports a healthy learning environment. Premium rubber flooring keeps students alert by promoting

healthy IAQ and reduced surface glare that can lessen fatigue and cognitive discomfort for students and teachers.

Gymnasium – Premium rubber flooring can withstand the effects of heavy traffic and harsh impacts. Its slip-resistant and comfort underfoot make it ideal for physical education classes. Athletes can play with greater confidence on a floor that delivers less glare and slip resistance than other coated surfaces.

Music Rooms – Noise-reducing premium rubber helps control the disruptive reverberation and background noises that make it difficult for musicians to hear what they’re singing or playing. Its sound absorption properties help block noise transmission to and from adjacent spaces.

Science Labs – Chemicals used in laboratories can stain floors and compromise IAQ. Premium rubber flooring’s inherent stain resistance makes spills easy to clean. Its inherent hygienic properties contribute to a cleaner learning environment.

Stairwells and Hallways – Busy, crowded spaces such as stairs and hallways can be challenging areas when it comes to potential for slips and falls. Premium rubber floors and stair treads provide a higher COF to reduce injuries, while its acoustical properties help reduce unwanted ambient noise.

Commitment to healthy classrooms

The link between the physical environment and learning in the classroom must be taken into consideration when designing K-12 schools. Additionally, premium rubber flooring’s lower maintenance outlay reduces operational costs in schools already constrained by tight budgets.

Interior finish materials in the built-environment can impact health, safety and educational outcomes. Selection and specification of resilient flooring must support EBD drivers and focus on reducing health and safety risks while providing a sustainable solution that embraces LCCA and lowers TCO.

The performance characteristics of premium rubber flooring, such as nora premium rubber, can help schools reduce absenteeism, provide greater speech intelligibility, improve indoor air quality (IAQ) and reduce slips, trips, falls and surface contamination.

Sources

1. <https://www.infrastructurereportcard.org/cat-item/schools/>
2. https://www.washingtonpost.com/long-rated-by-test-scores-schools-may-soon-be-judged-on-student-achievement-2017/04/18/c5d85922-2082-11e7-be2a-3a1fb24d4671_story.html?utm_term=.11d053297af1
3. <http://thethirdteacherplus.com/>
4. <http://schools.forhealth.org>
5. https://www.washingtonpost.com/long-rated-by-test-scores-schools-may-soon-be-judged-on-student-achievement-2017/04/18/c5d85922-2082-11e7-be2a-3a1fb24d4671_story.html?utm_term=.11d053297af1
6. <https://centerforgreenschools.org/state-our-schools>
7. https://www.ecocosmnc.com/img/2011_McGraw_Hill_Green_Outlook.pdf
8. <http://ftp.iza.org/dp6106.pdf>
9. <https://www.healthdesign.org/certification-outreach/edac/about>
10. http://forhealth.org/Harvard.Schools_For_Health.Foundations_for_Student_Success.pdf
11. http://forhealth.org/Harvard.Schools_For_Health.Foundations_for_Student_Success.pdf
12. <http://www.centerforgreenschools.org/impact-school-buildings-student-health-and-performance>
13. University of Salford, Manchester, UK
14. <https://www.wbdg.org/resources/life-cycle-cost-analysis-lcca>
15. <http://s3.amazonaws.com/assets.burkeflooring.com/page/pdf/afad192a5dfc484387a76a7d54d4af75/EPD-Rubber-Tile-Download.pdf>
16. <https://itci.com/about-the-industry/>
17. <https://onlinedegrees.sandiego.edu/steam-education-in-schools/>
18. <https://www.theguardian.com/lifeandstyle/2008/jul/06/healthandwellbeing.relaxation31>
19. <https://smithsystem.com/resource-library/article-library/color-world/>

nora systems, Inc.

9 Northeastern Blvd.

Salem, NH 03079

Toll-free: 800-332-NORA

Phone: (603) 894-1021

Fax: (603) 894-6615

E-mail: info-us@nora.comwww.nora.com/us