LVT in Education:

How Luxury Vinyl Tile Can Contribute to Better Education Design

Graham Capobianco

Graham.Capobianco@Novalis-Intl.com

Novalis Innovative Flooring

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Introduction

It's safe to say that education is changing. Researchers, regulators and educators alike are finding new ways to improve the quality of education in both the public and private sector, intent on creating educational environments that lead to better academic outcomes for both students and educators. While educational coursework is an important consideration for educational improvement, as we begin to understand more about how interior design can influence human health and behavior, researchers have found that improving indoor air quality and classroom design can also affect academic outcomes. As such, interior products such as flooring have come under increased scrutiny in education – perhaps this is unsurprising, as flooring makes up a significant portion of interior spaces and may be the most used product within interior environments.

One of the newest product categories on the commercial flooring market is Luxury Vinyl Tile (LVT). LVT is inexpensive, has a wide variety of design options and is easier to maintain than other traditional flooring products that have historically been used in education, such as Vinyl Composition Tile (VCT). LVT has had a meteoric rise in use in many residential and commercial construction, yet has not seen widespread use in educational environments. While there are many possible factors that influence slower adoption rates in education design, chief among is a lack of awareness of how the LVT product category uniquely benefits educational environments.

This white paper will discuss how research has affected our understanding of flooring product selection, use and maintenance in education. This paper will review the

opportunities and challenges that architects, designers and end-users face when making flooring decisions, especially as it relates indoor air quality and overall design. This paper will also explore how flooring selection, specifically LVT flooring, can help all stakeholders meet the unique challenges that they face when designing, creating, using or maintaining spaces in educational environments. Ultimately, creating more options to achieve stated design goals will lead to better outcomes for all those involved in educational environments.

The Effects of Indoor Air Quality Research on Education Design

One of the principal concerns with interior design selection is occupant safety, especially as it relates to the quality of the indoor air that occupants breathe. The study and regulation of indoor air quality is primarily fixated on limiting the amount of Volatile Organic Compound (VOC) emissions in interior spaces. VOCs are organic compounds that have a low boiling point and high vapor pressure – in other words, they are hazardous chemicals that easily evaporate into indoor air in normal temperature conditions (EPA, 2022). Since many humans spend 90% of their time indoors and students will spend the bulk of their education within classrooms, it only makes sense that the VOC emissions of all interior finishes, including flooring, must be limited to ensure that the Total VOC (TVOC) emissions of indoor spaces are well within safe levels for humans (RFCI, 2022). For the stakeholders in education design and construction, early research into indoor air quality had a domino effect that led to the ubiquity of indoor air quality and VOC emissions.

As early as 2001, regulatory agencies and governing bodies began studying the human health impacts of VOC emissions from common building materials, especially

flooring. One such study, conducted by the California Office of Environmental Health Hazard Assessment (OEHHA), found that indoor emissions of formaldehyde, one of the most well-known VOCs, were likely to cause irritation and toxicity in humans at levels as low as 32 micrograms per meter cubed (μ/m^3) in adults and 15.8 μ/m^3 in children (OEHHA, 2001). While formaldehyde is present in outdoor air, usually at levels between 3.6 – 14.9 μ/m^3, indoor environments were found to contain 11 – 39 μ/m^3 of formaldehyde emissions, more than double the amount of normal outdoor conditions (OEHHA, 2001).

Needless to say, this raised the eyebrows of consumers, environmental advocates and regulatory agencies alike. However, what was most alarming was the VOC emissions found in schools: the study found that formaldehyde emissions rates were as high as 121.5 μ/m^3 in educational environments (OEHHA, 2001). This showed that children, who are more susceptible to formaldehyde and many other VOCs than adults, had been subjected to some of the highest concentrations of harmful toxins and potentially breathing air that was as much as ten times more toxic than outdoor air. Though the correlation between indoor air quality and education should be obvious, studies have shown that chronic health conditions, many of which arise from exposure to toxic chemicals, can adversely affect academic performance (Taras & Potts-Datema, 2005).

The OEHHA study that was published in 2001 was perhaps one of the first dominoes to fall - the chain reaction and subsequent actions were swift and can still be felt today. In 2002, California began adding indoor air quality requirements to Construction Specifications Institute (CSI) construction contract documents - these

requirements were added to the ‘General Requirements – Special Project Procedures’ section, which is 01 35 00 in CSI’s MasterFormat (CalRecycle, 2022). As a result, this requirement became known as CA Section 01350. Not long after that, the California Department of Public Health (CDPH) developed a Standard Practice for VOC Testing, in order to standardize and regulate VOC testing of interior products, such as flooring. This method, commonly known as CDPH Standard Method V1.2 – 2017 in it’s current version, includes specific parameters for recreating test chamber conditions that resemble school classrooms, ensuring that VOC testing realistically creates conditions that are similar to these environments (CPDH, 2017). A few years later, the Collaboration for High Performance Schools (CHPS), which certifies schools that maximize occupant well-being, resource conservation and stewardship, integrated the CA Section 01350 requirements and the CDPH Standard Method into its certification and product selection requirements, heavily incentivizing schools to ensured products are well within limits (CHPS, 2022). Today, CA Section 01350, the CDPH Standard Method and CHPS are widely known acronyms that many within the design and construction industry use on a routine basis.

Without a doubt, the indoor air quality of educational environments is of paramount importance when it comes to academic outcomes – this is likely why many are concerned about VOC emissions in indoor environments today. VOC Testing and certification are so routinely requested and required that they may often be seen as an expectation and afterthought in school construction. However, perhaps due to how ubiquitous VOC requirements are, researchers have turned their attention to other

factors that affect academic outcomes in schools – the way school interiors are designed.

The Effects of Education Design & Construction on Academic Outcomes

Though their effects on human health and academic achievement are widely known, VOCs are not the only thing in the built environment that affects academic outcomes in schools. As many education stakeholders began to understand how buildings and interior spaces influence human health and behavior as well as academic excellence, many schools began to wonder if building and classroom quality and aesthetics had an impact on academic outcomes. In the early 2000's, researchers were undecided on the direct correlation between interior design and academic performance. While some researchers found that improving building and classroom construction had an effect on test scores and academic engagement, others failed to find a direct, quantitative correlation between design improvements and academic improvement (Schneider, 2002). However, most researchers asserted that a link between school design and academic excellence was likely.

In 2007, this theoretical assertion aligned with the direct experience of U.S. Schools. A U.S. Department of Education survey showed that 43% of U.S. schools experienced design and construction flaws in school buildings and classrooms that impeded the ability of schools to deliver an adequate education - these impedances had a measurable impact on student achievement and teacher productivity (2007). As a result of these findings, the topic of interior design and its effects on educational environments has become more widely researched and understood in recent years. For instance, researchers have found that things like classroom layout, the amount of natural light in

spaces and other specific design choices can increase or decrease academic performance by as much as 25% (Barrett, Davies, Zhang & Barrett, 2015). Other researchers have found that things like air circulation and the overall point of view of students can lead to better academic scores in students (Ariani& Mirdad, 2016). In fact, most studies find that the built environment can motivate or demotivate students and teachers alike. Put simply, research indicates that sensory inputs in educational environments and classrooms have a direct correlation to academic outcomes for all education stakeholders.

As many architects and designers consider how interior design elements, such as color, natural light and airflow, can have a positive or negative impact on the educational careers of both students and teachers, they are being forced to rethink traditional school environments, from overall construction down to the selection of specific flooring products. Designers around the world are experimenting with education design in bold new ways, intent on improving the educational experience of all occupants (Cotrell, 2012). One such flooring product category that has drawn more attention in recent years is LVT, a product that allows for flooring designs that meet VOC requirements while allowing for unique design experimentation and long-term performance.

Vinyl Tile Flooring Options for Education Design

The most commonly used product category in educational environments is VCT: it accounts for more square footage than any other product in schools (Capobianco, 2007). Known for its iconic 12-inch x 12-inch square tile format, VCT was derived from a vinyl chloride polymerization process that created durable, rigid vinyl that was not

considered useful until Waldo Semon added a plasticizer to the original formula in the mid 1920s (Bellis, 2020). Technically speaking, Vinyl Composition Tile or VCT is a homogenous vinyl tile that features a through-pattern construction and, due to its relatively low vinyl content and subsequent higher porosity, often requires the application of a protective floor finish, colloquially referred to as a wax (RFCI, 2019a). VCT is a durable flooring product: as long as the floor finish is continually maintained, VCT can last for up to 25 years on average (RFCI, 2019a). Despite its historically usage in education, designers have begun to look for more lively and unique designs or have looked to ways to create realistic wood and stone looks that are more affordable – one category that helps designer accomplish these goals is LVT.

Though LVT has seen tremendous growth in the commercial market over the last decade, LVT is not a new flooring product category. Manufactured since the 1980s, LVT is technically considered a Heterogenous Solid Vinyl Tile: it is a multi-layer flooring product that features a decorative print film (sometimes described as a color or pattern layer) covered by a protective wear layer, with a scratch-resistant UV-cured polyurethane coating on top (RFCI, 2019b). The combination of a wear layer and a polyurethane coating makes LVT a durable, long-lasting product that can last up to 30 years on average without the need for extensive maintenance procedures (RFCI, 2019b). The multi-layer format of LVT makes it a versatile product that can be used in and customized for a wide variety of a locations, from single-family houses to heavy commercial buildings. However, LVT categorically has a high vinyl content, especially in the wear layer: this leads to a higher initial cost, which can sometimes preclude it’s use in education (ASTM, 2020).

Vinyl Tile Challenges in Education Design

As we consider the challenges that designers face in educational environments, there is one element of this conversation that is often overlooked: cost. Though researchers and regulators have taken steps to improve schools, studies have shown that it could take as much as $322 billion to accomplish the emerging goals of education design (Irons, 2009). This is perhaps why VCT is still such a prevalent flooring product in educational environments: since VCT has less vinyl content, it has a lower initial cost, making it appealing for education design projects with low budgets (Sullivan & Horwitz-Bennett, 2014). However, initial cost analysis may be short sighted when we consider the life-cycle cost of VCT in educational environments.

As previously mentioned, VCT often requires that a floor finish be applied to the surface after initial installation. While VCT has a relatively low initial cost, it will usually require routine periodic and restorative maintenance. This usually involves deep cleaning, burnishing and/or chemically removing the existing floor finish in order to re-apply new finish and maintain the appearance of the flooring over time (Jensen, 2016). The below table shows an example of the initial costs of VCT and LVT, using early 2020 market averages gathered from various regional commercial flooring contractors in the United States.

Initial Installation Costs of VCT & LVT (per sq. ft.)		
Cost	**VCT**	**LVT**
Material	$0.75	$2.00
Installation	$1.25	$1.25
Initial Maintenance	$1.00	$0

Total Initial Cost	**$3.00**	**$3.25**

Figure 1: Initial Installation Costs

As the table suggests, although LVT doesn't require specialized maintenance and has a similar installation cost to VCT, it has a substantially higher material cost, which makes the initial cost at least $0.25 per square foot (sq. ft.) more than LVT. Though this may not seem like a significant increase, education projects are often large – if the project were 25,000 sq. ft., this would lead to a $6,250 cost increase. Considering that education construction budgets are often very low, this additional cost may not be palatable to some, especially on larger projects.

However, using initial installation costs to make design decisions is a fairly one-dimensional way of looking at costs, especially since product maintenance is often required for VCT flooring. As previously mentioned, VCT will require periodic and restorative maintenance over its lifetime – though the intervals in which this maintenance is performed varies, it is commonly performed on an annual or bi-annual basis (Jensen, 2016). Though LVT will also need to be maintained, it does not require that the finish be burnished or removed and reapplied. The below table shows an example of what the total cost of VCT and LVT are after year two of installation.

Total Installation Costs of VCT & LVT: Year 2 (per sq. ft.)		
Cost	**VCT**	**LVT**
Initial Installation	$3.00	$3.25
Average Annual Maintenance	$1.00	$0.50
Total Cost	$4.00	$3.75

Figure 2: Total Installation Costs After Year 2

After just 2 years, the installation cost of VCT exceeds the cost of LVT – as VCT proceeds through its 25-year lifespan, these costs will compound and continue to be absorbed by the educational institutions that are responsible for these costs. Using previous examples and tables, a 25,000 sq. ft. school with VCT installed would cost $98,750 dollars more to maintain after five years of use than a school with LVT installed. While it's important to ensure that construction budgets in education are met, the same institutions responsible for construction budgets are also responsible for maintenance budgets – in other words, short term reductions can lead to long term increases in education.

However, the additional cost of maintenance is just one important consideration. As previously established, indoor air quality is of paramount importance in schools, as VOC emissions has been shown to have potentially harmful effects on humans, especially children, and education design has become more holistic in recent years, in order to include all humans in the indoor environment. VCT's restorative maintenance process often involves the use of chemical floor finish removers, colloquially known as chemical strippers. Though most are marketed as safe and sustainable, they often contain VOCs, such as 2-butoxyethanol and ethanolamine (Hospital Employee Health, 2006). As with all hazardous chemicals, exposure limits and ventilation are key, but VOC emissions from undiluted chemical strippers can easily accumulate in unventilated areas and exceed the required exposure limits established by the U.S. Occupational Safety and Health Administration (OSHA) and the National Institute for Occupational Safety and Health (NIOSH) (Hospital Employee Health, 2006). Considering air

circulation and quality is already a concern in indoor educational environments, the use of chemical strippers alone can pose a hazard for all school occupants.

How LVT Can Help Education Design Improve Academic Performance

Education architects and designers are tasked with finding interior finishes, such as flooring, that meet strict VOC emissions limits and enable them to create interior spaces that are more conducive to learning, all while being aware of budgetary restraints – it's a tall task, to be sure. The budget process itself can eliminate many high quality floor products from contention, which is why VCT has been so widely used. However, LVT has unique advantages that make it another ideal choice for designers in their pursuit of educational environments that create better academic outcomes.

Most products in the LVT product category have been tested for VOC emissions in accordance with the CDPH Standard Method and meet the VOC emissions requirements of CA Section 01350 and CHPS (RFCI, 2019b). Some LVT products may even have third party verification that they are well below the limits of even the most stringent school VOC emissions requirements. Since LVT does not require the use of a chemical stripper or other hazardous chemicals during maintenance, there is virtually no VOC emissions risk for this material, meaning it will not contribute to TVOC emissions levels that will cause human health risks.

Additionally, LVT's multi-layer nature makes it easy to create an almost limitless number of unique designs that can mimic other product categories that may be cost-prohibitive for education design budgets (Sullivan & Horwitz-Bennett, 2014). Bright colors and creative visuals can help designers make educational environments that not only lead to better student academic outcomes, but also better job satisfaction in

teachers and other staff. LVT design options can also enable designers to integrate school colors, wayfinding and other unique design elements directly into the flooring design and installation.

Although VCT is heralded as an ideal, low-cost flooring solution for education design, the devil is in the details. While some design projects involve turning construction projects over to end-users, who then absorb the maintenance costs, educational institutions are often responsible for both the construction costs and the long-term maintenance costs of flooring installation. Over the course of the installation, educational institutions will absorb these maintenance costs, adding to the overall cost of the flooring. LVT, on the other hand, is significantly less porous than VCT and does not require the use of a floor finish to maintain its appearance and protect it from dirt accumulation and staining. As previously figures show, the cost of VCT installation can exceed the cost of LVT installation in just two years when annual maintenance is factored into total cost.

AVA 2SPRK: Familiar and Sustainable LVT for Education Design

AVA 2SPRK is a LVT product that is ideally suited for educational environments. It is rated for heavy commercial applications, such as school corridors and cafeterias, and does not require the use of a site-applied finish to maintain it’s 20-year heavy commercial warranty. AVA 2SPRK is protected by a 0.55mm (22 mil) wear layer and the AVA AMP finish, which offers excellent stain resistance and superior resistance to wear.

AVA 2SPRK has been independently tested via CPDH Standard Method V1.2 and is certified to meet the requirements of CA Section 01350 and CHPS. AVA 2SPRK is also GREENGUARD Gold certified, which tests for more chemicals than CDPH

Standard Method V1.2 and has more stringent emissions limits than CA Section 01350. Additionally, 2SPRK's ingredients are full disclosed via a Health Product Declaration (HPD) and a Declare Label, reporting all chemicals in concentrations above 100 PPM. These disclosures confirm 2SPRK does not contain any phthalates, heavy metals, or chemicals on the California Proposition 65 (Prop 65) List. Additionally, 2SPRK does not contain any Living Building Challenge (LBC) 2021 Red List Chemicals other than PVC and is REACH compliant.

2SPRK Features 38 dynamic colorways that provide bright and crisp essential colors with coordinating neutral tones, creating one off the largest palettes of impactful design options in the LVT product category. This unique blend of colors, combined with the 18 inch x 18 inch tile size, enables designers to create spaces that are similar to other product categories with several added benefits. 2SPRK can easily be maintained with low VOC neutral cleaners and many common cleaning machines and chemicals found in education settings. Put simply, AVA 2SPRK is a great overall flooring option for all educational environments.

Conclusion

Designing schools is a challenging proposition: it often involves making interior selections that must consider the health and well-being of children and young adults, who are the most susceptible to many of the dangers that lurk within building products. Children and young-adults also represent some of the most cherished individuals in most societies – communities specifically seek to provide the youngest among us all of the opportunities they need to overcome many of life's challenges. The gravity of this

challenge has led to many important discoveries about building products and interior spaces in general – it has literally benefited the whole of our society.

Considering the many human health, safety, design and budgetary elements that must factor into effective education design, LVT is uniquely poised to help architects, designers and end-users alike make better design solutions that help educators and regulators meet their stated goals: better academic outcomes. While flooring represents just one part of the built environment in education, it is a crucial part of all design. As the saying goes, “the journey of a thousand miles begins with a single step,” - whether we realize it or not, what we step on matters (Tzu, L. 2007).

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