

House Bill # 443: An Act Relative to the Consideration of Ergonomically Designed
School Buildings

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As part of the General Court of Massachusetts public hearing of the Joint Committee
on Education will hold a public hearing

Chairpersons O'Leary, Waltz and members of the Joint Committee on Education,
members of the audience, ladies and gentlemen, it is a pleasure to be here with you
today. I am an occupational therapist; board certified professional ergonomist, professor
at Boston University and a former president of the American Occupational Therapy
Association (AOTA).

I am here to offer my support of House Bill #443: An Act Relative to the Consideration of
Ergonomically Designed School Buildings. My goal is that the School Building
Assistance Authority will consider ergonomic design features in all aspects of any new or
rehabilitated school building that receives state money.

This legislation would be part of the "green school" initiative that was developed by US
Green Building Council (www.greenschoolbuildings.org/g101.aspx) and which is
embraced by Massachusetts.

*"The U.S. Green Building Council (USGBC) is a nonprofit composed of leaders from
every sector of the building industry working to promote buildings that are
environmentally responsible, profitable and healthy places to live and work"
(www.greenschoolbuildings.org/g101.aspx).*

As you know, being part of the green school initiative means making a commitment that
*"...a school building ...creates a healthy environment that is conducive to learning while
saving energy, resources and money" ..."By promoting the greening [ergonomics] of all
[Massachusetts] schools that receive state money - new or existing - we can make a
tremendous impact on student health, test scores, teacher retention, school operational
costs and the environment"* (www.greenschoolbuildings.org/g101.aspx).

Far too often our Massachusetts' *"...schools are only built to code and we send our
children to spend six hours a day in facilities that just barely meet health and safety
standards"* (www.greenschoolbuildings.org/g101.aspx). As stated by the US Green
Building Council, *"Every child deserves to go to a school with healthy air to breathe and
conditions that encourage learning"* (www.greenschoolbuildings.org/g101.aspx).

I would like to bring this statement closer to home by saying that every child in Massachusetts deserves to go to a school with healthy air to breathe and conditions that encourage learning. The addition of ergonomics will assist in this endeavor.

In this testimony, I will share the state of research conducted by a broad array of disciplines globally ranging from occupational therapy, physical therapy, ergonomics, social and environmental psychology, education and architecture. This research provides support to the impact of school buildings on students' health, well being, behavior, attitudes, and performance as well as the teacher's ability to teach. Wherever possible, I will include the cost in medical care for adults who have not been received education in "green" schools/ergonomic environments.

This testimony was developed based on input from colleagues globally who are members of the *International Ergonomics Association's* (IEA) Technical Committee called the *Ergonomics for Children in Educational Environments* (ECEE). I thank members for their contributions. In particular, I thank Michelle Newman, Marina Ciccarelli, Charlotte Heim, Valerie Rice, Rani Lueder, Judith Schoonover, Jennifer Kaldenberg, Pat Kane, Susumu Saito, Sara Dockrell, Kirsti Floerenes Vandraas, Stephen Legg, Chrys Peralta, Jackie Markowitz and Peter J Turner for their assistance.

According to researchers Higgins et al (2005)

"...the design of the school environment, internal and external, has profound effects on the activities and outcomes of teaching and learning, both formal and non-formal."

As the Commission for Architecture and the Built Environment stated:

"...we know that good design provides a host of benefits. The best designed schools encourage children to learn" (DCMS, 2000).

Michelle Newman, a research assistant with the *Design and Ergonomics Applied Research Group* in Coventry, UK conducted a comprehensive literature review on the impact of school environments including system and processes, the school built environment, physical environment in the classroom, products and services and communication (Higgins et al. 2005).

Newman (2009) stated,

"The broad conclusions of the review were that there is strong evidence that physical elements such as air quality, temperature and acoustics, has a tangible effect on learning and should therefore be taken into account from the earliest stages in the design process" (p.45).

Based on a review of the literature, this testimony will look at specific physical and environmental factors that are having an impact on students in school buildings:

1. Full spectrum lighting & natural lighting
2. Noise
3. Thermal conditions (temperature)
4. Indoor air quality (IAQ)
5. Class size, classroom density and furniture

1. LIGHTING

Appropriate lighting is critical to the everyday activities of students. Research has demonstrated that *...poor lighting makes the perception of visual stimuli, such as written texts, difficult and therefore affects attitudes to learning and student performance* (Dunn 1985; Phillips 1997; Jago 1999). In fact, Tanner (2000) found that poorly or inappropriately lit classrooms can cause jetlag type symptoms.

Newman reported in her dissertation that

“...students in the most daylit classrooms progressed faster than those in the least daylit rooms” (Plympton 2000). These findings were supported by comparative research on four elementary schools in the U.S.A. that found an overall improvement of 14% in daylit schools (Nicklas 1995).” The Heschong Mahone Group found that children with more daylight progressed 20% faster than their counterparts without daylight (HMG 1999). Classrooms cannot have full daylight at all times, however there are lighting systems available that mimic natural light which have been found to have a positive effect on school attendance, achievement, growth and development, (Hathaway 1990) It has been found that in classrooms where direct sunlight, or glare, is allowed to enter through skylights standardized test scores fall (HMG, 1999); (California Energy Commission, 2003).

As well as academic attainment, lighting can affect the health of students including the regulation of internal body clock or circadian rhythms (Alexander, 1977), the production of vitamin D, mood swings, depression and headaches (Guzowski 2000; Benya 2001; Benya 2003). There is also an association between the flicker of fluorescent lighting and some serious health problems such as epilepsy (Harding 1994). The distraction of flickering lights can also exacerbate the symptoms of ADHD and autism (Thompson 1999; Kluth 2004)...It is suggested that the use of flicker free full-spectrum lighting should be used to combat some of these health problems (Karpen 1993) (Newman 2009:49-50)

According to Dr. Marina Ciccarelli, PhD, a Senior Research Fellow at the Centre for Research into Disability and Society| Faculty of Health Sciences and lecturer at the Curtin University of Technology in Western Australia,

“Visual and musculoskeletal symptoms and disorders are the most common occupational health problems experienced among adult office workers, especially those who use computers, (Hagberg & Rempel, 1997).

These symptoms and disorders are due to risk factors such as awkward postures, poorly designed workstations, inadequate seating, poor lighting including glare. Many classroom environments expose children to similar risk factors that are causing visual and musculoskeletal problems in adults and so children are also at risk. In fact, children may even be more vulnerable because their musculoskeletal and visual systems are still developing (Junghanns & Hager, 1990), and that permanent damage may be done as it is occurring during critical periods of development in their skeletal and visual systems (Ramos, James, & Bear-Lehman, 2005).

However, there is little information available about the numbers of children who are developing visual and musculoskeletal disorders. This is mainly due to the fact that disorders occur as a result of exposure to risk factors, but might not fully manifest as a chronic health condition until later in life. Therefore, cost-effective interventions such as House Bill #443 which will promote healthy physical development during childhood can prevent the development of chronic and costly ill-health among adults (Taylor, Pezzullo, & Keefe, 2006)” (Ciccarelli,2009, personal communication).

2. NOISE

According to Newman’s investigation of the evidence literature:

It is now widely concluded that noise and poor acoustics in classrooms can have a detrimental effect on children’s learning and academic achievement (Hetu 1990; Evans 1993; Lundquist 2000; MacKenzie 2000; Maxwell 2000; Gifford 2002; Shield and Dockrell 2002; Shield, Dockrell et al. 2002; Shield and Dockrell 2003; Klatte 2005; Dockrell and Shield 2006). Effects have been found to be particularly deleterious amongst primary aged children (Green 1982; Crandell 2000). Excessive noise impacts on attainment in various areas of children’s learning, for example reading (Bronzaft 1975; Bronzaft 1981; Lukas 1981; Green 1982; Evans 1997; MacKenzie 2000; Shield and Dockrell 2002), memory, (Fenton 1974; Johansson 1983; Hygge 1993), concentration and behavior (Lehman 1983; Evans 1993).

The UK Department of Education and Skills has recognized the potentially deleterious effect of poor acoustics on teaching and learning and has recently produced mandatory guidance on the acoustic design of new schools (Newman 2009:56-57). In Massachusetts, we can do the same through House Bill #443. We can help prevent the impact of noise on children's learning, academic achievement, as well as lifelong hearing health.

3. THERMAL CONDITIONS (TEMPERATURE)

Newman (2009, 52-3) writes:

Jaakkola (2006) stated, Temperature is probably the most important indoor air quality parameter in schools...surprisingly small variations in temperature and humidity may feel uncomfortable and disturbing." A field intervention experiment by Wargoeki et al. (2005) reported that reducing temperature in a classroom by ~3 degrees increased work rate in both subtraction and reading. Mental performance has been found to decrease in conditions above 90°F (Bell 1976; Bell 1990). Test scores of children were considerably lower in non-air conditioned rooms than those with air conditioning (Kevan 1980)"

4. INDOOR AIR QUALITY (IAQ)

Newman (2009, 54-55) found in her search of the evidence literature that

"Approximately half of the schools in the United States are estimated to have at least one building defect (GAO, 1996) which results in indoor air problems. Poor indoor air quality has been associated with reduced attendance in schools and respiratory illness (Mendell & Heath, 2004). Addressing air quality in schools is important because growing children are more susceptible to the health problems associated with them than adults are. This is because children breathe higher volumes of air relative to their body mass (Landrigan 1998; Faustman 2000; Mendell and Heath 2005)"

The United States Environmental Protection Agency writes:

"Poor IAQ can cause illness requiring absence from school, and can cause acute health symptoms that decrease performance while at school. In addition...poor IAQ can reduce a person's ability to perform specific mental tasks requiring concentration, calculation or memory" (E.P.A. 2000).

One of the primary concerns with poor IAQ is its association with asthma, which is a major health issue. In the USA alone asthma accounts for 10 million missed school days per year, accounting for 20% of absences in US schools (Richards 1986). This of course will have long-term effects on the health and education of the affected children (Newman 2009: 55); and it also has an impact on health expenditures.

5. CLASS SIZE, CLASSROOM DENSITY AND FURNITURE

Increased aggression, conflict, decreased social interaction and non-involvement have been associated with high social and spatial density in classrooms. These detrimental effects could affect children's ability to learn (Aiello 1979; Moore and Lackney 1993) and can also result in stress and poor health, including high blood pressure (Evans 1998).

"For children with learning difficulties the problems associated with crowded classrooms are exacerbated. They may become aggressive or withdrawn when either social or spatial density is increased (McFee 1987) (Newman 2009: 47). "The Student Teacher Area Ratio (STAR) project, a longitudinal study of 6500 children in Tennessee studied two groups of students: those in classes of 13-17 per room, and those in classes of 22-25 per room. Children in the smaller groups were found to score higher in all Stanford Achievement Tests, especially for reading and mathematics, with an improvement of up to 15% (Finn 1990)" (Newman 2009:47).

Lackney (2008) recommended that,

"School buildings which have classroom environments that give teachers more control (e.g., adjustable desk layouts, visual displays) may best support specific educational goals (e.g., collaborative environments, student productivity)".

Our own research among other research studies globally is indicating that musculoskeletal disorders are becoming more prevalent among school-aged children (Jacobs, et al 2009). Furniture in classroom environments that does not match schoolchildren's body measurements may be a contributing factor to musculoskeletal discomfort and pain. Poor posture because of poor lighting can add to this issue. Research findings confirm that pain experienced in the lower and upper back during adolescence is associated with ongoing pain in adult life (Harreby, Neergaard, Hesselsoe, & Kjer, 1995).

We all know the magnitude of the problem to society. One low back injury costs ~ \$40,000. Presently, the cost of US medical care is at 16% of GDP and is rising. Workers' compensation insurance presently extracts ~\$ 88 billion annually from business and government. Prevention strategies such as included in House Bill #443 would improve productivity since there would be fewer future workers (our schoolchildren) who will

develop back injuries. The fewer number of future workers with chronic back pain results in fewer federal dollars spent for Social Security Disability Insurance and fewer dollars spent by state and local governments for welfare.

As Dr. Ciccarelli shared,

“Providing minimum standards for the design of physical learning environments for children, including provision of either adjustable tables or chairs, or a range of furniture sizes; and the design of computer-specific workstations can promote supported seated postures and healthy behaviors in school children to assist in reducing the costs associated with musculoskeletal disorders later in adulthood”
(Ciccarelli, 2009, personal communication).

Lackney (1991) summarized the issue well in a testimony that he provided as part of a Congressional Briefing to the US House of Representatives Committee on Science sponsored by the Environmental Energy Study Institute:

“...physical factors [I have mentioned] - full-spectrum and natural lighting, the reduction and control of noise, the location...of schools, optimal thermal conditions, and school size and class size, as well as building condition -- can have a mediating effect on a variety of variables known to have a link to student achievement: time-on-task, student-teacher interactions, classroom interruptions and student participation.” He continues, “In addition, the quality of the learning environment is known to affect teacher behavior and teacher attitudes towards continuing to teach (Johnson, 1990), [something we have not been able to touch upon here, which can have an additional mediating effect on student behavior and attitudes.]

To conclude, the evidence is overwhelming that school buildings are of critical importance to the teaching and learning process. It is my belief that the application of sustainable design principles [discussed in this briefing], if applied early in the school design process will most certainly have a positive influence on the bottom-line indicators of quality in education into the next century (p. 5 & 6).

The evidence exists to support the need for House Bill #443 that the School Building Assistance Authority will consider ergonomic design features in all aspects of any new or rehabilitated school building that receives state money.

If House Bill #443 is supported by your Committee, it will be another step for Massachusetts to lead the way to keep our children healthy so they can enter the workforce of tomorrow as contributing members and not as another burden to our state and the nation’s health care system. I encourage you; let Massachusetts make ergonomics a part of the “green school” movement.

Thank you for the opportunity to speak with you today.

Respectfully submitted,

A handwritten signature in black ink that reads "Karen Jacobs". The script is fluid and cursive, with the first letters of each name being capitalized and prominent.

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