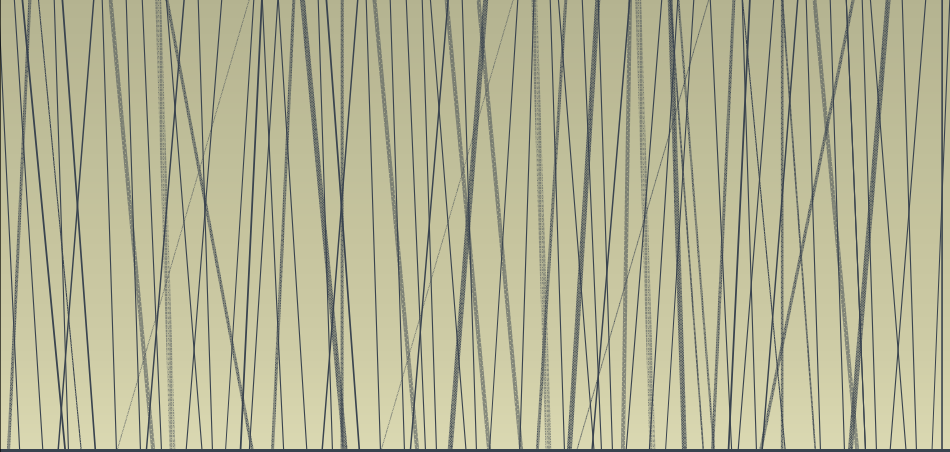


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Children's Education and Scholastic Experience

Existing Condition of schools

Number of children engaged with design

- According to National Center for Education Statistics - Public school enrollment at the elementary level (prekindergarten through grade 8) rose from 27.6 million in fall 1980 to 34.4 million in fall 2009.
- It is projected to continue a pattern of annual increases through 2020 (the last year for which NCES has projected school enrollment).



Existing Facilities

- Elementary school education in America frequently occurs in outdated facilities from earlier generations
- Average age of a public school building in the United States is 56 years old.¹
 - 28 percent built before 1950
 - 45 percent built between 1950 and 1969.



Static Learning Styles

- “The lecture with the discussion is the standard delivery system throughout American education... But the world is changing.”²
 - Traditional learning styles focus on the idea of teacher-led content and students as consumers.
- Typical length of school day is 6.7 hours
- Dr. James A. Levine, a professor of medicine at the Mayo Clinic, advocates what he calls “activity-permissive” classrooms.³

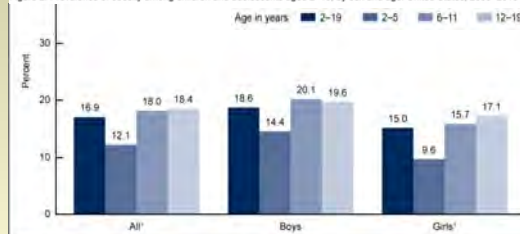
Children's Health

Existing Status of Children's Health

Health - Obesity

- “For the first time in history, children today are projected to have a shorter life expectancy than their parents.”⁴
- The primary cause is increasing Obesity
 - Childhood obesity has more than doubled in children and tripled in adolescents in the past 30 years.
 - The percentage of children aged 6–11 years in the United States who were obese increased from 7% in 1980 to nearly 18% in 2010.
 - In 2010, more than one third of children and adolescents were overweight or obese.⁵
- Overweight and obesity are the result of “caloric imbalance”—too few calories expended for the amount of calories consumed—and are affected by various genetic, behavioral, and environmental factors.

Figure 2. Prevalence of obesity among children and adolescents aged 2–19, by sex and age: United States, 2009–2010



⁴Significant increasing trend (trend by age $p < 0.005$).
SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey, 2009–2010.

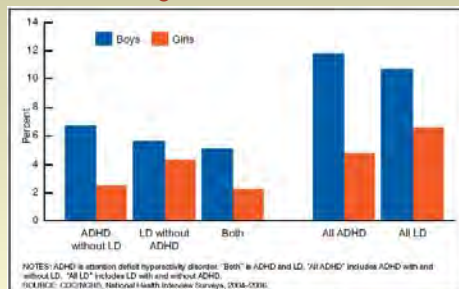
Health - Depression

- Approximately 7.5 million children in the United States are experiencing mental and emotional disturbances, including depression.
 - 1% to 9% of primary school children and 4% to 7% of adolescents suffer from depression.
 - Depression limits the ability of children to learn by not only increasing absenteeism but also by limiting the ability of the child to concentrate and focus on classwork.
- More than fivefold increase in depression for a youth with ADHD.⁶
- Up to 65% of children with ASD also suffer from depression.⁷



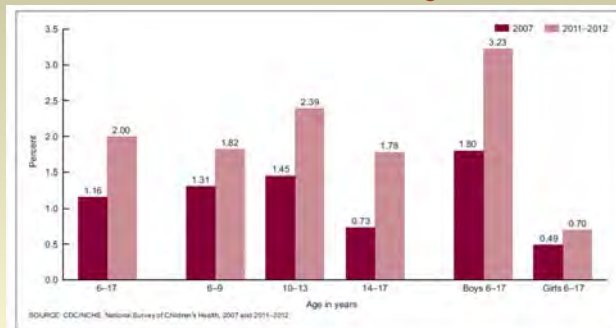
Health - Developmental Disabilities

- In addition to physical health issues - About 1 in 6 children in the U.S. had a developmental or learning disability in 2006-2008, including:
 - Attention deficit hyperactivity disorder (ADHD) is a problem of not being able to focus, being overactive, not being able to control behavior, or a combination of these.
 - As of 2007, approximately 9.5% or 5.4 million children 4-17 years of age had been diagnosed with ADHD.



Developmental Disabilities

- Autism spectrum disorders (ASDs) are a group of developmental disabilities that can cause significant social, communication and behavioral challenges.
- Centers for Disease Control and Prevention's (CDC) revealed a nearly fourfold increase in parent-reported ASD between the 1997–1999 and 2006–2008.
- Autism prevalence in the 2011-12 National Health Statistics Report was found to be 1 in every 50 children.⁸



Developmental Disabilities

- “More than 95 percent of students with physical, emotional, learning, cognitive, visual, and hearing disabilities receive some or all of their education in regular classrooms.”⁹





Inactivity

Relationship to Health

Inactivity

- One cause of health problems is children's lack of exercise
- "In just 44 years (approximately 1.5 generations), physical activity in the United States has declined 32 percent and is on track for a 46 percent drop by 2030".¹⁰
- "Only 42% of US children aged 6–11 years meet PA (Physical Activity) guidelines which are ≥ 60 min of moderate and vigorous PA (MVPA) every day"¹¹



Inactivity at School

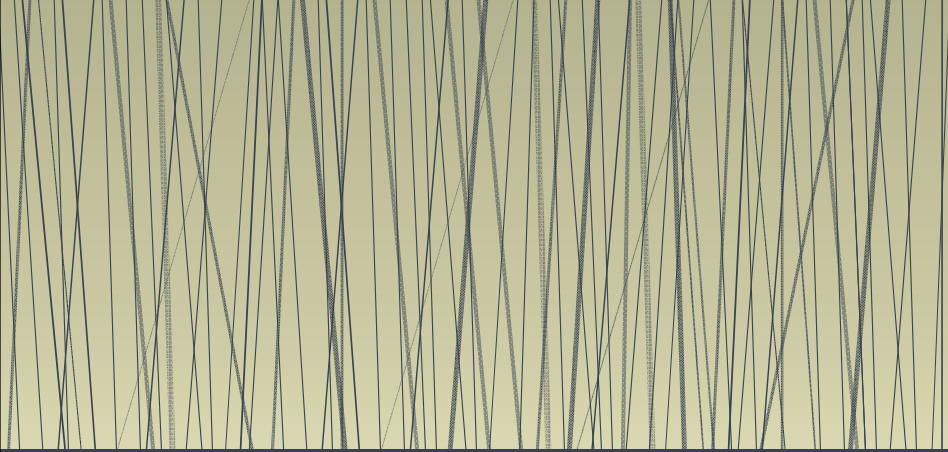
- Kids are not exercising at home – or, unfortunately, at school.
- 30% of schools did not offer third grade children recess every day.¹²
- Only 3.8% of elementary students receive daily physical education in the U.S.¹³



Resulting Health Problems

- CDC links the lack of adequate exercise to the obesity epidemic, “Nearly 1/3 of children and teens, more than 23 million kids, are overweight or obese – and physical inactivity is a leading contributor to the epidemic”.
- Direct connection between inactivity in children and an increased risk for “dying prematurely, dying of heart disease, and/or developing diabetes, colon cancer, and/or high blood pressure”.¹⁴
 - Currently inactivity is blamed for 9% of premature deaths a year.



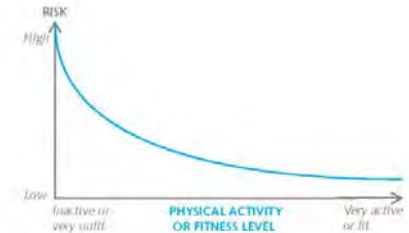


Health Benefits of Movement

Impact on Students Health

Fitness – Health Benefits of Movement

- **Active children:**
 - Display healthier cardiovascular profiles
 - Are leaner
 - More likely to remain lean into adulthood
 - Develop higher peak bone masses
 - Higher bone masses in young people reduce the risk of osteoporosis in old age
 - Biological carry-over effect into adulthood
 - Active children are more likely to become more active (healthy) adults.
- “Having many children sit in a classroom isn’t the craziest idea, but look at how children have changed.” Dr. Levine said of the sedentary lives of many. “We also have to change, to meet their needs.”¹⁵



Source: Department of Health (2004) *At least five a week: Evidence on the impact of physical activity and its relationship to health*. A report from the Chief Medical Officer

How even small movements can benefit health – Fidgeting

- “Changes in NEAT (Non-exercise activity thermogenesis), which is associated with fidgeting, maintenance of posture, and other activities of daily life, accounted for 10-fold difference in fat storage that occurred and directly predicted resistance to fat gain with overfeeding”.¹⁶
- “People who tap their feet, prefer standing to sitting and generally move around a lot burn up to 350 more calories a day than those who sit still.”¹⁷
- Study found that students burned 114 more calories per day when using standing desks then when using a typical desk.

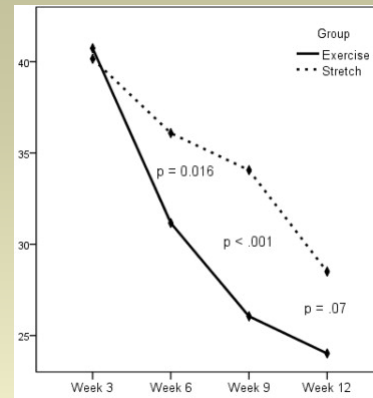
How even small movements can benefit health – Fidgeting

- “Sitting is the new smoking” - Study published October 2012, British Journal of Sports Medicine found that for every hour of TV that people watch, presumably while sitting, it cuts about 22 minutes from their life span. Smokers shorten their lives by about 11 minutes per cigarette.¹⁸

Additional Health Benefits of Movement

- **Depression**

- “Children who experience symptoms of depression can also suffer from low self-esteem, and ...exercise ... boosts self-esteem as a child discovers that she is capable of doing many different things. Exercise also works to reduce symptoms of depression by improving mood and enabling a child to feel better about life and about herself”.¹⁹
- “A moderate, regular exercise regimen is as successful as a pharmacological treatment of people suffering from depression”.²⁰



Effectiveness of Treating Depression with Exercise

Additional Health Benefits of Movement

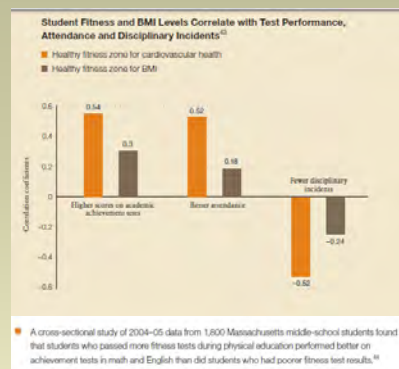
- **For Learning Disabilities**

- “Children with ADHD engaged in less physical activity, organized sports, and reading than their counterparts.”²¹
 - Children with ADHD who participated in three or more sports displayed significantly fewer anxiety or depression symptoms than did those who participated in fewer than three sports.²²
- Children with Autism face “a poor ability to utilize and control muscular systems”, which makes exercise more challenging and even less likely to be undertaken.²³
 - Post physical activity results in positive and significant increases in the amount of appropriate behavior and significant decreases in inappropriate behavior from autistic students.²⁴

Educational Benefits of Movement

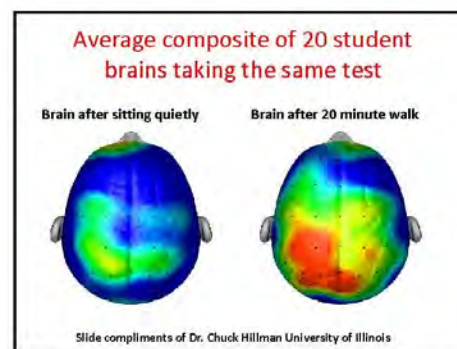
Educational Benefits of Movement

- *Learning is experience. Everything else is just information. Albert Einstein.*
- Physically inactive children have been shown to have lower academic achievement than their physically active peers.²⁵
- Study conducted in New York City of “more than 600,000 students in grades K to 8 found academic tests scores increase with physical fitness scores”.²⁶
- More than 2.4 million Texas students in grades 3 to 12 found students fitness and BMI levels correlate with academic test performance.²⁷



How Movement Benefits Education

- Changes that take place in the brains of active children; those who are more fit tend to have a larger hippocampus, an area of the brain that impacts memory and learning²⁸
- In addition, “Rhythms in the brain that are associated with learning become stronger as the body moves faster.”²⁹
 - “The gamma rhythm, a fast signal that occurs while concentrating or learning, gradually grew stronger as the mice moved faster”.



Educational Benefits of Exercise

- Centers for Disease Control and Prevention reports: “Collectively, eight of the nine studies reviewed suggest that classroom-based physical activities may have favorable associations with indicators of cognitive functioning, academic behaviors, and/or academic achievement. Furthermore, there was no evidence that allotting classroom time for these activities was negatively associated with academic achievement”.
- Time on Task, or academic engagement, which was shown to be a key predictor of academic success, was substantially increased for sedentary lessons directly following active lessons.³⁰
 - Specifically for overweight children TOT increased from 58% following sedentary activity to 93% following an active lesson.

Benefits for Special Needs Students

- Assessments specifically examining the results of Active Learning for students suffering from ADHD or ASD showed positive gains.
 - This group improved both their Reading scores as well as their Math scores significantly after participating in the program.³¹
- This can be partially explained by the fact that among least on-task students, activity breaks improved on task behavior by 20%³²
- All children became more active during a test in which they were required to remember and manipulate computer-generated letters, numbers and shapes. However, children with ADHD became significantly more active.³³
 - For these children this movement has been shown as their way of staying alert and engaged in an activity, as a means to stay focused.

Kinesthetic Learning

- Kinesthetic learning occurs as students engage a physical activity: learning by doing, exploring, discovering.
- Although only ~15% of the population is strongly aligned with a kinesthetic learning style preliminary research has shown that kinesthetic learning results in increased learning outcomes for all students.

Kinesthetic Learning

- Kinesthetic learners need to move around and work manually with ideas.
 - Touch, Smells and Textures are important.
 - Have difficulty sitting still in class just listening.
 - The more activity experienced while completing a skill, the better they learn it.
 - The more skin and muscles used, the better remembered.
 - Even small motions that seem unrelated to the activity such as swing a leg, drawing, or knitting help them understand ideas.
 - They learn best by doing or experiencing something. The more senses they can involve in learning, the better they will remember it.

Distracted Learning

- Studies indicate that the inattention of students to schoolwork increases with the length, familiarity, and repetitiveness of a task.³⁴
- An activity that uses a sense other than that required for the primary task can enhance performance especially in children with ADHD.
 - Doing two things at once focuses the brain on the primary task.

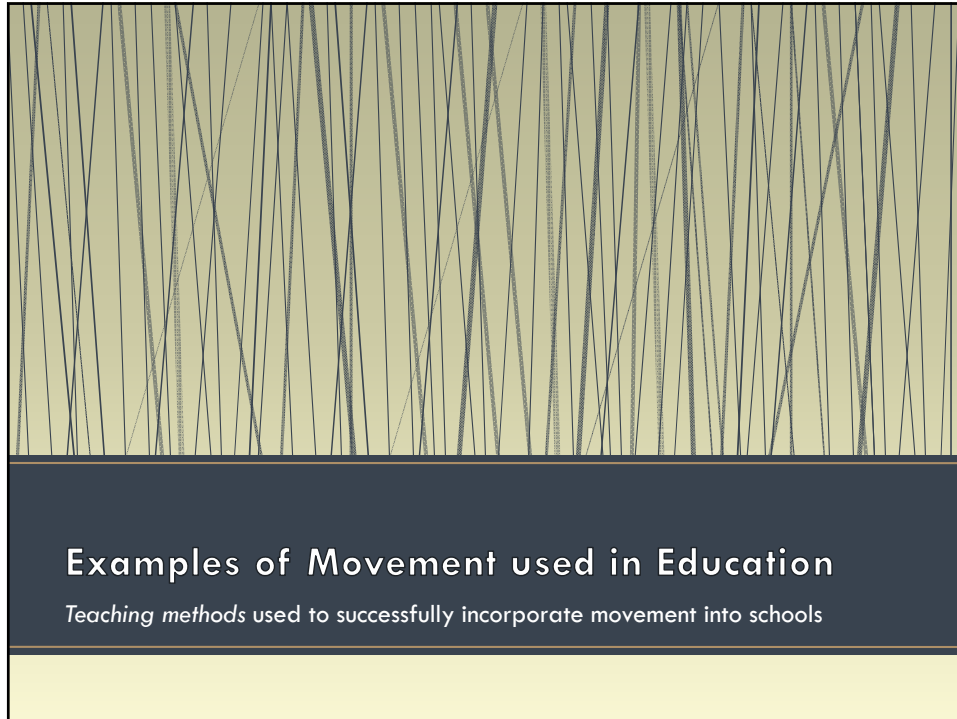
Learning while Fidgeting

- These movements could also be called “fidgeting”.
- Studies suggest that for children with ADHD or Autism fidgeting is a way to help them focus their attention, "Unless their behavior is destructive, severely limiting their activity could be counterproductive."³⁵



Educational Benefits of Exercise

- National Association for the Education of Young Children recommends in their 2009 positions paper that “The daily schedule provides a balance of rest and active movement.”
- Therefore, “Practitioners (need to) design and maintain the physical environment...specifically in support of young children’s physiological needs for activity, sensory stimulation.”



Examples of Movement based Education

Areas that are strongly influenced by design, as shown in the ITBS.

	Reading comprehension	Reading vocabulary	Language arts	Math	Social studies	Science
Movement and circulation	X		X	X		X
Day lighting		X				X
Views		X	X	X		

Source: C. Kenneth Tanner, Effects of school design on student outcomes, Journal of Educational Administration, Vol. 47 No. 3, 2009, pp. 381-399

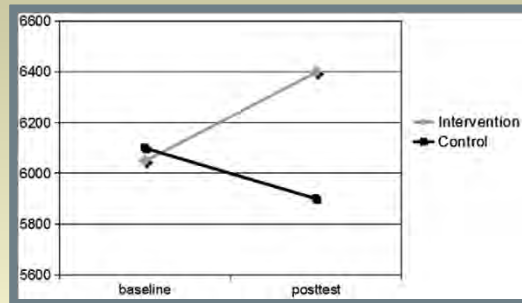
- **How teachers are embracing movement in teaching:**
 - Elementary schools unique in that children do not have “behavioral control” therefore non-discretionary time can be used to “compel activity”.
 - Some teachers are embracing this idea by encouraging students to stand, stretch, even do jumping jacks or other cardiovascular exercise between lessons.
 - Yoga has been successfully shown to improved students' behavior, physical health and academic performance, as well as attitudes toward themselves.

Examples of Movement based Education

- Although this approach is beneficial to health as well as learning, it is possible embed movement into learning, for the further benefit of both as shown in school-based studies on the academic benefit of movement.
- Take 10! – Program that promotes learning within 10 minute intervals of exercise.

- Cardiac Relay
- Spelling Freeze Tag

Change in average steps/day between the Texas I-CAN! intervention schools with active, academic lessons and control schools with traditional, sedentary lessons.



Source: John B. Bartholomew, Esbelle M. Jowers. (2011). Physically active academic lessons in elementary children. *Preventive Medicine*, 52, S51–S54.

Examples of Movement based Education

- Follow-up data comparing tests scores illustrate the effectiveness of the Take 10! learning methods.
 - Florida students participating in the study showed a “significant improvement” in math scores within the Florida Comprehensive Achievement Test (FCAT).
 - Kansas study, “Significant improvements in academic achievement from baseline to three years were observed... for the composite, reading, math, and spelling scores”.
 - Texas also showed similar improvements in math skills.

Examples of Movement based Education

- When teaching about verbs have students “act out” the word.
- Assign different movement types to different types of letters or words
 - Examples for a Language Lesson:
 - consonants - 5 jumping jacks
 - vowels - 5 toe touches
 - nouns - 5 raise the roofs
 - verbs - 5 push ups
 - adjectives - 5 squats
- Teacher calls out one of the words from the lesson.
 - For example, if teacher says “b”, the students must do 5 jumping jacks.
- This lesson can be adapted to be used in other subjects.
 - MATH - Assign numbers instead of word types and have the students move based on whether the number is odd or even, whole, decimal or fraction, tens, hundreds or thousands, a square root or not, or it is divisible by a particular number.
 - SCIENCE - Assign animals, plants, simple machines, weather or types of rock instead of word types.
 - GEOGRAPHY - Assign movement types to North, East, South, and West. Call out a state or country and have the students move based on where the state or country is compared to their current location.

Possible Problems

Especially if not designed for

Unless utilizing incidental methods must have Teacher Engagement

- While many elementary school teachers are aware of the impact of exercise on learning, few seem able to incorporate them into their daily class plans.³⁶
 - Study on the application of the Take 10! plan in participating schools revealed that only 37.5% of implemented the activities 3 or 4 times a week, despite the fact that 86% of the teachers agreed that the activities helped the students focus.
- Studies have cited “lack of planning time and available resources” were a significant barrier to implementation.

Classroom size and configuration could be considered one of the lacking resources

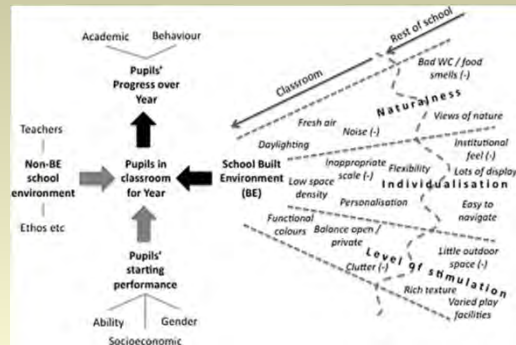
- Rooms/furniture are not designed to allow for or encourage movement
 - Rooms traditionally designed to allow for “lecture based” learning
 - Furniture too restrictive, static
 - Not designed to address issues of:
 - Allowing for movement without creating a distraction
 - Accommodate reading and writing while moving
 - Ease of transition from moving to sitting
 - How to indicate boundaries, keep students within their space.



Importance of School & Classroom Design

- Changes in education delivery not only affect students and teachers, they also affect classroom design.
- “The building is a facilitator — an incubator where teaching and learning happens”.
- Study conducted within 7 elementary schools in the UK showed the influence of the classroom environment on academic and behavioral progress

Source: Peter Barrett, Yufan Zhang, Joanne Moffat, Khairy Kobbacy, A holistic, multi-level analysis identifying the impact of classroom design on pupils' learning, *Building and Environment*, Volume 59, January 2013, Pages 678-689



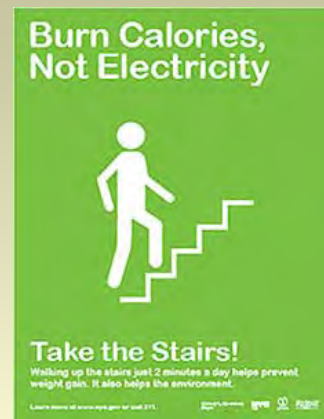
Designing to Allow for or Encourage Movement

Physically Active Design

- Architectural principle of creating spaces that encourage movement and exercise.
- Rick Bell, the executive director of the New York chapter of the American Institute of Architects states:
 - “There is a direct relation between the built environment and people's lifestyles. Although this current crisis may seem an insurmountable problem, and beyond the scope and reach of design, it must be remembered Architecture was successful in defeating infectious diseases such as cholera and tuberculosis in the 19th and 20th centuries.” This was done “by designing better buildings, streets, clean-water systems and parks. Today, obesity is the threat.”³⁶

Designing to Encouraging Stair Use

- Stairs have an obvious energy expenditure benefit for students and their use could be encouraged through the building's design.
- Calling attention to existing stairs
- Stair usage can be encouraged by
 - Placing signage by elevators reminding students of the benefits of utilizing the stairs
 - Locating signage at top of each flight of stairs indicating the number of calories utilized or other health or environmental benefits gained by climbing the stairs



Designing to Encouraging Stair Use

- **Creating new stairs**
 - Located in a prominent and highly visible area of the building
 - A recent study of stair use vs. use of elevators indicated the main determinates for stair use were: “effective area or occupant load of each stair, area of stair isovist, and number of turns required for travel from the stair to the closest entrance.”³⁷
- **Egress stairs**
 - “Code-mandated fire separations are traditionally achieved by encasing stairs in opaque masonry or gypsum board assemblies with solid metal doors. However, alternative assemblies, materials, and systems are available that allow egress stairs to be more visible while meeting code requirements for fire resistance ratings.”

Designing to Encouraging Stair Use

- **Egress Stairs, cont.**
 - Can be made more visible by incorporating:
 - Fire-rated glass enclosures
 - Open stairs between two or more floors with either the same or associated tenancies.
- **Simultaneously elevator use can be reduced by**
 - Relocating them away from the main entrance or primary circulation space within a building
 - Slowing the speed of the elevators to decrease their convenience.
 - This final suggestion could be utilized in existing building renovations in which the relocating of the elevators is structurally or financially unfeasible.



Schools Utilizing Physically Active Design


Exterior Rendering



- From New York City's Active Design Guideline:
 - "The task of creating activity-friendly buildings largely depends on the integration of active design philosophies into the building's circulation systems—especially its stairs and elevators—and its program."
- The New School's University Center, New York designed by Skidmore, Owings & Merrill
 - The University Center, slated to open in January 2014, incorporates active design elements through its large, showpiece staircases, visible from the street, which encourage not just physical activity, but cross-divisional conversations and collaborations.

Schools Utilizing Physically Active Design



- New York University Sterns School of Business, Perkins + Will
 
- University Of Toronto Mississauga Instructional Centre; Mississauga, ON, Perkins + Will

Other Means of Encouraging Stair use

- The “Fun Theory” Staircase
 - Subway Station, Stockholm
 - Sponsored By Volkswagen, Sweden



Other Means of Encouraging Activity through Design
Ramps

- Tado Ando – Omotesando Shopping Center, Aoyama, Japan
 - Corridor Ramps



Other Means of Encouraging Activity through Design

Increasing Circulation

- Greensburg Schools, Greensburg, KS
- Designed by BNIM, Kansas City
- Single-loaded corridors
 - Increase walking within building
 - Counter-intuitive to designer and architects who are “trained to look for the most efficient solution for any programmatic problem.”



LOWER FLOOR PLAN

Schools Utilizing Physically Active Design

- Buckingham Elementary School in Dillwyn, VA
 - Designed by: VMDO Architects
 - “Enhanced programming includes a teaching kitchen, innovative food and nutritional displays, an open servery to promote demonstration cooking, a food lab – small group learning lounge, scratch bakery, dehydrating food composter, ample natural daylight, flexible seating arrangements, and outdoor student gardens.”



Artist rendering of open kitchen and co-located teaching kitchen.

Schools Utilizing Physically Active Design

- **Buckingham Elementary School in Dillwyn, VA**
 - “Each grade level enjoys age-appropriate outdoor gardens and play terraces, which encourage children to re-connect and spend time in their natural surroundings. Inside the schools, in addition to core classrooms, each grade level has small group learning spaces that transform circulation pathways into child-centric “learning streets.” These spaces are intimately scaled with soft seating and fun colors that communicate both collaborative and shared learning experiences.”



Integrated school garden and outdoor eating spaces

How existing design is responding summary

- **Architecture**
 - Focus on:
 - Stairs
 - Corridors
 - Healthy Eating Habits
- *Not focused on changing classroom design to respond to new educational strategies encouraging movement.*

Furniture

- There have been several recent designs of student chairs that allow for non-disruptive movement.
 - MOVE stool designed by Varier
 - This stool was selected to be used in studies conducted by the University of Central Florida regarding the benefits of fidgeting - initial data indicates a positive response on the children's' learning.

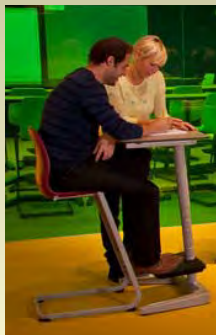


- Sivan Health and Fitness Balance Fit Chair



Furniture

- Vanerum Stelter - Chairs that encourage movement.
 - Chairs are made of plastic with a hollow core that has sway, waterfall edges that don't pinch the legs and narrow backs that make it easier for torsos to twist and turn.



Furniture

- **Fidget chairs** - There have been several recent designs of student chairs that allow for non-disruptive fidgeting.
 - Virco Company has introduced 2 lines of chairs, the Sage and Zuma lines, that feature cantilevered frames that allow rocking.



Furniture

- **Standing desks**
 - Standing appears to provide a 5–15% greater flow of blood and oxygen to the brain, thereby creating more arousal of attention.
- **AlphaBetter**
 - Designed by an elementary school teacher after witnessing her students struggles with staying seated for extended periods of time.
 - Includes swinging footrests



Other Furniture Being Used in Classrooms to Encourage Movement

- **Treadmill desks**
- **Stationary Bike Desks**
 - FitDesk — essentially an exercise bicycle, attached to a laptop stand.
- **Either could be linked via iPad or tablet to topic being discussed and/or to teachers presentation**
 - “that’s this Generation’s world... I knew that to engage students in becoming more physically active I had to incorporate technology”



Allowing Movement in Classrooms

- **“Fidgets”**
 - Allows “active learners” to move to maintain focus while learning.





Designing spaces in classrooms to allow for movement

- The consequences of high-density conditions that involve either too many children or too little space are: excess levels of stimulation; stress and arousal; a drain on resources available; considerable interference; reductions in desired privacy levels; and loss of control.
- Larger classrooms could:
 - Allow students to stretch, exercise adjacent to desk.
 - Incorporate changes in floor levels into room design, allowing for use of stairs and ramps and creation of separate learning areas.
 - Allow for divisions in classroom to have “active zones”.

Designing spaces in classrooms to allow for movement

- **Designing classrooms to accommodate zones:**
 1. Enclosed or private work zone
 - Study carrels or partially enclosed seating to accommodate students distracted by movement, or those needing a break.
 2. Active work zone
 - Containing active furniture such as:
 - Standing desks
 - Fidget desks or chairs
 - Exercise Equipment/Desks
 3. Group work zone
 - Area that would allow students to push desks together or work at large tables.
 4. Movement zone
 - Area that allows students to move freely while learning, see Take 10! examples, and engaging large muscle groups.

Enclosed Work Zone

- **Study Carrel**
- **Cocooned Seating**
 - Could allow for concentrated work
 - Fabric swinging cocoons allow for sensory input frequently needed for students with ADHD or ASD

Cuddle Swing



Gaylord Furniture



Vitra's Cocoon Chair

Active Work Zone

- **Dividing Existing Classrooms into "Activity Zones"**
- **Movable Furniture**
 - Stackable chairs that can easily create open space
 - Lightweight tables and chairs
 - Furniture with wheels
- **Smaller desks**
 - Not only to allow exercise adjacent to desk but to have adequate space between desks to prevent distraction caused by fidgeting



Example of classroom containing Active Work Zones.



Steelcase Node

Group Work Zones



- **Group Study Furniture**
 - J. P. Jay & Associates
 - Smith Systems



Movement Zones

- **Ramp Used within classroom**
 - Could be used with the active learning exercises challenging the students to run up the ramp to write the answer of a given problem on a mounted white board.
 - Area below ramp could be utilized for an enclosed “private” space or additional storage.
- **Alternatively, a series of ramps could be placed in the corridor just as an alternative circulation path.**
 - In single level schools where stairs are not an option, the use of ramps in previously level corridors could benefit students health.



Conclusion

Designing learning environments that encourage movement in education for the students who can't stay still or the many others that shouldn't.

- Current Condition of schools do not support movement
- Health of children demands additional movement
 - General Health
 - Obesity
 - Depression
 - Learning Disabilities
- In addition, movement has been shown to benefit education
- Educators have embraced idea, but existing classrooms limit implementation
- Although there are some existing schools and furniture designed to address this issues, there are many more opportunities. For further design and innovation

Designing learning environments that encourage movement in education for the students who can't stay still or the many others that shouldn't.

- There are many existing systems in place for testing effectiveness
 - Test scores
 - Absenteeism
 - Health/weight

Endnotes

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