Ergonomics Programs for Schools: Challenges and Opportunities

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With thanks to Kathryn Lasseter, Shawn Oates, Prof. Gary Evans & Prof. Lorraine Maxwell.

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Presentation Content

- Computer use in schools
- Children and computer use - issues + research evidence
- Implications and future action

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Conceptual Framework

- Latency
  - Mass computerization of the office in the 1980s is associated with the MSD issues in the 1990s
  - Mass computerization of the schools in the 1990s...
- Children as small adults (biomechanically)
- Lifelong habits
  - Learning good posture and work habits requires the same effort as learning poor posture and work habits.
- Healthful computer use
  - Promote healthful ways of working with computers.
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U.S. Schools 2001

- 45 million students attend schools.
- ~86,000 public schools.
- The number of students is growing, up 9% since 1990.
- The Department of Education estimates that 2,400 new schools will be needed by 2003.
- Average age of the nation's schools is 42 years.
- Schools welcome computers in an attempt to raise performance.
- School technology plans focus on the technology. Ergonomics is seldom on the 'radar screen'.

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U.S. Schools Report

(American Society of Civil Engineers, 2001)

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U.S. Schools Repairs Report: D- Grade

- 75% of schools need repairs.
- Total budget need = $268 billion.
- Average repairs per school = $2.3 million ($3,800 per student).
- Where considered, ergonomics is seen as another cost.

Professor Alan Hedge, Cornell University, 2001.
Computers in Schools

- Rapid proliferation of computers.
- Computer use in schools inevitably is increasing.
- Goal of ubiquitous computing.
- Competing budget constraints.
- Primary focus on hardware and networking.
- Secondary focus on software and curricula.
- Teaching training/technology integration lags.
- Laptop increasingly favored over desktops.
- Physical ergonomic issues seldom considered.
- Computer ergonomics is a lifelong skill (Larson, 1999).
- Tomorrow's workers are in today's schools.

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Research Issues and Studies

- Risk Factors and Exposure
- Ergonomic Design Research
- Ergonomics Information Research
- Ergonomics Programs Research

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Computers in Schools

(Coley, ETS, Policy Information Center, 1999)

- 98% of all schools own computers
- 4.4 million computers in classrooms
- Current average student-to-computer ratio:
  - 11:1 – Elementary schools
  - 9:7:1 – Junior High
  - 8:4:1 – Senior High
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Computers in Schools  
(Coley, ETS, Policy Information Center, 1999)

- 85% of schools have multi-media computers (MMC) [Keyboard + mouse]
- Current average student-to-MMC ratio is 24:1 (range 9:1 – Florida to 63:1 – Louisiana).
- US Dept. Education currently recommends a ratio of 5:1

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School Computers use by Children  
(Coley, ETS, Policy Information Center, 1999)

- Daily computer use in schools:
  - 4th grade – 9%
  - 6th grade – 10%
  - 12th grade – 19%
- Computer integration into the curriculum (work, games)
- Internet access
  - 1998 - 51% schools
  - 1999 - 89% schools
- One computer per desk policies

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Computers use by Children  
(AOL & Roper Starch, 1999)

- Computers in schools and homes.
- 1-3 hours per day computer use and growing.
- 43% of 9-17 year olds prefer web surfing to watching TV.
- Average on-line days per week:
  - 9-11 years old - 3 days/week
  - 13-17 years old - 5 days/week
- Internet:
  - Rookie average 6.6 hours/week
  - Experienced users (>3 years) average 10.5 hours/week
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Computer Use by Children
(AOL Canada, 1999)

- ~5 million children <12 years old use the Internet
- By 2002, ~20 million children <12 years old will be using the Internet

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Lifelong Computer Use
(Berenter, Greenhouse & Webster, + Fortress Group, 1999)

- Survey of 162 children 9-12 years, 6,000 children 10-17 years old.
- Children who use the Internet > 3 times/week spend only 65% time reading compared with non-users.
- Internet savvy kids score more 'A's in school, but do worse in spelling, punctuation and grammar.
- At present rates, during their lives children will spend >2 years on e-mail.
- At present rates, during their lives children will spend at least 23 years on the Internet.

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Technology Integration In Schools

- School Technology integration plans typically do not address ergonomic workstation design issues

- Typical Technology Plan (e.g. ICSD, 1995)
  - Teacher training
  - Updaging building infrastructure (power, network)
  - Hardware and software acquisition

- United States Congressional Study (1995)
  - “America’s Schools not designed or equipped for the 21st Century”
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Computer Use Issues
- How much do children use computers in schools in 2001?

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Ergonomic Design Questions
- How should computer workstation design be addressed in school technology integration plans?
  - What is the impact of computer workstation design on a student's physical well-being?
  - What is the impact of workstation design on the effectiveness of computer use?

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Risk Factors and Exposure:
How are children working at computers?
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Neutral Work Posture

- Upper body posture
- Back supported by chair
- Feet firmly on surface
- Head balanced on neck
- Popliteal angle >90°
- Upper arms relaxed close to body
- Elbow angle >90°
- Wrist neutral (~15°)

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Children’s Posture at Computers

(Oates et al., Computers in Schools, 14, 55-63, 1998)

- 95 elementary school children (46 boys, 49 girls)
- Grades 3 through 5 studied
- Ages 8.5 – 11.5 years
- Approx. equal numbers at the 5th, 50th and 95th percentiles for stature
- Urban, suburban and rural schools studied

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Research Procedure

(Oates et al., Computers in Schools, 14, 55-63, 1998)

- Children evaluated in their typical computer work area
- Children evaluated while working on a novel text-writing task
- Workspace dimensions and layout recorded
- Posture evaluated using the Rapid Upper Limb Assessment (RULA) method
- RULA measures taken after 5 minutes of work
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**Workstation Dimensions**

(Oates et al., Computers in Schools, 14, 55-63, 1998)

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Recommended</th>
<th>Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Keyboard height</td>
<td>21.5 – 24&quot;</td>
<td>22.5 – 24.5&quot;</td>
</tr>
<tr>
<td>Monitor height</td>
<td>18 – 20&quot;</td>
<td>17.4 – 18.2&quot;</td>
</tr>
<tr>
<td>Backrest height</td>
<td>26 – 30&quot;</td>
<td>26 – 32.5&quot;</td>
</tr>
<tr>
<td>Seat pan width</td>
<td>12 – 15&quot;</td>
<td>11.8 – 13.5&quot;</td>
</tr>
<tr>
<td>Back seat angle</td>
<td>90 – 120°</td>
<td>90 – 100°</td>
</tr>
</tbody>
</table>

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**Interpretation of RULA Scores**

- (1-2) Posture is acceptable if it is not repeated for long periods of time.
- (3-4) Further investigation is needed and changes are required.
- (5-6) Further investigation and changes are required very soon.
- (7) Further investigation and changes are required immediately.

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**Overall RULA Results**

(Oates et al., Computers in Schools, 14, 55-63, 1998)
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RULA: ‘At Risk’ Body Segments

(Oates et al., Computers in Schools, 14, 55-63, 1998)

<table>
<thead>
<tr>
<th>Body Segment</th>
<th>Grade 3 (%)</th>
<th>Grade 4 (%)</th>
<th>Grade 5 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Back</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wrist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leg</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Research Conclusions

(Oates et al., Computers in Schools, 14, 55-63, 1998)

- Children working in ‘at risk’ postures:
  - Keyboards too high
  - Incorrect keyboard angle
  - Monitors too high
  - Legs dangling
- Short duration of computer work
- Marked lack of attention and commitment to consideration of ergonomic issues in schools

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High School Students

(Deutsch, 2001)

- 509 students: 311 boys; 198 girls.
- Where is pain felt after computer use:
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Ergonomic Design Research

How ‘ergonomic’ are different hardware and furniture designs?

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Risk Reduction:
Ergonomic Interventions for Better Posture?

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Improving Workstation Ergonomics


- Tested effects of computer workstation design on:
  - Posture
  - Task performance
  - Engaged behavior
  - Preferences
- Studied keyboard and mouse use
- Compared conventional and tiltdown keyboard arrangements
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Research Design
- 58 middle school children tested:
  - 30 6th grade students
  - 28 8th grade students

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Research Design
- Keyboarding and mousing tasks
  performed under two conditions:
  - desktop arrangement
  - tiltdown keyboard system

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Experimental Measures
- Posture
  - RULA method
- Performance
  - computer program for each task
- Engaged Behavior
  - video tapes
- Preferences
  - interview
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6th Grade: keyboard use


- 6th grader using the keyboard on the table top set at the height of the school computer surfaces.

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6th Grade: keyboard use


- 6th grader using the keyboard on a tiltdown tray system.

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6th Grade: mouse use


- 6th grader using the mouse on the table top set at the height of the school computer surfaces.
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6th Grade: keyboard and mouse use

6th grader using the keyboard on a lowered platform.

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8th Grade: keyboard and mouse use

8th grader using the keyboard on the table top set at the height of the school computer surfaces.

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8th Grade: keyboard and mouse use

8th grader using the keyboard on a tiltdown tray system.
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8th Grade: keyboard and mouse use

8th grader using the mouse on the table top set at the height of the school computer surfaces.

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8th Grade: keyboard and mouse use

8th grader using the mouse on a lowered platform.

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8th Grade: keyboard and mouse use

Tall 8th grader using the keyboard on the table top set at the height of the school computer surfaces.
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8th Grade: keyboard and mouse use

Tall 8th grader using the keyboard on a tiltdown tray system.

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8th Grade: keyboard and mouse use

Tall 8th grader using the mouse on a lowered platform.

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Posture

Results confirmed that seated posture improved when the workstation had the adjustable tiltdown system:
- keyboarding (p<.001)
- mousing (p<.001)
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Posture Improvements

Keyb oard Use

<table>
<thead>
<tr>
<th></th>
<th>Upper arm</th>
<th>Forearm</th>
<th>Wrist</th>
<th>Trunk</th>
</tr>
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<tbody>
<tr>
<td>Conventional</td>
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Posture Improvements

Mouse Use

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Performance

- **Typing performance**
  - small but significant decrease with Ergonomic arrangement (<1%; p<.001)
  - likely can be overcome with practice
- **Mousing performance**
  - small but significant improvement with Ergonomic arrangement (3%; p=.018)
  - may be due to change in posture or possibly improved mouse pad surface
Limitations of the Study


- Implications limited to immediate effects of the workstation
- Students all from the same school
- Unequal number of males and females
- Self-selection – volunteer sample
- Normal ability children
- Desktop computer

Ergonomics Information Research

- How effective is currently available ergonomics information?

Ergonomics Programs Research

- "Get Techfit" program – Blackwell Elementary School, WA and Cornell University.
  - Classroom instruction on computer ergonomics
  - Class exercises on computer ergonomics
  - Parent booklet on computer ergonomics
  - Web-based program information
  - Teacher commitment (Diane Tien)
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Good or bad?

- What is right or wrong with these pictures?

Extract from an Ergonomics slideshow prepared by children for children at Blackwell Elementary School, WA.

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Laptop Computers in Schools


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Future Research and Actions
Ergonomic Issues

- Children's Posture
- Children's age
- Computer design
- Furniture design:
  - Desktops
  - Laptops
  - Laptop Weight
  - Backpack design
- School and home use
- Effective Ergonomics Information
- Effective Ergonomics Education

Ergonomic Design Issues

- Environmental conditions for computers:
  - Lighting
  - Ventilation (heat, IAQ)
  - Cable management/electrical fields
- Furniture for computer work:
  - Workstations
  - Monitor height
  - Keyboard tray
  - Mouse platform
  - Document holder
  - Chair
- Layout for computer work:
  - Workstation layout
  - Classroom layout

Future Agenda

- Intensify efforts to promote public awareness of the importance of Ergonomics in school and home computer use.
- Promote professional awareness of classroom ergonomics issues.
- Provide effective Ergonomics education information for schools and parents.
- Define effective Ergonomic designs for hardware, software and furniture.
- Continue encouraging professional initiatives for IEA/HFES to promote Ergonomics in Schools.
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Our Responsibility?

It is our responsibility to protect future generations against known injury risks, and to ensure that our children acquire good lifelong skills based on sound ergonomics practice.

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Cornell Ergonomics Web

http://ergo.human.cornell.edu