Changing education ergonomics

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Abstract. Information technology has been changing the implements of education. Young students are being exposed to ergonomic risks related to this change as they transport and use these tools. Furniture, computers and backpacks are putting students at risk and they receive little training about these hazards. Elements of education that pose a risk to students are presented. Potential changes to educational ergonomics are discussed.

INTRODUCTION

Until recently the basic ergonomics of education were relatively stable for centuries around the world. Print technology and socioeconomic factors influenced the availability of information. Information was transmitted orally or distributed as printed material. Now computers are present in almost every school in developed countries and are rapidly becoming more common in most countries.

Classroom activities, homework and transportation of study materials have increased the ergonomic risks to students. However, widespread education has not been informing students, teachers or parents about these risks. New approaches to the ergonomics and technology of education are needed to reduce the risks and ensure children are not denied the opportunity to become productive members of the next generation.

CURRENT ELEMENTS OF EDUCATION

Seating

Students spend most of their time in school seated in some manner. The seated posture allows the attention to be focused on external or internal stimuli while the body is supported and relatively relaxed. In Western cultures students have traditionally been seated in a chair. When assumed for long periods of time, however, the standard chair-seated posture puts considerable stress on the lumbar spine (Parcells, et al., 1999). The sitting position has been found to be the most toublesome situation in connection with low back pain (Balague, et al., 1988, Troussier, et al., 1994, Troussier, et al., 1999). Yet researchers have observed young children remaining seated more than 60 minutes in any 90 minute period (Storr-Paulsen and Aagaard-Hansen, 1994). Most of the furniture found in classrooms is not designed or suited to the anthropometric dimensions of the students. Many, if not most, students have been found to sit in mismatched chairs at desks or tables that are not ergonomically suitable (Oates, et al., 1998, Parcells, et al., 1999). Even when the furniture is adjustable it is often not adjusted (Bennett, 2001).

Seating comfort has been found to have an effect upon "on task" behavior in class (Knight and Noyes, 1999). It is easy to imagine that pain and discomfort have an impact on the ability of students to focus on learning. Sitting in mismatched furniture may also contribute to or aggravate back problems.

Figure 1: Student using non-adjustable furniture during computer session in an elementary school

Information technology

Computers have been introduced into the school environment with minimal accommodation in terms of furniture. Commonly computers have been placed upon existing tables and desks within the classroom, in a computer laboratory or in a library. Funds designated for the purchase of computers have either been restricted from purchasing furniture or schools have chosen to purchase computer hardware and software rather than furniture (Bradley, 2001, Straker, et al., 2000). Students have been observed to adopt even more static postures when involved with computer-based lessons than when engaged in other types of lessons (Murphy and Buckle, 2002) thus making the impact of chair sitting even greater.

Not only are children using computers in the classroom, they are using them at home as well. In the home, furniture designed for adults is standard. The range of ergonomic issues such as the computer station (adequate space, chair, keyboard and monitor height), visual and vision issues, and the environment are not likely to be optimal for a child. When evaluated in the classrooms for students 15 to 17 years in Canada and Australia, visual and individual workspaces were consistently rated low (Zandvliet and Leon, 2001). The areas where adults use computers in the home would likely receive low ratings and if rated for children would be lower.

Laptops and personal digital assistants (PDAs) are further blurring the distinction between information technology introduced within the school setting and electronic device activities conducted elsewhere. A technology consultant estimates that about 15% of school districts in the U.S. have some kind of laptop initiative (Corcoran, 2002). Entire school districts are vying to equip students with laptops or PDA-type hand-held computers for students to use for assignments and to take home. A representative of the State of Maine reports that laptops are being provided for all seventh graders in Maine in 2002.

For laptop computers designed with the screen attached to the keyboard, the monitor is too low when the keyboard is at a comfortable height encouraging neck flexion. (Harris and Straker, 2000). If an external keyboard, monitor and pointing device are used, the laptop can be adjusted into what is considered an ergonomic configuration. However, the portability feature is compromised. Laptop

screens are often reported to be difficult to see and the liquid crystal display can be more difficult to view than a desktop computer (Saito, et al., 1993).

To date research on the computer environment in the home has largely been based on self-reporting. Estimates of time spent by students on computers have been obtained from large populations in Australia where 314 students age 10-17 years reported a mean weekly use of 16.9 hours at the computer ranging up to 80 hours (Harris and Straker, 2000). Also in Hong Kong where 2110 students from 13-18 years reported a mean 18 hours per week (Subrahmanyam, et al., 2001). Subrahmanyam includes time spent playing on other electronic platforms (e.g., stand-alone game sets such as Nintendo and Sega or hand-held games, such as Gameboy) as "computer games" because:

> Even the distinction between games and the Internet is getting blurry as interactive games can be played on the Internet. With the expected convergence of different media in the near future, assessing the impact of computer technology on children will only get more complex and challenging. (Subrahmanyam, et al., 2001)

The musculoskeletal disorders that desktop computer use has resulted in among the adult occupational population forewarn of the effects of the cumulative time children will spend using computers. Some 60% of students in Australian study reported discomfort associated with computer use (the Hong Kong study did not include comfort data). When laptops have been evaluated, 82% of. Grade 6 students reported discomfort. Early epidemiological studies indicate that children are at least as much at risk as adults (Straker, 2001).

Book bags and backpacks

Information technology is impacting the transportation as well as the use of the tools of education. Around the world many are concerned with the increasing load students carry to and from school in book bags and backpacks (Gill, et al., 1998, Ho and Lee, 2001, Negrini, et al., 1999).

The ages at which students have been found to be carrying the heaviest loads (8-18 years) are the years during which the spine is undergoing sporadic and extreme growth (Grimmer and Williams, 1998). Investigators have found that carrying book bags of 17% of body weight alters posture and gait when walking (Pascoe, et al., 1997).Others have found detrimental affects on lung volume when subjects of this age carry more than 10% of their body weight (Ho and Lee, 2001). Even loads of 10% of body weight may lead to a variety of musculoskeletal complaints (Grimmer and Williams, 1998). A study in Milan found the average load to be 22% of body weight for 11.6 year students (Negrini, et al., 1999).

The weight of typical books is such that just two or three books can equal 10% of the body weight of younger students (Grimmer and Williams, 1998). Laptops are becoming another element in the loads carried by students. These heavy loads can affect the development of the spine as well as result in musculoskeletal disorders and back pain.

IMPROVING EDUCATIONAL ERGONOMICS

What is needed to improve the ergonomics of education? In an ideal world the above mentioned elements of education would be recognized and countermeasures would be implemented to protect children who are vulnerable to injury and who constitute the future workforce. In reality, budgets,

political forces and inertia assure that change occurs slowly. Thus, a single simple solution is not feasible and only a multifaceted approach can be effective.

In a litigious society legal action can sometimes bring about change most rapidly. An examination of the potential legal basis for lawsuits in the U.S. related to negligence or educational malpractice indicates either assertion would be difficult to maintain. The variance in state law and the difficulty in establishing a successful claim make the possibility of widespread change as a result of lawsuits highly improbable (Bradley, 2001). However, the costs of accommodating students with disabling conditions such as repetitive strain injuries through the 1994 Individuals with Disabilities Education Act (IDEA) could be tremendous. If students are treated in large numbers for such injuries the costs may be enough to cause the federal government to act proactively. The initial investment of federal funds in the high cost of education, training and ergonomically appropriate furniture would ultimately be more cost effective than the "wait and see" approach (Bradley, 2001).

Education of teachers, students, parents, school administrators and politicians is essential. Students need to be educated to appreciate how activities like playing computer games, carrying a backpack or sitting for long periods of time can affect their bodies. Their future career and potential could be limited by debilitating repetitive motion disorders, especially if they ignore pain. While several reports of back care education can be found in the literature (Balague, et al., 1996, Cardon, et al., 2001, Cardon, et al., 2000), general ergonomics education has rarely been reported and is not commonly provided. Teachers need to be trained to be motivated and effective in teaching students. Providing training for teachers can involve unions, School Boards and State standards. Federal mandates would provide a shortcut to incorporating new topics into the training agendas for teachers.

Providing ergonomically appropriate furniture for classrooms and learning (computer) stations is an important part of the process. This does not necessarily mean all the old furniture should be thrown out and all new furniture purchased. Inexpensive ways to retrofit existing furniture have been identified (Parker, 1995). In fact providing fewer chairs and allowing more floor sitting during classroom activities may have a beneficial effect for those in Western cultures. Ergonomic information that has been developed for adults and is being applied to children is based upon sitting in chairs (Gurr, et al., 1998). Dramatically lower incidence of back pain have been found among native Indian jungle dwellers who customarily sit on the floor or squat: a reported zero incidence of back pain (Fahrni, 1975). There is a trend toward providing more carpeted areas in classrooms for sitting areas and conducting lessons with children sitting on the floor. This trend should be encouraged.

Reducing the loads students carry in backpacks can be accomplished by either setting limits or reducing the weight of the items they need to carry. When schools accomplish this by purchasing dual sets of textbooks, storage becomes more of problem and the environmental cost of the paper products is untenable. An alternative to textbooks is becoming within the realm of real possibilities with the rapid development of small electronic devices with large memory capacity.

Improving the ergonomics of computing devices is a key element in improving the overall ergonomics of education in this millennium. Innovative measures are needed to create new modes of access to information technology. Children naturally sit or lie on the floor and change position frequently. A survey of school children using laptop computers found they were used in non desk postures 66% of the time (Straker, et al., 1997). New design concepts created by observing the natural activities of children and fitting the technology to them should be sought. If new implements of education could be designed with these postures in mind some of the risks could be reduced. This can serve to make information technology more accessible to all economic and ability levels and to make the

use of technology safer for all. Regardless of the legal basis for lawsuits, it would be criminal to let an epidemic of repetitive motion disorders among children be required for change.

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