Trends in Neuroscience and Education 3 (2014) 81–85

Contents lists available at ScienceDirect

Trends in Neuroscience and Education

journal homepage: www.elsevier.com/locate/tine

Information technology in education: Risks and side effects

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ARTICLE INFO

Keywords:
Addiction
Education
Information technology (IT)
Multitasking
Reading
Writing

ABSTRACT

The use of information technology (IT) in education carries risks and side effects, which are often overlooked or played down. In this paper, examples from the published literature are provided to demonstrate the down-side of IT in education: typing impairs reading and writing. Impaired reading and writing impairs learning and memory. IT leads to shallow processing, exemplified by the smaller amount of learning through the use of Google as compared to books, journals or newspapers. WLAN in lecture halls causes decreased student learning because of increased distraction. Finally, IT causes IT-addiction in a considerable number of students (up to almost 20%). In sum, the known risks and side effects of IT stand in marked contrast to the often claimed but largely unproven possible benefits. Educators and policy makers should take note.

Wherever there are effects, there are risks and side effects. This truism does not just apply to medicine but to any field of human activity. The automobile was a great invention for mobility, but causes obesity by inactivity, injury and death, as well as environmental hazards. X-rays are great for diagnostics but harmful to the body in larger doses. Asbestos works terrific for insulation and fire protection but causes lung disease and death. Burning fossil fuels keeps our economy going but wrecks our climate in the long run. Along the same lines, using information technology (IT) in educational settings – from childcare to the classroom to the lecture hall and beyond – may have benefits but also carries serious risks and side effects.

Let me give an example: early in 2013, Chinese authors published a paper on the reading capabilities of nearly 6000 pupils in grades three, four, and five, using the same tests that were already used 10 and 20 years ago [49]. Back then, the proportion of children with severe reading difficulty, defined as those children who performed two grades below their grade level (i.e., were 2 years behind their peers in their character reading development) while having a normal non-verbal IQ, ranged from about 2% to 8%. In a previous paper, the authors had already shown that the ability to read Chinese is strongly related to a child's writing skills [48]. Unlike in the Western world's alphabetic languages, where the characters represent how an utterance *sounds*, the characters of the Chinese logographic system represent what the utterance *means*. It therefore comes as no surprise that the relationship between phonological awareness and Chinese reading is much weaker than that in western alphabetic languages. What counts in terms of reading development in China is rather the practice of hand-writing a couple of thousand characters and thereby learning their meaning by heart.

Have you ever wondered how people in China use computers for writing? Do they use keyboards the size of a dinner table to represent all their characters? – To make it short: they don't. Instead they type, on regular alphabetic keyboards, how the word sounds (e.g., "li"), let the computer display a list all the possible words that sound "li", and then select the appropriate Chinese character by clicking on it with the computer's pointing device ("mouse"). This method of typing Chinese characters is called *pinyin*. It is highly effective and therefore it is taught in Chinese elementary schools during the second half of third grade.

This increase in "media literacy", as some may call it, however, is accompanied by a marked decrease in reading ability: using similar tests as one and two decades ago, the frequency of severe reading difficulty in the fourth and the fifth grades was found to be above 40% and above 50%, respectively. Quite tellingly, in the third grade reading ability was found not (yet) to have decreased. Additional correlational data obtained on a subsample of children on daily total time spent (still) handwriting, total time using IT in general, and average time using the *pinyin* method established a link between these variables and reading: traditional handwriting significantly increased reading capability, whereas IT use in general and use of the *pinyin* method in particular decreased it.

This study clearly demonstrates that teaching the use of IT in classroom settings can have severe side effects. The authors ([49], p. 1119) correctly state at the outset of their paper: "Written Chinese as a logographic system was developed over 3000 years ago." You may add: it survived entire dynasties and even the "cultural revolution" of the 1950s and 60s – and now 3 months of using educational IT is enough spell doom for this extraordinary cultural achievement. Needless to say, the Chinese government was not

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http://dx.doi.org/10.1016/j.tine.2014.09.002
2211-9493/

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SMILEY	BEDEUTUNG
:-)	Einfaches Lächeln, fröhliches Gesicht
:-))))	Sehr fröhlich oder überglücklich
:-D	Herzhaftes Lachen
:´-)	Zum Weinen glücklich
;-)	Lächeln mit Augenzwinkern
;->	Verschmitztes Lächeln
:-P	Zunge rausstrecken
:-C	Unglücklich
:-(	Traurig
:-((	Ganz traurig
(:-(	Sehr unglücklich
;-(	Weinen
>:-<	Verärgert
:-|	Nachdenklich oder auch gleichgültig
:-/	Skeptisch oder auch unentschlossen
:-o	Erstaunt oder auch schockiert
:-X	Schweigen (verschlossener Mund)
:-*	Kuss

Fig. 1. Cover (left) and sample page (right) of the guidelines for computer and internet use in preschools, funded by the *Austrian Ministry of Education* and the *European Union* ([34], p. 1, 37).

amused learning that more than half of the forthcoming generation is unable to read. It implemented countermeasures such as spelling contests during prime time, reinventing an old US-format, and challenging the Chinese youth to use their scripture.

Those who think this is just a minor problem in China should take note that handwriting has long been known to benefit learning and memory: you write something down and thereby keep it in mind. Recent studies from experimental psychology and neuroscience clearly found this bit of general wisdom to be true: compared to typing, handwriting – with longhand being superior to printing uppercase characters – is superior for memorizing anything from the shapes of characters to the content of a lecture [28–30,32,33]. And just as *handling* things, i.e., coming to *grips* with them, is important for thinking about them later [23], experiencing handwriting is beneficial to brain development [22,46], and the development of fine motor skills in particular [47].

Student writing in general is deteriorating, with ever more internet slang, abbreviations ("lol" for "laugh out loud"), and so called "emoticons" (☺ etc.) found in formal writing such as school work [26], making professors lament about declining writing skills in College Freshmen [12]. In the light of these studies and facts, it is hard to believe that in 2013, handwriting has been eliminated from the elementary school curriculum in 46 US States. It is even harder to believe that children at preschool age in Austria are *taugh* that ":-P" means "sticking out the tongue" (see Fig. 1), i.e., they *have to learn* at a very young age what responsible educators think kids *should not learn* even at an older age!

On top of this, educators must take note of the fact that the internet, computers, tablets, and smartphones have a strong potential to cause *addiction*. In South Korea for example, a nation with one of the most IT use by young people [2], smartphone addiction in the age range of 10–19 years has risen to almost 18.4% by 2012, up from 11.4% in 2011 (data from the South Korean *Ministry of Science, ICT and Future Planning*, quoted in [2]). According to Government data from Germany, the number of IT-addicts is about half a million.

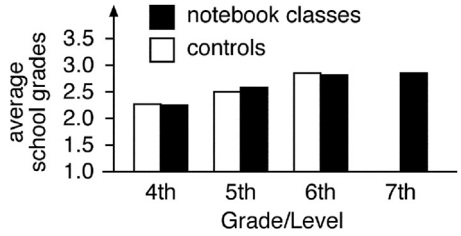

Fig. 2. Main result of the Austrian study on the effects of Classroom computers on school grades (data from [45], p. 48). There is no difference in the average grades (lower is better) of children with and without computers from 4th to 6th grade.

Media representatives, the IT-industry, as well as educational policy makers over and over repeat the statement that computers are good for learning in schools, and therefore, public money should be spent, even though this claim is not supported by any data. For example, data from the international PISA-Study (on no less than 250,000 15 year olds!) show that a computer in the teen's bedroom lowers school performance [16].

In line with as several US studies on the effects of computers on learning in schools [36,39,43,52–54] similar studies in Austria and Germany have demonstrated that computers have – at best – no positive impact on learning (Figs. 2–4), and clearly have distracting effects that hinder learning. Likewise, a study from Israel found computers to hurt performance in elementary and middle schools [1], just as Romanian children of low socioeconomic status, whose families received money to buy a computer, performed more poorly in school than children who did not have computers [31].[1]

Almost 20 years ago, Todd Oppenheimer debunked the belief that computers increase learning as *computer delusion*. For about the same time, the lack of any beneficial effects of the internet on

[1] This study as well as similar experiences from other counties show that the *One Laptop Per Child (OLPC)* initiative may not implement philantropy on a large scale, as claimed by its founders, but instead exemplify a poorly conducted experiment on the risks and side effects of IT in education [14].