

Computers and General Education: a position paper.

(A replacement for EWD867: it turned out that the topic for the panel discussion was not "Computers and Society" but "Computers and General Education.")

At least to me it is not obvious that "Computers and General Education" is a worthwhile topic for a seminar like this. It is not a combination that immediately comes to my mind. If computers have to be part of it, why not "Computers and Bureaucracy"? If general education has to be in, why not "Bureaucracy and General Education"? I even think it could be argued that either of these alternatives is of greater societal relevance. But I shall not do so. Let us try to find out instead the possible significance of the topic as chosen by the organization.

A possible explanation for the choice is that the topic is a fad. That is not a nice explanation, but we cannot dismiss it since also organizers of panel discussions are not exempt from the influence of the media, and the latter really push the idea down our throat. I am not exaggerating. Here is, how, in a column recently published in The International Herald Tribune, Russell Baker describes it:

"WASHINGTON -- Here is a television commercial trying to sell household computers:

In the first shot Mom, Dad and Son are at the quaint old railroad depot. Mom and Dad wave Son goodbye as the train pulls out. Son is off to college to realize the American dream: A future with an expense account and so many tax lawyers that the IRS will never lay a paw on his annual income.

In the next shot the train is pulling into the same depot it just left. Mom and Dad are standing there looking lugubrious, and no wonder. There is Son about to disembark with his luggage. He looks wretched. He has been kicked out of college.

The invisible narrator says the lad lacked the computer savvy needed to pass. Mom and Dad didn't buy him a computer when he was a little boy.

Do you want this to happen to your child? If not, better buy a computer at once. The narrator recommends the computer made by the sponsor."

Evidently, computers are now sold with the same aggressive blackmail as encyclopedias used to be sold with, the education of your children providing

the lever. The analogy might go further: the household computer might turn out to be as helpful and as reliable as the average encyclopedia. The analogy might even contain a warning, since the encyclopedia market collapsed when money became a bit tight and people came to their senses.

Further down, Russell Baker comments:

"The commercial aims to make Mom and Dad feel guilty about the boy's failure. What nonsense. Mom and Dad have nothing to feel guilty about. The boy is so dumb he deserves to be kicked out, and no computer ever made will help him overcome his obvious inability to make a sensible judgement of his situation."

So much for Russell Baker, whom we may classify as someone that entertains grave doubts. If the phenomenon were restricted to television commercials, it would not be too bad, for television commercials are not renowned for their impartial presentation. But it is much worse, since the phenomenon has also intruded into the scientific world. Allow me, in order to show that I am not exaggerating --and to show, in passing, how up-to-date I am on my literature-- to quote from the Computing Reviews, Nov. 1983, in which a new scientific journal is announced. It is called "Machine-Mediated Learning". To begin with we note that, if you have a memory, and if you are linguistically sensitive, that title should make you rather suspicious. We started with "Computerized Instruction"; via "Computer-Aided Instruction" it became "Computer-Assisted Learning". And now it is "Machine-Mediated"..... I can think of only one explanation for such frequent renaming: a new name was needed each time the previous one had lost its lustre. A convincing demonstration that the whole idea of machine-mediated learning is a bloody mistake would certainly be pertinent to that journal's area of interest, but it is very unlikely that such a result would reach the pages of this journal, since its Editorial mentions only one criterion in the evaluation of articles considered for publication, viz. "the extent to which they facilitate the development and utilization of effective machine-mediated learning systems". The conclusion is clear: rather than classifying this journal as scientific literature, we should classify it as propaganda.

So, let us start afresh and ponder as honestly as we can whether the advent of computers --undoubtedly a radical novelty with an exciting potential-- has any consequences for the time-honoured goal of general education. Immediately, this question falls apart into two different ones: does the existence of computers give rise to new possibilities for general education, and causes it new obligation for general education?

Hard questions. Since I deny the existence of experts on general education, I refuse to pose as one myself. The only general education I can talk about is the one I enjoyed myself at the Gymnasium Erasmianum at the age from 12 to 18 years. I enjoyed it immensely and never missed machine mediation because I had never heard of such a thing. Having no complaint at all about my general education, which was pretty thorough by today's standards, I had a hard time thinking of ways in which computers, had they existed at the time, could have helped in achieving what my teachers tried to achieve. Eventually I found one. Suppose that in my school days I had had the full text of Homer on a floppy disk. Homer himself knew that text by heart, but I did not, and as a result I could not answer the question that sometimes came up in my mind when I met an unfamiliar word, viz. "What are the other occurrences of this word? What are its other usages?". Had I had Homer on a floppy disk, I would have been able to get an answer to that question and I might have been tempted to try to figure out that word's meaning myself. As things were, I had to make do with Mehler's Dictionary. Homer on a floppy disk was the only thing I could think of; admittedly it is a meagre harvest, but I am not disappointed since I did not expect to find much.

For the sake of completeness, I mention two other reasons one hears why general education could profit from the introduction of machine-mediated learning, but I tell you in advance that I think neither of them very convincing.

The one argument is one of, say, constant quality. Instead of subjecting the pupils to teachers of wildly varying degrees of competence and incompetence, it is better to give a single excellent course. The investment in such an excellent course would be very high, but it would be worth the trouble if its dissemination can be mechanized and thus will take place unpolluted by the incompetence of the teacher that happens to stand in front of the classroom.

It is an argument, but particularly in connection with general education I find it utterly unconvincing. General education has been defined as what remains after you have forgotten what you learned at school. It sounds as a bon mot, but it is no joke. In order to keep the discussion simple, let us stick to Homer, whose poetry I liked. During my last year at school, before going to sleep I would regularly read a few hundred verses of Homer's poetry before going to sleep, looking up the few words I had missed the next morning. It is a habit I can genuinely recommend for the restless mind. The ability to read Homer without a dictionary and to enjoy it greatly turned out to be extremely volatile: I went to University where I was otherwise engaged and within six months I had lost the ability completely. In a highly knowledge-oriented world, my study of classical Greek should probably be regarded as a waste of time, but I don't do so. If I close my eyes, the images of the scenes Homer evoked in me 35 years ago are as vivid as ever, but, more importantly, I owe to the teachers that taught me Greek, and who happened to be excellent, by virtue of their example that it would be a great idea to become a scholar. In short: the intellectual level of the people educating me made a much more lasting impression than the specific subject matter they taught me. At the University history repeated itself. After these confessions I hope that you are willing to respect that I am not convinced by the supposed virtue of machine-mediated learning that it can compensate for the intellectual limitations of the teachers.

The other argument in favour of the introduction of computers into the educational process --believe it or not, it has been seriously put forward-- is orders of magnitude more fishy. That argument is that the introduction of computers into the educational process requires the design of educational software, and that the unusual explicitness required for that task would be of great benefit for educational science in general. It would force the educationists to make their educational models explicit, etc. This argument treats our schools as the happy hunting ground for the educationists; and for precisely that reason the argument strikes me as eminently ignorable.

In short: for the traditional aims of general education I see very little use of computers. The next thing to ask ourselves is, whether in response to the advent of computers, general education should extend or shift its goals.

I think it should, if we knew how. I shall give my reasons why I think it should, but at the same time these reasons explain why it will be very difficult for general education to meet this new challenge.

A general purpose computer is a device that, under the proviso of limitations of its capacity, can execute any algorithm and can do no more: without algorithm to execute, it does nothing. A computer is in what it can do so simple that, from a logical point of view, it is ignorable. The consequences of its existence are, however, profound.

It means that now all thinkable mechanisms can be implemented by as many specific algorithms, all executed by the same general purpose computer. The fact that now all thinkable mechanisms can be implemented with essentially identical hardware is a major feat of abstraction. We never had a device of such a flexibility, and to appreciate what that flexibility implies, one has to grasp what is meant by "any algorithm". In its great flexibility the computer is without precedent in the long history of devices, and it is so much so that its advent represents a discontinuity in the history of devices. The unprecedented flexibility is a drastic novelty of a qualitative nature; grasping it is a conceptual challenge.

These conceptual problems are compounded by quantitative characteristics of modern computing equipment: storage capacity and processing speed are so huge that what takes place inside a computer at work completely baffles the human powers of imagination. And, when I say "completely" I mean "completely". A simple factor of 10 makes already all the difference; I remember asking a housewife that did not believe that, how many children she had, knowing that she had 6 of them. Then she saw the point. Confront this with the fact for several decades, machines gained a factor of 2 in power each year: that is a factor of a thousand per decade and of a million within 20 years. When what was a gradual difference becomes big enough it becomes an essential difference because the analogies break down.

Most people, though grown-ups perhaps more than young children, try to understand the unfamiliar in terms of the already familiar. They think in terms of analogies, which work if the new thing is sufficiently similar to

what they know already. But if the novelty is drastic enough, the analogies are too weak and people can no longer cope comfortably with the novelty. And such drastic novelty is precisely what technology can inflict on us: it happened with the creation of the atomic bomb, it happened with the invention of the computer and perhaps with the invention of the pill as well.

What could be the role of general education in all this? We should keep in mind that not the computer but the algorithms constitute the heart of the matter. Programming, i.e. the design of such algorithms, is much too difficult to teach to the public at large. Recent experience has confirmed what many of us knew already, viz. that programming is even too difficult for the average mathematician.

There is always the feeling "well, with a little machine and a simple programming language you should be able to show the kids something, shouldn't you?". Regrettably, that is true, and regrettably, showing the kids something is probably precisely what is going to happen. I said "regrettably" because then the kids will get such a misleading experience that it will never clear up the confusion. It is much too similar to the way in which the manufacturers sold their machines by showing to top management in a one-afternoon programming course how simple it all was; and later top management not understanding how they had dug themselves into the hole called "the software crisis". Another reason to regret it, is that the kids will acquire patterns of thought that are deeply inadequate when they wish to become professional computing scientists. At the Universities we foresee that our freshmen will face an increasingly hard job of unlearning, and there is all reason to fear that the introduction of a little bit of programming at school will greatly enlarge our task --which is already considerable now-- of undoing the damage done to the kids at secondary school. Let us be unreasonably optimistic and hope that programming will share the fortunate fate of the General Theory of Relativity, viz. the fate of not being included in the highschool curriculum.

What can general education then do to protect the layman. And among the layman I include the average housewife, child, businessman, mathematician, electronic engineer, politician, and educationist.

I think we should try to make them more immune for all the humbug and

dishonesty in which the world of computing abounds. I believe that that can be done. We should teach them the critical, sceptical reading of advertisements. Advertisements are very significant in two respects: they reveal the manufacturer's perception of his customers' appreciation of his products, and, furthermore, they are for the layman a major source of information.

It must be possible to make even the public at large immune for advertisements such as the recent one that under the slogan "You can't reach the top by being a pencil pusher" suggested that, in order to become vice president, it sufficed to buy one of the company's "Thought Processors".

People should first learn to identify the misleading messages coming from the professional public relations men, viz. the advertisers. This should give them some immunity against more subtle misrepresentation as the one given by the enthusiastic computer user. The trouble with the latter is that he need not be dishonest: he may be a propaganda victim himself.

I refer to the wide-spread, but in general unchallenged, belief that making something "computer-aided" amounts to making it better. (The misery of computer-assisted examinations, better known as "multiple choice" should have cured us, but I am afraid that the lure was too strong.) Under no circumstance the dogma of automatic improvement should be accepted without challenge, for otherwise we would have in no time computerized jurisdiction.

Theses, added to oil the discussion.

Thesis 0. The idea of using computers in the process of general education came from two beliefs, viz. in the usefulness of computers and in the competence of educationists. Both beliefs could very well be exaggerated.

Thesis 1. The introduction of computing science in the secondary school curriculum can hardly be expected to give the layman a balanced opinion about the potential and the pitfalls of computer usage.

Thesis 2. For computing science students, prior exposure to microcomputers is a severe handicap.

Thesis 3. Fascination with the equipment is the hallmark of the amateur.

Thesis 4. The argument in favour of Information Technology that presents wide-spread application of Information Technology as an aid to the democratic process is at least suspect, and probably wrong in the sense that totalitarian regimes have at least as much use for Information Technology. Better than by equipment, democracy is served by the art of debunking. (In this respect, democracy is not alone.)

Plataanstraat 5
5671 AL NUENEN
The Netherlands

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prof.dr.Edsger W.Dijkstra
Burroughs Research Fellow