Changing the Way We Think

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One constantly hears the computer referred to as a tool, as though this were reassurance of some sort. It is reassurance only until one remembers how the tool has shaped the human hand, and notes with a shock that this tool is shaping not the hand but the mind. A tool used as extensively as the computer cannot help influencing how we think.


In my work as computer inservice coordinator, curriculum developer and general adviser to school districts in the United States, I talk each year with hundreds of educators, spanning the range from computer addicts or tentative new users to absolute sceptics. Over the past few years I have become aware of the cliche status of statements like "I’ve realised the computer is just a tool", or "I use the computer just like any other tool", statements which are loaded with much more meaning than their utterers realise, and I have begun to feel quite uneasy.

How did people think about the computer before they decided it was a tool? Maybe we do not have an adequate context within which to assimilate new technologies. Why was the loaded word just included in such expressions suggesting the need to diminish the status of the computer in the speaker’s mind? Why had this realisation of tool status become a cliche so quickly? Obviously a common nerve in educators had been touched. Why the obvious satisfaction in such an apparently simple task of being able to label and categorise something? Did this suggest a paucity or immaturity of ways of talking about computers and our relationships with them? What, if any, is our common socio-cultural context for understanding what tools are? And finally, shouldn’t our consideration of the place of technology in education reach deeper than this artifact level?

Hence my delight in coming across James Dickey’s statement, quoted above, in which he so eloquently reflected my concerns and unknowingly inspired me to pursue my questions about the narrowness of the prevailing context for technology in education.

My reading odyssey is taking me through the fields of philosophy, quantum physics, anthropology, artificial intelligence, linguistics, architecture, cognitive science, history, sociology, literature, political science, science, math, robotics and biotechnology. It has been a delightful journey which has opened up so many new ways of thinking, not the least of which is the conviction that as we work with the integration of computers across the existing school curriculum, we must also spread a wider curriculum net across computers. This context must incorporate a greater awareness of the influence of philosophical, cultural and scientific ideas within which all technology develops.

Our current model of technology in education is endowed with the attributes of the mathematical, computational, rational model which has guided science for the past few centuries, and within which our ubiquitous serial computers were founded over 40 years ago. This model is now being challenged on many fronts:

- the theory of chaos in science and mathematics,
- the notion of complexity in science,
- the recognition of the role of visual thinking in engineering, architecture and mathematics,
- the questioning of the objectivity of the observer in psychology, philosophy and quantum physics, and it seems appropriate to question it with regard to our models for technology in education. In addition to being more aware of these changes within the physical and social scientific research domains, we must also realise that much of the rationale for the incorporation of computers in schools is based upon the now outmoded productivity and accountability principles of Frederick Taylor, rather belatedly borrowed from business and industry. In other areas, the adequacy of the conduit model of language and the information processing model in communication (both digital models) are being questioned by linguists, philosophers and artificial intelligence researchers (Winograd and Flores, 1987).

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ous nature of objectivity, the interaction between micro-analysis and macro-analyses, the nature of error and the role of our everyday understandings (Davies, 1988). These topics have in turn been considered by researchers in areas such as perception and philosophy (Churchland, 1988; Gregory, 1981; Winograd and Flores, 1987)

Thus, as we move computers more into the science area, using them as instruments to sense conditions, record data, and produce reports, we should become more aware of these larger questions which face the quantum physicists. When we delegate the observation and sensing role to a computer, we must at the same time adopt a new, higher-level role for humans within the experiment. This interactive role will capitalise on the skills, experience and intuition which we bring to the situation, in roles as error-watcher, information manager and arbiter about the appropriateness and completeness of the activity.

This call for more acknowledgement of the human factor in a technological environment is not new. The appropriate technology, energy conservation, and vernacular architecture movements all called strongly for a more ecological approach to design and implementation. With an interactive relationship with the computer as a new instrument or tool for sensing, we open the doors for new ways of seeing and thinking, but we also take on the new responsibility of developing decision-making, management and thinking strategies which will acknowledge all aspects of the human-technology environment?

And, as Howard Gardner (1985) points out, our understanding about our ways of thinking is limited by our models of the world, by the language we use to discuss these models, and by the visual images we create. The Greeks’ explanatory model depicted humans as marionettes, controlled by strings. Descartes used a hydraulic model of fluid in nerve tubes to explain the way humans think. More recently, telephone switchboard and digital computer operations have been used to define thought processes. But, as many researchers in cognitive science have realised, human thinking is somewhat more messy, intuitive and opportunistic than serial computer functioning can be.

Paradoxically, the rigorous application of methods and models drawn from the computational realm has helped scientists to understand the ways in which human beings are not very much like these prototypical computers. ... the kind of systematic, logical, rational vision of human cognition that pervaded the early literature of cognitive science does not adequately describe much of human thought and behavior. (Gardner, 1987)

The more recent models being explored by researchers in areas such as the new connectionism, neural networks, parallel distributed processing, fuzzy sets and neuroscience will probably become as inadequate as the switchboard model, but I do feel we owe it to the students to base our educational interpretations and models in the broadest and deepest possible context of accumulated thought.

Changing the Way We Think About Ourselves

Humans have consistently been having the stuffing knocked out of their sense of importance over the last few thousand years. The Egyptians, Greeks and Romans were obligated to a wide range of gods and Copernicus showed that the earth was not the centre of the solar system. It was thought that science would enable us to obtain control over the world through orderly experiment and technology, but now chaos theory and environmental ethics are intruding. Humans were above the animals because we use tools - but then chimpanzees were observed using sticks as tools. Language was the next discriminating factor, but Washoe changed that. Now trees have rights in the courts, robot rights are being discussed, and whales can generate more concern than homeless people. Our bodies are talked about in terms of engines (the heart is a pump, we let off steam), and our minds have been described as rule-bound information-processing boxes.

Over the last 20 years, a new challenge has risen to our sense of identity - high technology. More complex than the industrial technology which had previously been feared by workers, the common message about the new technology is that it is yet another form of external supremacy, able to do things faster, better and more reliably than humans, with the added complication that some of the devices are also made to look human.

Because of this tendency for humans to define themselves, or be defined, in terms of external entities, we are going
Through the emergence of new tools, we come to a changing awareness of human nature and human action, which in turn leads to new technological development.

Through an intense time of concern over control and identity. We read repeatedly in the press and in school texts that the capabilities of computers and robots are rising exponentially, while our own scores on tests are falling. As we are reminded that our capabilities relative to technology seem to be diminished, we find our levels of understanding and our language to be quite inadequate for dealing with the complexities of the situation. Things inevitably deteriorate to an "us-them" comparison, and control becomes a central issue. (Winner, 1977)

When we seek more complete evidence, however, we find that one of the greatest contributions made by artificial intelligence and cognitive science researchers over the last twenty years, has been the realisation of specific ways in which human thought far exceeds the capabilities of the best computers - on certain kinds of tasks? In learned activities, like chess and arithmetic, which are very recent and contrived developments in the history of man, computers can indeed out-perform humans? But in activities which we perform in an unconscious everyday way, such as walking, recognising faces and interpreting ambiguous statements, we are far superior. There are niches in which technology thrives, but there is a greater niche within which our own poorly acknowledged capabilities excel. And unless one holds to a very deterministic model of our own development, it is not unreasonable to see a interactive pattern of continued development of both human and technological capabilities.

Within education, there is a tendency to continue to define and value the human niche in terms of skills which technology now demonstrates, such as memory and computation? When we realise how long it took for educators to begin to break away from the use of the human Intelligence Quotient as an identifier of intellectual worth, we have reason to feel uneasy about our potential to respond to the invitation to this new dance? We can no longer even use the distancing reassurance that technology is inanimate and non-biological, as developments in biotechnology are proceeding rapidly, unnoticed by many educators.

In keeping with the multidimensional approaches being adopted by researchers in many fields, it is time for educators to become more aware of research into multiple intelligence theories (Gardner, 1985; Sternberg, 1985), multiple sensing abilities (Rivlin and Gravelle, 1984), and complex language functions (Winograd and Flores, 1987), which postulate more complex interactions with technological models and design. Several authors have addressed this need for humans to consciously change the conditions and assumptions under which we interact with technology. Richard Gregory (1981) expresses it like this:

No? that we have the beginnings of computer-based autonomous intelligences, and we can apply kinetic intelligence in biotechnology, we may have to decide whether to stay as we are - and live symbiotically with intelligent machines - or apply intelligence to meet the future by recreating ourselves.

And Robert Ornstein and Paul Ehrlich have written a book which calls for a new consciousness and awareness of these issues under the title "New World New Mind: Moving Toward Conscious Evolution". (Ornstein and Ehrlich, 1989)

Changing the Way We Think About technology

The most concrete connotation of the word technology is that of the tool, or artifact. But the word can also refer to the more abstract systems, organisation, techniques, people and values involved in the invention, production and use of these artifacts (Winner, 1977). It is to this larger context for technology which I believe educators must now turn for direction, for our thinking about technology will not improve without a concomitant enrichment of language, sociocultural context and awareness of our responses to the whole range of technological activities. It is not necessary to be a direct user of a technological artifact, to be involved in technology. In computer education we have so far focused on the equipment aspect of technology, as shown by the imbalanced results of K-8 survey, in which more than 80% of the topics in U.S. computer education curricula are equipment-oriented. (Oman and Willson, 1986) The broader aspects
of technology are given lip-service under topics such as privacy, careers and control, which are couched in government, business and legal terms with little or no sense of social or cultural history, or of the validity of idiosyncratic response. We have operated under the assumption that all people should be able to use computers in the same way, because they are, after all, "just tools". But we all have such different histories of tool use in our lives, and we each bring our personal pre-understanding to any involvement with technological artifacts.

If you spontaneously ask a group of people to tell you the first word they think of when you mention the category "tool", you will most probably hear "hammer" as the most frequent response. But if you hold up a portable electric mixer, and ask what category it belongs to, you will hear "appliance". Hold up a flute - that's an "instrument". A Veg-O-Matic? That's a gadget. Yet all of these are extensions of ourselves (i.e. tools) in the way that the computer is claimed to be an extension of our minds. When we refer to the computer in blanket fashion as a tool, we are not acknowledging the complexity or range of contexts within which tools are used, nor are we reflecting the range of responses which we each seem to have toward technology. Our language and our understanding of our own part in the dance has simply not kept up with the development of our artifacts and their range of uses. When the prototype of a tool in our minds is a hammer, constant reference to the computer in all its guises as a tool is somewhat simplistic. Winograd claims the computer is different from other tools because it can be networked to such a wide variety of other devices. Indeed, it may not be long before the computer itself disappears, as the devices we now call peripherals become the dominant aspects of our systems. Perhaps then more specificity and more sense of individual response and choice will enter our language.

It is useful to pay attention to tools, for they are such a natural part of our everyday comprehension of the world, that we tend not to see them. Conscious consideration of the development of systems of end effectors, including stone axes, hammers, spoons, brushes, the drill bits used by dentists, the feet for sewing machines, and the hands used by robots show that humans as tool-users have long sought to develop physical extensions of themselves. In the category of tools known as instruments, we place items which extend our sensory capabilities in a variety of ways. The telescope not only enables us to actually see things which we could not previously see, it also provides a whole new percept of "farness". The microscope provides "smallness", and carbon-dating techniques give us a sense of "pastness"? At one level, the artifacts of technology do simply provide us with physical, measurable extensions of ourselves, but at another level, their use also opens up new ways of thinking, visualising and understanding.

Finally, if we continue to consider the computer as just a tool, the least we can do is consider the human who uses the tool as an artisan or crafts-person, whose methods, tools and materials can be thought of as extensions or even aspects of one another. In the most obvious way the material dictates his tools and methods. But from a larger view, a craftsman works to develop a tool out of an ableness in himself....(Dooling, 1986)

I believe that the development of this sense of ableness in ourselves, as we dance with the capabilities of technology, should be a major goal in technology education.

References