Teaching and the New Technology: A Pedagogical Viewpoint

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In case you missed it, we entered the information age officially in 1991 — the year corporate spending on IT exceeded that of spending on manufacturing technology. In the area of higher education, however, you would hardly know it. The technology supporting teaching is still largely pre-Gutenberg.

Teaching, especially in large first year classes, is still conducted overwhelmingly by students sitting in lecture theatres transcribing notes while they listen to a one-way monologue from the front. Their role, it seems, is to copy down as much as they can, memorise as much as they can and hope that they can recall about half of it accurately a few weeks later in an exam. This is not to suggest that all higher education is conducted in this way, but it is still the way most of our students are expected to learn.

It is not that faculty are strangers to IT. In the mid 1980s we saw the first wave of the IT revolution in the form of microcomputers. Before long we were word processing our manuscripts, producing fancy overheads on our desktop machines and introducing multimedia programs as interesting add-ons to the standard laboratory class. However, most faculty kept teaching in much the same way as before.

Now, in the mid 1990s, we are experiencing the second phase of the IT revolution with a shift of emphasis to the desktop computer as a communication tool and a way of accessing a vast array of data, images and text. It is hard to believe the WWW is only a few years old and its growth in that time has left even the most hardened technophiles bewildered. From the comfort of my home I can now search a library catalogue in New York, check the latest pictures being downloaded from Mars, read this weeks research news in *Nature* and send some data to a colleague in the UK.

All of this must have major implications for how we teach, what we will expect students to do, and indeed how we define learning itself. Yet, till now, the way higher education has been practiced has remained remarkably impervious to technological change and is still defined by classroom hours of instruction. What is not clear, however, is how we should use the new technologies in teaching. That question is currently exercising the minds of academics all over the world. Two strong themes appear to be emerging.

The first is concerned with improving the efficiency of, or access to, higher education. It is hoped that IT will enable the delivery of education to a wider more diverse student population, allowing students to decrease the time they take to complete their courses or allow the same number of students to be taught with fewer resources.

The second theme is concerned with teaching and learning with the hope that IT will allow students to engage more actively, more collaboratively and more meaningfully with the curriculum and achieve enhanced learning outcomes.

These are not alternative or mutually contradictory pathways, but given the pressures to achieve the first goal we must ensure that the second goal is not compromised. In order to ensure this we need to have in place a satisfactory model of student learning and this is what I would like to talk about here. I want to argue that one of the reasons IT has failed to make a major impact on university

teaching and learning is that it is being used to perpetuate and potentially entrench an inappropriate model of student learning and that in order to reap the enormous benefits of the new technologies we have to change the way teaching and learning takes place in universities.

Most academic staff in universities have not explicitly developed and articulated a personal view as to how students learn and how they as teachers might best facilitate this learning and in this sense university teaching is remarkably unprofessional. Much of the teaching that goes on in universities is conducted on the basis of what we might call folk pedagogy, that is a set of tacit beliefs that are rarely examined or discussed. I believe that much of the folk pedagogy prevalent in higher education is not in accord with how we know that people learn.

A great deal of the teaching that takes place in universities can be thought of as broadcast teaching, that is, it is conducted by telling people things on the assumption that if somebody hears a new idea then that idea will replace any pre-existing idea. The problem is that learning does not happen this way. What we hear or see is interpreted by our existing ideas and those ideas are very resistant to change.

One of the striking features of the science education literature is how hard it is to get people to change the way they view the world, which is presumably what most of us think higher education is all about. At the same time it is clear that students are able to pass and even do very well in conventional university courses without ever achieving a real understanding of what they have been studying. The research on science education is quite clear about the ineffectiveness of traditional didactic teaching in either changing the way people think or developing in students their ability to analyse, synthesise and evaluate information.

Let us look at some principles that underlie what we understand as how people learn as a first step in examining the implications of IT for teaching.

1. Learning is not necessarily an outcome of teaching.
2. Learning involves the construction of meaning from experiences.
3. The construction of meaning is influenced to a large extent by the learner's pre-existing knowledge, experiences and beliefs.
4. Knowledge construction involves relating new information to prior knowledge in order to build new more elaborate knowledge structures.
5. The meanings constructed by the learner may not be those intended by the instructor.
6. The construction of meaning is negotiated socially.

Most university teaching is conducted according to an entirely different set of principles which embody the notion that learning can take place by ideas being transferred directly from one individual to another and learners play an essentially passive role in the process.

Failure to embody these principles in teaching can result in students being forced into taking what is called a surface approach to their learning where they simply focus on memorising the information as given without attempting to understand it. A great deal of research has shown that many university students do indeed adopt a surface approach to their learning and much of what they memorise is quickly forgotten even though they might retain enough to pass a test.

We now know a great deal about the conditions under which students will engage in meaningful learning. People learn when:

1. they are motivated to ask questions that they perceive are of value and relevant to their goals;
2. new information is presented in the context of the questions they are asking;

3. knowledge is constructed while they engage in authentic tasks;
4. their learning acknowledges, builds on and extends what they already know;
5. specifics precede generalisations;
6. they have opportunities to discuss, explain, write and reflect on the new ideas they are learning;
7. they have some control over what they are learning;
8. they are practicing rather than studying;
9. they are allowed to fail in their initial attempts at learning something new;
10. they receive frequent feedback on their learning; and
11. they are able to self-assess the extent to which they are achieving their goals.

This type of learning is very different from the way in which most students learn in our universities and the exciting thing about IT is that it is potentially able to support this type of learning in a way that the traditional lecture format is not. We can think of it as a change from a teacher centred model of instruction to a learner centred one.

So in what ways can IT be used in this transformation? Robert Kozma and Jerome Johnston (*Change* January/February 1991) suggest seven ways:

From reception to engagement — The traditional model of learning in higher education has involved students taking a passive role, listening to a one way flow of information from the lecturer. IT can facilitate students actively seeking information and constructing knowledge.

From the classroom to the real world — IT, through the Internet, can allow for bridges to be built from the classroom to the world outside.

From text to multiple representation — Traditional teaching in higher education has been dominated by text. IT potentially allows for other forms of symbolic representation, in particular visual representation, which will be more suited to the learning styles of many students.

From coverage to mastery — One of the things computers do best is to allow students immediate feedback and multiple opportunities to learn procedures.

From isolation to interconnection — IT potentially facilitates greater collaboration among learners — an essential feature of learning.

From products to process — IT allows students to actively search for and manipulate information rather than being presented with packages of pre-processed information typical of textbooks.

From mechanics to understanding in the laboratory — IT has enormous potential in enriching laboratory experiences, allowing students to explore alternative hypotheses.

IT in teaching is not new, of course, and many people have been supporting their teaching with multimedia programs. My criticism with the way IT is used in teaching is that it is often too over-prescriptive and in a sense attempts to do the thinking for students. Computers are being used as the machine analogues of the traditional teacher centred model of instruction.

If we are to achieve learner centred instruction with IT, planning, decision-making and self-regulation should remain firmly in the hand of the learner. What we should do is use computers for what they are very good at:

- providing access to vast amounts of information — text, sound, images which students can explore;
- providing tools to learners for them to organise and analyse their knowledge and construct representations of it through text and images; and
- providing a means of communication.

The exciting thing about using computers in this way is that it forces us to think about those things that computers do best, like store information, and those things, like analysis, evaluation and synthesis which are uniquely human.

What IT can do is to provide powerful tools to facilitate learning rather than doing the thinking for students. The criteria for the appropriate use of IT should be that it promotes discussion, reflection and problem solving and that users have a large degree of control over the activities and options. By allowing students to construct and represent their own developing knowledge computers can empower learners to assume ownership of their own knowledge rather than simply reproducing the teachers'.

Using IT in this way could facilitate a shift in thinking to lifelong learning as an outcome of an undergraduate education. Of the different dimensions of higher education:

- mastery of a body of knowledge
- critical thinking ability
- communication skills
- ability to find information
- ability to interact with others

current undergraduate education emphasises the mastery of a body of knowledge above all others. Yet, ironically, this probably rates lower than any of the other factors in determining subsequent success in life and the work force.

Our challenge is to think of ways to exploit the incredible potential of the new technologies in order to allow learners to build meaningful personal interpretations of the world.

How should we proceed? One way is to recognise the three contexts within which IT can be used in learning:

- face-to-face teaching — lectures, tutorials, laboratories;
- telecommunication — phone, email, video link; and
- independent study.

For each of these settings we should ask not what do we want students to know but what do we want our students to be doing — what activities do we want them to be engaged in? Only then can we ask ourselves how IT can facilitate these activities.

What is certain is that if we are to achieve the benefits of the new technologies we will have to rethink how we structure teaching and learning.

First, the very concepts of having students spending a high proportion of their class time doing nothing more than transcribing notes is clearly an inappropriate use of their time and resources and yours. Different models of teaching, such as the successful workshop and studio models of science teaching, need to be explored.

Second, access to intellectual resources via the Internet means that we have to rethink the very goals of the undergraduate experience and what learning outcomes we should be trying to achieve. Our graduates now need to know how to find information, manipulate data, draw independent conclusions and communicate findings. There needs to be a greater emphasis on problem solving and design making skills.

Third, and as a direct consequence of this, we will have to find new ways of assessing student learning that involve knowledge construction rather than simple recall. If we continue to assess and reward memorisation and recall of information supplied by the instructor then we might as well continue with the traditional didactic lecture.

Seeing computers as tools for thinking and communication raises the interesting question of whether human thinking should be judged in isolation. Assessing learning in the absence of our books and computers could be considered a bit like assessing a pianist without a piano. The fact that this idea might strike us as strange is probably a reflection of the extent to which our assessment in higher education is focussed on factual recall — the lowest level of cognitive function.

I believe that universities will have to change and adapt to the changing technologies in the way that business has. If we do not, then other non-traditional providers will move in and we have seen the beginning of that already where universities' traditional monopoly in credentialising students is being threatened. Widespread access to information will make us rethink the role of universities as guardians and gatekeepers of access to knowledge and learned communities.

What is becoming clear is that in order to realise the benefits of the new developments in IT universities will have to change in ways that we have yet to fully explore.

At a time when resources in our universities are so stretched the pressure to look at some of these technologies as ways of improving productivity seems almost overwhelming. At a minimum I hope that we will at least maintain levels of student learning in the face of greatly reduced funding. However, the speed of change is so great and the costs, and hence the associated risk, so high that I think we must be very cautious how we introduce IT to ensure we do not entrench current, and I believe, inappropriate teaching practices.