



Autores Invitados

University of Adelaide, South Australia

THE ROLE OF COMPUTERS IN MEDICAL EDUCATION

Assoc. Professor Peter Devitt and Mr. Edward Palmer

SUMMARY

Changes in health care delivery and styles of learning in medical education have forced a need to use and critically evaluate a variety of new teaching tools, including the computer. While the computer is unlikely to ever replace the patient as the primary focus of learning, it does have the ability to reproduce a highly interactive environment and can mimic many situations in Medicine. Apart from virtual reality and simulation, which is still in its infancy in medical education, the computer and appropriate software can be used to generate extremely effective case scenarios. Increasingly large amounts of material are being delivered in electronic format and medical schools place greater emphasis on computer-based instruction in their curricula. This has potential benefit for speed and ease of access of up-to-date information and the material can be used by individuals and organisations off-campus. It is possible that suitably prepared computer-based materials will be used to replace traditional styles of teaching and learning, namely, the lecture, tutorial and practical class. There is evidence in the literature that such computer material can be at least as effective in terms of short-term knowledge gain and problem-solving abilities, but the place of this resource as an aid to understanding and long-term learning has yet to be defined. Computer-based instruction is expensive and to make effective, efficient and appropriate use of this resource in medical education will require considerable and careful thought.

Subject headings: MEDICAL INFORMATICS/education; MEDICAL INFORMATICS COMPUTING; STUDENTS, MEDICAL; TEACHING/methods; COMPUTER-ASSISTED INSTRUCTION/methods.

The computer has often been touted as the answer to diminishing conventional resources, particularly in the area of medical education. The first serious introduction of computers into medical education was made two decades ago. De Dombal reported the use of computer-based material to enhance the understanding of trainees faced in an emergency department with the management of patients with acute abdominal pain. Trainees' understanding of diagnostic issues improved significantly with this additional material. However, the trainees also improved with paper-based resources, and no good claim could seriously be made for the superiority of computers or computer-aided instruction.

Since then, there have been a number of serious attempts to evaluate the use of computers in medical education, often in terms of measuring short term knowledge gain. In many cases, computers have been shown to improve student learning in this area. Two important questions which need answering are whether the apparent benefits obtained outweigh the cost and whether the medium really is any better than traditional methods of instruction.

Until recently, teachers and their pupils have been content with, and able to rely on, the traditional resources that have always been available in medical education. This involves teaching and learning centred on the patient, and backed up by lectures and tutorials. Other information can be obtained from journals. For a number of reasons these resources are no longer sufficient.

Perhaps the most important factor that has forced the need to look for other resources in medical education is the increasing financial restraint placed on health care. The current policies on streamlining the delivery of health care, with concentration of time and money on patient services in preference to education now dominate the health care system. While this may be a rather short-sighted view; from the perspective of the shrinking health dollar it is a practical one. These changes in attitudes mean that medical practitioners are exhorted to spend their time more efficiently -and one of the first casualties in such a system is education. Thus, one of the most precious assets we have in medical education, the practitioner, has less and less time to give to teaching and education. In addition, there has been a change in attitudes of patients. Increasingly, patients have different expectations of their medical attendants. They no longer accept medical decision-making at face value and patients now expect to be treated as equals and participate in their own management decision. This change in attitude is particularly noticeable in Western countries, where patients are often less willing to be seen by trainee doctors and students. In other words, patients are now less accessible as a learning 'resource'. Perhaps the computer can be used to simulate the doctor-patient and teacher-student relationship.

There has been a philosophical shift in medical education in recent years. Pioneered by the McMaster and Newcastle medical schools, there has been a move from the traditional lecture-focussed program to a problem-based approach (Harden).

This style of learning places increased demands on teaching resources and the need for large numbers of tutors. It can be difficult to find, train and finance tutors and other resources such as the computer need to be considered.

It is therefore important to find supplements and even replacements for both the patient and the teacher. There are a number of resources to be considered.

POTENTIAL ROLES FOR THE COMPUTER

Patients. Increasing use is made of surrogate patients (Stillman) and anatomical models. Surrogate patients can be coached to provide realistic and reliable histories. Some can be taught to mimic physical signs, and most will forgive and understand the hesitancy and uncertainty of the novice. Mistakes can be made on models without serious consequence (Jones, Torkington). Both these resources can be expensive and in short supply.

The use of virtual reality in simulated procedures is a new application of computers in medical education and is as yet in its infancy. Procedures can be standardised and trainees able to test and practice their skills. At present these devices are expensive and have limited availability. As with the training of pilots on flight simulators, it may one day be a requirement that medical practitioners go through similar exercises to develop and maintain their professional skills. Yet, at the end of the day, the most valuable clinical experience a student can gain is by talking to and examining real patients. At present the use of computers in this area is minimal and prohibitively expensive for most institutions.

One of the most potent learning environments outside real life is the case scenario. (Irby, Clayden). Classically played out around the patient's bedside, the case scenario may be adapted with some difficulty to the tutorial, and even occasionally to the cleverly written textbook. However, it is in this learning style that the computer can be used to maximum effect. The multimedia, decision-making and immediate feedback facilities can all be used to build realistic case studies in which students can explore, solve problems, analyse data and make decisions without any detrimental effects to either the patients or the students themselves. This type of resource is increasingly in use in teaching institutions.

Creating computerised case scenarios is an expensive option. Although there are many commercial applications of this nature, the cost of the product, the suitability of the content and the maintenance of the software can make this an impractical alternative. Developing one's own case scenario software is always more expensive and should not be considered until commercial alternatives have been explored.

Library resources. The modern library places an increasing amount of its material in electronic format and increasing numbers of journals are available either on CD-ROM or over the Internet. This represents a considerable saving in storage space

and manpower. Many students who wish to pursue their studies using library facilities can now do so in electronic fashion, and often from their own home. There are additional benefits if paper books and journals are not available in the first place. Whilst not a problem in most Western communities, books and journals are often difficult to obtain in developing countries. They are often out of date and in short supply. Could the computer make up this deficiency? Access to computers may be just as difficult and entry to the Internet made at a premium. If these logistical problems can be overcome, then it is likely that computer, combined with the Internet and CD-ROM will prove a useful educational resource in those countries where access to printed texts is difficult. It is important to appreciate that the Internet contains a vast amount of unsolicited information, often of questionable or unproven value and care must be taken recommending students to particular websites.

Teachers and teaching forums. The lecture is the standard format for the delivery of information. In a relatively short period of time a large amount of information can be delivered by one individual to many. A good lecturer will provide a relatively small amount of fact, stimulate the audience, ensure that they remember something of what was said and are motivated to go away and learn more. On the negative side, after 20 minutes most of the audience will have lost concentration and will not absorb any more information. Unfortunately, most lectures are dreary, passive and the contents quickly forgotten. Therefore, it is quite reasonable to explore and evaluate alternative means of delivering volumes of information.

In its simplest form, the computer can be a tool used to provide material traditionally delivered in lecture format - either as text on the screen replacing lecture note handouts, or slide presentations duplicating what was previously the lecture. There are many websites which illustrate this change from traditional to electronic delivery of lecture material. There is little evidence that passive text on the computer screen is any better than the same material delivered in lecture form (Garrud, Mangione). However, providing this information in electronic forms makes it easier to update and correct. It also has the potential to save significant administrative time and money, freeing up resources, which might be used to better effect elsewhere.

Apart from the lecture, the mainstay of medical education has been the tutorial. A good tutorial should be a dynamic activity, capable of fostering active learning. It is possible to construct programs that are designed to provide students with an experience similar to tutorials. A number of studies have shown that in terms of knowledge gained, there is little difference between tutorial and the computer (Andrews, Devitt). This may be a reflection on the size of the tutorial group, where a small group is likely to be more dynamic and interactive than a large group. It is possible that being able to work at their own pace, students may develop a greater understanding of data analysis with computer-based materials (Devitt), but there is no clear-cut advantage of one resource over the other. Perhaps this matters little. What is more important has been the observation that it is possible to construct on

the computer, software which will allow students to learn as well in this environment as in the small group tutorials.

Another educational concept is distance education. Although not new, distance education has entered a new era with the advent of the internet and multimedia teaching. For those with minimal facilities and without access to current information, the electronic environment may be a blessing, but while students may be able to work at their own pace and in their own time, they lose the dynamics of group interactions with students, teachers and patients. Working in isolation may appeal to many students, but in a profession where communication skills are of paramount importance, there is much to be gained by focussing as much learning as possible in a team or group.

CRITICAL EVALUATION OF THE COMPUTER AS AN EDUCATIONAL TOOL

Users and critics of computer-based education need to be convinced about the value of the medium. In many cases, this means showing that the computer can be at least as effective as the resource it is intended to replace or supplement.

In the business world, these dynamics are well recognised and a needs analysis is performed. The economic viability of the proposal is determined, any potential improvements in outcome are determined and questions asked as to why the change should be made. Will the new product or situation lead to increased productivity or efficiency? Have these concepts been applied to the introduction of computers as a learning tool in medical education?

There are relatively few studies in which students' views on computers and computer-aided instruction have been canvassed. (Devitt, Khadra 1995, Kidd). Many of these were undertaken before computers truly became household appliances and the relatively negative views expressed by in some reports are probably a reflection on limited exposure to the computer as an educational resource, rather than an informed judgement through experience. The more recent the publication the more positive are the views expressed by students and this is most likely a reflection of increasing confidence in use of computers by the students.

Student opinion has been canvassed as whether they have used computers and what they use them for (Asgari), but often material is produced for student use without any real effort being made to establish its worth. Changes are introduced into curricula to suit faculty planning, rather than to meet student needs. Consultation with the latter group may be token, and relatively little has been documented to suggest any genuine effort has been made to determine users' attitudes, needs and requirements with regard to computers and computer-aided instruction.

There is little published data on the views of faculty staff and clinicians on computers as an educational tool. The experience of clinicians with computers is

variable and in general, the more senior members of staff have less familiarity with the medium compared with their junior colleagues. Whilst they all appreciate the value of computers for literature searches, research and patient records, few see much value in the medium as a teaching tool and most remain sceptical of the role of computers as an educational resource (Polyakov). Despite this, increasing numbers of medical schools plan to incorporate the resource in their curricula. (South). This important observation -if correct- means that more effort will have to be made by those who believe computers have a role in education, if they are to convince their colleagues of their value. The most useful strategy is to show through unbiased observation (the controlled trial or a qualitative analysis) that computer-based education does have value. Unfortunately most of the published literature is devoted to description of the process rather than measurement of its worth (Campbell).

In any evaluation of the computer as a teaching and learning tool, two issues must be addressed. What is the value of the medium and what is the value of the content? It is too easy to be seduced by the medium and the content ignored. Since the report by De Dombal evaluating the role of computer-based material on helping residents improve their diagnostic skills in the patients with acute abdominal pain, relatively little has been published in the way of formal assessment of the medium. A search of the published literature on computers in medical education found that only one third of 258 publications showed any research methodology to suggest that efforts had been made to measure the effect and effective needs of multimedia computer-aided learning in medical education (Campbell).

It is difficult to apply quantitative scientific rigour to educational research, as such comparative studies may be fundamentally flawed in terms of variation of subject content, learning activities, teaching objectives and styles of learning. Whilst these studies, if well performed, will produce reliable results, qualitative assessments are likely to be more valid. Amongst the quantitative studies that have been undertaken, Andrews showed that computer-based material was as effective as the lecture in increasing student knowledge on a pediatric topic. Others have shown that in terms of short-term knowledge gained, the computer fares as well as the lecture (Garrud), practical class (Stanford), tutorial (Devitt) or conventional reading material (Wu, Khadra 1996).

Short-term retention of fact is not a particularly useful educational activity and assessment of analytical processes, problem-solving abilities and cognitive skills would have more validity. The few studies that have looked at these aspects of education have not shown any advantage for computer-related resources over conventional approaches. In terms of decision-making and problem-solving, two studies reported no benefit for the computer-based material (De Dombal, Devitt). A recent study showed that students were at a disadvantage trying to learn practical skills through the computer compared with conventional instruction (Rogers). In terms of data analysis, the dynamics of being able to go through material at the student's own

pace and in their own way may confer some benefit on to the computer (Devitt). In all these cases the assessment was made on knowledge retained after exposure to the teaching tool, rather than any understanding of the material or long term retention of the material.

THE PRACTICALITIES OF COMPUTER-AIDED INSTRUCTION

Computer-aided instruction is expensive. To build a computer suite, furnish it with the necessary technology and provide the appropriate software and educational content costs money.

Whilst most medical institutions are prepared to use texts produced elsewhere, when it comes to computer software, there is an irrational fervour to produce a home-grown product rather than to use perfectly reasonable educational material produced at another site (Stensas)). What this reveals is a lack of understanding of the complexity and cost in the production of computer-based materials. Not only do these materials have to be constructed and tested, but they have to be maintained. The more sophisticated the program, the more difficult it is to maintain and the more problematic to access and change the content.

In conclusion, the computer as a tool for teaching and learning in medical education is here to stay in one form or another. It is unlikely that any amount of scientific data on its reliability or validity will influence use of the medium. However, used appropriately computers can be of considerable educational benefit and will serve medical practitioners throughout their careers. Information technology must not be viewed as a potential cure to the current ailments of medical education. It may be part of the solution and should be treated as such. If this resource is to be used appropriately and to best advantage, the needs of students need to be clearly defined and material constructed for the medium that is built for the medium and is not a mere duplicate of something that could be more easily delivered in another mould. William Osler stated that 'to study medicine without books is to sail an uncharted sea; to study medicine without patients, is not to go to sea at all'. The addition of computers to our teaching armamentarium has not altered this philosophy.

RESUMEN

Los cambios en la atención médica y los estilos de aprendizaje en la educación médica han llevado a la necesidad de usar y de evaluar críticamente una variedad de nuevas herramientas de enseñanza, incluyendo la computadora. Aun cuando la computadora difícilmente nunca podrá reemplazar al paciente como foco primario del aprendizaje, sí tiene la capacidad de reproducir un medio altamente interactivo y puede mimetizar muchas situaciones médicas.

Aparte de la realidad virtual y la simulación, que aún están en su infancia dentro de la educación médica, la computadora y un *software* apropiado pueden ser usados para generar escenarios clínicos extremadamente efectivos. Se ha ido incrementando la elaboración de una gran cantidad de material en formato electrónico y las escuelas médicas dan mayor énfasis, en sus *curricula*, a la instrucción basada en la computación. Esto tiene un beneficio potencial para la velocidad y facilidad de acceso a la información actualizada y el material puede ser empleado por individuos y organizaciones fuera del recinto universitario. Es posible que materiales basados en la computación, adecuadamente preparados, puedan emplearse para reemplazar estilos tradicionales de enseñanza-aprendizaje, entre ellos las conferencias, los tutoriales y las clases prácticas. En la literatura existen evidencia de que tales materiales computacionales pueden ser al menos efectivos en términos de mejoría del aprendizaje a corto plazo y de las habilidades de solución de problemas, pero el lugar de estos recursos como una ayuda para la comprensión y el aprendizaje a largo plazo aún no ha sido definido. La instrucción basada en la computación es cara y para el uso apropiado, efectivo y eficiente de este recurso en la educación médica requerirá un análisis considerable y cuidadoso.

DeCS: INFORMATICA MEDICA/educación; COMPUTACION EN INFORMATICA MEDICA; ESTUDIANTES DE MEDICINA; ENSEÑANZA/métodos; INSTRUCCIÓN POR COMPUTADOR/métodos.

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Assoc. Professor *Peter Devitt*, Department of Surgery, Royal Adelaide Hospital Adelaide South Australia 5000 Email pdevitt@medicine.adelaide.edu.au