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Teaching versus learning

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Curriculum

A curriculum is a course of study during which a student learns knowledge, skills and attitudes. Any curriculum has several identifiable components. There is usually an educational intent – an overall aim or goal of the course of study. There is also an educational content – the actual knowledge, skills and attitudes to be developed. Such content may be defined for the student in descriptive terms, by means of a syllabus or in operational terms as a set of instructional or learning objectives, which the student is expected to accomplish by the end of the course. Every course will have an educational outcome – the end result of learning. The outcome is measured by means of an assessment procedure. Ideally this should compare the performance of the student against targets derived from the course aims and objectives.

The final component of a curriculum is the educational process. This term describes the ways in which learning takes place. Because the educational process determines the pattern and degree of learning, it forms the link between the intent, content and final outcome of the curriculum. The better the educational process, the better will be the achievement of the students.

This paper is about the educational process.

Two educational perspectives

Within the basic medical sciences and elsewhere, any examination of the curriculum process usually reveals a set of activities which lie somewhere along a spectrum. This spectrum extends from teacher-oriented processes to those which are learner- or student-oriented.

A course which is organized from the perspective of the teacher has similarities with a 'command economy' in which central planning and delivery are prominent. The course is highly structured and usually delivered as lectures from experts. Practical classes use well-tried protocols with predictable results which substantiate conventional theory. Small-group teaching serves to control student misunderstanding or error. The role of the teacher is one of certainty, authority and control.

At the opposite extreme lies the curriculum which is organized from the perspective of the student. The student takes responsibility for setting and achieving objectives; the role of the teacher is one of facilitator or mentor, helping students to learn, rather than telling them how or what to learn. This process has parallels with a 'demand economy' in which the needs of the customer and market forces determine supply. Indeed in some courses students may even enter into negotiated learning and learning contracts, where each student sets his or her own particular agenda for study in consultation with a member of academic staff. In medicine, this student-oriented approach is taken in the problem-based curriculum offered by several North-American medical schools, at Maastricht in the Netherlands and at Newcastle, New South Wales. Students are given a series of problems to investigate which require, first and foremost, that the student decides which knowledge, skills and attitudes have to be learned in order to tackle the problem effectively [1]. The formal taught component of the course is minimal. In a similar way many professions allied to medicine favour an element of 'reflective learning' [2], in which the everyday experiences of the student or practitioner in the workplace are used as a source of issues, from which educational needs can be identified and met.

All of these student-oriented learning processes emphasize self-directed learning on the part of the student as the key element of the educational

Abbreviation used: CAL, computer-assisted learning.

process. Why should this be so? The answer lies in the results of research into student-learning strategies and in judgments as to what constitutes good and less good learning.

Student learning strategies

Most, if not all, students are motivated to learn by the need to pass assessments, but variations exist in the individual strategies which students adopt. At least three student learning strategies can be identified [3].

Superficial approach

All students study to pass examinations, but for the student with the superficial approach this is a primary determinant of learning activity. These students often adopt a passive approach to much of their education, saving their efforts until an intensive period of revision just before the examinations. If the course is lecture-based and the assessments emphasize the regurgitation of factual material, then the superficial learner can achieve his or her objective simply by rote-learning. Rote-learning leads to poor structuring and integration of knowledge and to rapid loss of educational gain. Such students can survive well in basic medical sciences and their facility for forgetting is the source of the 'don't you teach them anything' criticism, frequently directed at basic medical scientists by their clinical colleagues.

Deep approach

Other students have a more inquisitive approach, asking questions of the subject matter and of their teachers, reading around, integrating information and applying concepts from one area into another. This deep approach leads to better learning of more useful information which is better retained. Such students are motivated by a need to understand in order to learn and are less dominated by examinations. For most of us they are the 'pearls' in the educational 'oyster'.

Students with the deep strategy tend to be natural self-learners, extending their education within and beyond the curriculum.

Strategic approach

In addition to the superficial and deep approaches, a third learning strategy has been identified – that of the strategic learner. This is someone, rather prevalent in courses such as medicine, who has as a prime motivation the desire to do well in examinations and to be successful, rather than just to survive the system or to understand the material. The strategic learner plays the assessment game, using a combination of deep and superficial approaches to obtain the best results. Clearly the actual form of learning which these particular students pursue depends critically on the design of the assessments and a deep approach can be generated if the assessments demand it of the student.

Given the above types of student, any teacher should prefer to produce students with a deep approach, not only for the quality of learning which they achieve, but also because this strategy leads naturally into self-learning processes which can be carried forward into a career as a doctor, dentist, biochemist, physiologist or whatever. How can the educational process encourage a deep approach to learning?

Factors affecting the approach to learning (modified after Gibbs [5], see also [5a])

Factors encouraging a superficial approach:

(1) A heavy workload; (2) an excessive amount of course material; (3) little opportunity for study in depth; (4) little choice over topics and study methods and (5) assessments which encourage anxiety and the regurgitation of factual information.

Factors encouraging a deep approach:

(1) A motivational context: 'A need to know'; (2) active learning; (3) interaction with others and (4) a well-structured (that is, integrated) knowledge base.

Passive and active learning

Perhaps the most important feature of the deep approach to learning is that the educational process is searching and acquisitive. There is less reliance on the passive osmosis of information prepared by the teachers. Students with the deep approach are active learners.

If a curriculum can encourage the processes of active learning and self-learning, then a deep approach is likely to be demanded of each student. This should lead to an improved educational outcome. Since the assessment process also shapes learning for most students, this too should reward active-learning processes.

Active learning is not new. The Oxbridge tutorial system has long encouraged active learning by setting students tasks, usually essays, which are researched and written by the student before being evaluated by the tutor. Such a system places heavy demands on resources, and as active learning has grown in popularity in recent times with educationalists, techniques have been devised to introduce active learning with less demands on resources. Active learning has become so popular that the Universities' Staff Development and Training Unit of the Committee of Vice-Chancellors and Principals has now generated some 12 volumes on the subject, perhaps as much to use staff more effectively as to enhance the educational process [4].

Many proponents of active learning maintain that, for full benefits to be obtained, the whole of the educational process should be active [1]. Thus many claim that a problem-based curriculum should be exclusively problem based. This is partly because problem-based learning can be slow in the early stages, while the self-learning techniques are developed, and also because partial use of the technique can result in students slipping back into old ways when a conventional curriculum is resumed. Nevertheless, Gibbs ([5], see also [5a]) has shown that even partial enhancement of various curricula using active-learning techniques can be beneficial.

What is probably most important, as far as active learning is concerned, is that teachers should be aware of the concept and should try to develop active-learning processes in their teaching style and in the learning style of their students. This shift of emphasis can be achieved in a number of ways within a conventional curriculum and some suggestions follow.

Techniques for active learning

Lectures

These need not be simply a speech by the teacher. Even with a large audience, some interaction with the students is possible. Lectures can assume a questioning style, seeking student responses. Students can briefly discuss issues in small groups during a lecture and contribute a series of points from their general or prior knowledge. These points can then be organized and developed by the lecturer. Lectures can take a problem-based approach, giving some aspects of a patient history or of a scientific problem and seeking help from students as the scientific explanation of the situation is developed in the lecture.

Practicals

While practicals need to introduce practical skills to students, they need not be cookery classes. Once again a problem-based approach can encourage active thought and student discussion. A tutorial at the end of the laboratory session can produce active participation of students in the analysis and discussion of results.

Tutorials and other small group teaching

Small group sessions are, perhaps, one of the most powerful ways of introducing active learning into an otherwise traditional curriculum. They can be used most effectively as an end-point to a period of self-directed study or of problem-based learning.

There are advantages in using groups of students rather than single students in tutorial situations. Firstly precious staff time is saved and secondly, while working as a group, teamwork, the recognition of the responsibilities of an individual to the group and communication skills can all be developed as part of the learning process. Tutorial time can be used early in a problem-solving process to help students set their own objectives, discuss what they need to learn, what resources will be required and how work may be divided between members of the group or sub-groups. Later sessions can be used for students to present their findings (either as formal presentations or by discussion) to other members of the group, to explore and to develop the theme and to decide on a common conclusion.

In these situations the tutor is not expected to direct students or to provide answers and solutions to problems – the students must do this as part of their active learning. The role of the tutor is to deploy various techniques which ensure that the members of the group know each other, that all members of the group participate and that the activities of the group stay on the right tracks. The techniques for creating and maintaining a group dynamic have been described by many authors (for example [6, 7]) and include the use of personal introductions by members of the group (including the tutor), 'brainstorming' and the use of 'buzz groups' to clarify issues and to set an agenda for action, role-playing and plenary sessions or mini-presentations to formulate conclusions and allow feedback on activities or an assessment of them.

The method demands that teachers put considerable effort into designing the tasks for the students and into showing restraint in their natural desire to direct activities of the group. It can be very hard to sit back and allow the group to determine its own direction or pathway to the answers to a problem, but most groups will get there in the end. If the tutor is persuaded by the students to resume the role of director, rather than stage manager, then the students will sit back, become passive recipients of wisdom and active learning will cease.

Projects

These are, perhaps, the most widespread vehicle for active learning in use today. Individuals or small groups of students tackle an independent study task involving library, laboratory or survey skills and various resources, to perform research on a chosen or given topic. The relationship between supervisor and student is typically one of discussion and agreement, of negotiation rather than direction. The student establishes what is to be done and then works independently towards producing a final report of the activities.

Because projects are resource intensive, in staff time and other costs, they are limited in application often to the most senior and the most able students. There is considerable scope for the introduction of 'mini-projects' at all stages of the curriculum and group projects can work well. The problem of marking numerous written reports can be limited by using a group report or symposia and poster sessions for the presentation and assessment of project work.

Computer-assisted-learning (CAL)

CAL, using simulations and other interactive programming and audiovisual techniques, is currently enjoying great favour, perhaps because hard-pressed teachers see that once the difficult initial period of design is complete, students can study independently with minimal involvement of teachers.

Early efforts at CAL were derived from a taxonomic approach associated with programmed learning. These used a question-and-answer approach, with students being directed to additional information on providing incorrect responses. Modern media have allowed this technique to be extended to cover very large databases. Other notable early developments were interactive computer simulations of body systems, such as those of the MacMan series [8] which allowed students to investigate the effects of altering parameters of cardiovascular, respiratory or renal homeostasis in either normal subjects or simulations of patients (see also MacPuff, MacPee and MacDope simulations). These programs are rather cumbersome to use, but have the great merit that the student learns by doing, that is, that learning is the result of action.

Modern programming techniques should permit the development of problem-based learning, using, for example, the microcomputer environment as a simulated patient. If the programming avoids being prescriptive and allows the student to explore and to devise their own learning pathway, then CAL may have much to offer as a vehicle for active learning.

Other techniques for encouraging active learning

If more widespread revision of the curriculum is envisaged, then problem-based learning may be introduced on a large scale. Alternatively a 'core and selectives' approach will allow students to perform an in-depth study of some aspects of the course. The latter approach means that students will not study all of the curriculum, but each student will have some choice over which areas are studied in detail. Other techniques include the use of log-books and other strategies to encourage students to identify their learning needs and to negotiate individual learning contracts with the teachers.

Conclusions

The use of active learning encourages self-learning and is associated with a deep approach to study. This is thought to result in better integration of information, a better grasp and use of concepts and facts and a better retention of learned material. The principles of active learning can be incorporated into any curriculum using a variety of teaching and learning techniques.

Perhaps the most important factor in increasing active learning is to encourage teachers to shift their efforts towards a more student-oriented approach, to concentrate less on the demands of teaching in the traditional sense and to focus more on the learning process.

It is not certain that a shift to active learning either increases or decreases the demands placed on the teacher. What is more certain, however, is that the role of the teacher changes from one of instructor to one of enabler in the educational process.

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Two revolutions and the scientific culture

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In the United Kingdom, as in the United States and other developed countries, medical educators have been called upon to improve the way they teach medical students. This demand for change has been stimulated by the rapid increase in the knowledge and skills required to practice modern medicine and by the recognition that the traditional modes of medical education fail to challenge and satisfy the high-quality students who are now entering medicine. In England, organizations like the General Medical Council have articulated the need for change and outlined their expectations.

The challenge to medical education comes at a difficult time for medical schools. Governmental funding for education has been reduced, research support is ever more difficult to find and, for clinical education, both hospitals and National Health Service consultants, on whom the teaching depends heavily, are increasingly beleaguered.

To complicate these problems further, two major changes are occurring in basic-science education that may fundamentally alter the landscape of medical student teaching. Firstly there is an increasing disjunction between the skills and knowledge needed to teach medical students and that required to do state-of-the-art research. Secondly educators are discovering that the principles of adult learning apply to students at all educational levels, including medical school and are encouraging this practice. I will say more about each of these topics and then consider their implications for basic-science medical education.

Medical schools have always been an amalgamation of research institutes and educational colleges. For many decades, the two have co-existed happily. Generally biochemical, pharmacological and physiological research have involved investigators working at the cellular, organ or even whole-body level. Clinical models were important to research and a knowledge of disease was useful to many investigators. Consequently medically trained investigators found it easy to supplement their clinical training and to enter research careers. Medical-school teachers in the basic sciences, many with clinical backgrounds and most working on clinically relevant problems, found it simple and fruitful to learn and to teach the general basic-science disciplines required by medical students. The growth of molecular biology has changed much of this, at least in the States. In the space of a decade or two, research which is fundable has shifted dramatically to the subcellular and the molecular levels. The discoveries at these levels of research have been new and profound. For the first time investigators have the capacity to understand the mechanisms of inherited disease, have the potential to unravel the guidance systems that influence the development of cancer, the regulation of the self-identity of the body and of its ability to defend itself and to enhance greatly our ability to explain fundamental issues in the development of disease and in the maintenance of health, as well as the specific ways in which drugs can modify these processes. New frontiers in science have opened rapidly and few funding agencies are immune to the allures of such breakthrough possibilities in research.

Corresponding with this increase in sophistication and in the level of explanatory detail available to researchers has come an increase in the sophistication of laboratory techniques and equipment. To engage in molecular and genetic manipulations, investigators must increasingly specialize in the work they do. The capital investment in equipment for such research is large. The generalist researcher with a clinical background is no longer either as valuable as he or she once was, nor as able to pick up laboratory techniques easily, because of similarities with clinical work. At least in the United States,