Cognitive learning in the health sciences: a case for self-instruction

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INTRODUCTION

Health sciences education is fundamental to the provision of quality health services, and represents a continuing documentation of one of the most challenging and exciting developments in systematized education—the increasing emphasis on self-learning and self-regulation in the instructional process.

We are now clearly in the midst of a knowledge utilization dilemma. The body of biomedical knowledge is so large and changes so rapidly that adequate coverage is impossible. Yet, education in the health professions has been slow to change. The traditional teacher-centered approach to content coverage is still emphasized in both pre-professional and continuing education programs. A more important educational goal than content coverage is to teach students how to learn independently so that they will be prepared to deal with changing biomedical knowledge throughout their professional careers.

For every aspiring and practicing health professional, there is the need for a better means of knowledge acquisition and renewal. Traditional methods will continue to prove inadequate as knowledge continues to expand and techniques become more diversified. Most education will need to shift toward a learner-centered approach through carefully developed, critically tested, and carefully used methods. Such a change cannot be adopted by merely restructuring the curriculum in some more fashionable mode or introducing more varied instructional technology; it requires fundamental changes in educational planning and decision-making as well as in teaching practices.

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CURRICULUM PLANNING

In the past, those involved in academic affairs associated with curriculum planning generally made organizational decisions. They manipulated blocks of subject matter (content) or academic time units. But these kinds of decisions are merely tactical; decisions required in an accountable curriculum model should deal with the level of professional competence that must be achieved in order to qualify for credentialing. Curriculum decisions should stress performance, not subject organization or assignment of time.

The process of curriculum development employed by faculty usually begins with the identification of the areas in which competence should have been acquired by health professions students by the end of their schooling program. Once agreement has been reached on this score, specific learning objectives should be delineated, with the organization of clusters of learning activities, through which these objectives might be achieved. These should follow a set of instructional decisions (e.g. lecture, self-instruction) through which the curriculum can be implemented: the specifics of who will do what and when, in other words, the curriculum plan.

Curriculum decisions such as these focus on the student, not the teacher, and the resulting thrust of instruction is designed to facilitate certain learning outcomes in terms of performance and competence—not courses and content. Health professions students who embark on such a program can shift their energies from memorizing facts to acquiring the competence that clinical practice requires. They can become actively involved in meaningful learning and take much of the responsibility for it while being guided and tutored by faculty members. Since demonstration of defined learning rather than passing through a specified set of instructional experiences is emphasized, students, faculty, and administration alike can be freed somewhat from the artificial constraints of instructional time and sequence.

Most curriculum plans take the form of descriptive course outlines, the content to be covered in them, the time assigned to them, and the instructional methods to be employed. Such a document usually guides faculty in preparing their instruction, tells students where to go and what experiences to expect, and provides external reviewers with the kind of evidence that is generally sought when evaluations are made of educational faculty. But it tells none of these individuals or groups what the product of the curriculum is intended to be. In contrast, self-instructional modules—re-
Regardless of the form they take (programmed instruction, computer-assisted instruction (CAI), and so forth) require very deliberate analyses of content and sequencing. Learning objectives must be stated in terms of behavioral results to be attained by students. Such descriptions not only focus on learning outcomes to be achieved and the varied resources to which students may regularly turn, but also on the different modes of learning which may be available. This approach would serve to remind faculty that there is no single curriculum optimal for all students and hopefully would encourage faculty to create options and alternatives for students rather than continue to pursue the unreachable goal of the curriculum. It would provide students with a definitive guide as to what they are expected to become, not merely what they are expected to do. And it would serve external reviewers (as well as internal faculty and administration) as a point of reference for judging educational quality in terms of planned learning outcomes rather than designed instructional content.

The task of evaluating student achievement is also substantially simplified since self-learning modules provide for immediate identification of errors and appropriate remediation. Also, evaluation input is continuous from the beginning to the end of the learning sequence. This provides for continuous reinforcement of correct responses and usually enhances the learner's confidence.

**Faculty Development**

Most health professions faculty have had minimal preparation for the teaching responsibilities associated with the development and implementation of self-instructional programs, and they often express interest in acquiring more information and skills in this area of educational methodology. For example, the Association of Medical Colleges Faculty Development Survey (Final Report 1977) describes the following major findings:

- Faculty have had little formal preparation for their roles as teachers. It is estimated that only 21 per cent have taken education courses and that only 39 per cent have ever attended an educational workshop.
- Faculty make considerably more use of traditional than "innovative" instructional methods. For example, 56 per cent use lecturing on a frequent basis, while only 6 per cent use CAI frequently.
- Faculty are not thorough in their management of the instructional process. They gather little background on their students, are not explicit concerning their
expectations for students, and are less than systematic in their evaluation practices (1).

The survey findings are based on a 71 per cent response rate from 2,700 faculty sampled from a total population of 28,293 full-time medical school faculty with teaching responsibility for undergraduates. With few exceptions, one can generalize these findings to include most health professions groups. A need is thereby created for educationists with specialized training who can work cooperatively with clinical faculty in designing, developing, implementing, and evaluating educational programming in needed areas. Much greater emphasis should be placed on the systematic application of educational science to problems of health science education if we are to transcend the relatively primitive efforts undertaken in educational research and development in the past 20 years.

Current data show that 92 per cent of the educational institutions in the health professions are involved in educational development activities (2). Although faculty indicate a desire for information and support in their teaching efforts, most of these institutions are not presently benefiting from the support of formal units of educational research and development. Such units typically are capable of providing support services in curriculum development, instructional development, instructional materials development, faculty development, and evaluation. The resources required are usually modest when compared with the total operating budget of the academic program being served and in terms of the impact such units should have in improving efficiency and effectiveness with which instructional programs are conducted.

FACT GATHERING VS INQUIRY

Health professions education today involves too little thinking and problem solving. In a recent article, Ludwig Eichna, a physician who returned to medical school to gain a better grasp of contemporary problems in medical education, states that the educational process consists largely of too many facts in too little time (3). Students attend medical school inculcated with this concept by previous education (especially colleges) where facts and examinations are a way of life. The clinical years perpetuate non-thinking while inordinate amounts of time are spent on mechanical "doing." Eichna points out that facts are essential and recognizes that problems cannot be solved without their sequential arrangement. But in medicine, the answer may not be there even after the facts are ar-
ranged. Students must learn to handle uncertainty; that too is medicine. Emphasis on facts does not teach this aspect of medicine any more than it teaches problem solving, and every patient presents a problem to be solved. It is vital to replace the concept of learning as fact gathering with the concept of education as inquisitiveness, sequential thought, problem solving, and the satisfactions that result (4).

Learning is a thinking, **problem-solving** process that requires time. In order to make more time for such learning processes to occur, time spent on learning factual content should be reduced without compromising the quality or quantity of the information gained. Attempts should therefore be made to utilize more effective ways of communicating factual information to students. Unlike many areas of education where most content can safely be forgotten, the health professions require long-term retention of significant amounts of detailed factual and theoretical knowledge. Studies by Ausubel and others have concluded that well-organized presentations followed by opportunities for drill and practice enhance the long-term retention of subject matter knowledge (5). Programmed instruction and CAI represent two excellent forms of self-instruction with these very attributes.

**PROGRAMMED INSTRUCTION**

Programmed instruction techniques have been employed successfully with both low and high ability students in several health service areas including some of the more advanced areas of medicine.

Programmed instruction individualizes the pace of instruction over extremely small steps (instructional frames) which present the student with information or a problem. The student responds to the frame by demonstrating an understanding of the information or progress in solving the problem, and presentation of succeeding material is then based on the quality of response to the current frame. Programmed instruction may either be linear (in which an incorrect response results in repetition of the frame), or branching (in which the type of error determines which of the alternative frames or sequence of frames will be presented to correct the response). The “size of step” from one idea or concept to another is usually quite small and students may move through a series of frames which display elements of an idea or problem before arriving at a conclusion or generalization. Deductive strategies and indeed presentation followed by drill and practice are also possible in programmed instruc-
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Programmed instruction may be presented through text materials, instructional machines, or computers.

**COMPUTER-ASSISTED INSTRUCTION (CAI)**

Computer-assisted instruction is more a technology than a technique which has been employed successfully in almost all health professions fields. The instructional advantages of computers lie in their enormous storage capacity and flexibility which allow a wide range of individualized options and possibilities for the sequencing of material and then the virtually instantaneous retrieval of information which facilitates interactive instruction.

CAI has employed virtually every instructional strategy. Much of its initial development focused on drill and practice and on the tutorial strategy of programmed instruction. One of the best known examples of this type of programming is the Pilot Medical School track at Ohio State University (6). The computer is used as a manager of educational resources by monitoring the students' progress via self-assessment examinations and guiding them in the appropriate use of textbooks, audiovisual materials, and faculty tutorials.

More recent programs present data and other information in a discovery or problem-solving mode. In this form of CAI, most useful in clinical education, the computer represents the patient and his/her environment and confronts the student with a variety of diagnostic and/or therapeutic problems to be solved.

It is difficult to achieve competence in clinical problem solving through reading or observation alone. Supervised practice in clinical problem solving is the best way to develop clinical judgment. Using computer-based simulated patients, a student may be given total responsibility for managing the disease process, whereas in actual practice this would not be the case. The computer can point out errors in technique or knowledge through comments or by allowing the student to observe the effects of improper management on the "patient's" deteriorating condition.

Another major advantage of the computer simulation is that the simulated model can react and change in a much more variable manner than is possible in a written example. The responses of the model can be made a function not just of the student's last decision, but of the whole interaction up to that time. Thus in a simulation of a disease process, the clinical state of the simulated patient can change as a simulated time func-
tion of the disease process as well as in response to the different therapies chosen by the student (7).

Another advantage of the computer simulation over more traditional instructional models is that the simulation can be completely specified and standardized for every student. The computer can keep an exact, detailed, and complete record of the student's performance and can evaluate the student's interaction in a reproducible and unbiased fashion.

Finally, the computer simulation can be made available to the student at a variety of times, not just for single scheduled exercises. The enormous hardware and software development costs are also being reduced through widespread use of materials. For example, in regional programs which had been made available over voice grade telephone lines in Ohio, poor transmission and high costs combined to limit the extent to which distant users could access CAI programs. Acting on the recommendation of the Association of Medical Colleges, the Lister Hill National Center for Biomedical Communications of the National Library of Medicine (NLM) in July 1972, set up an experimental CAI network (8). This network, operating over leased lines of a commercial firm (Tymshare, Inc.), made available programs developed at the Massachusetts General Hospital, Ohio State University, and the University of Illinois Medical College. Users in about 36 cities around the country could dial a local telephone number and be connected with the computers of the contracting institutions. The availability of the network has allowed health professions schools and other institutions to demonstrate CAI to students and faculty and to use programs in their curricula at very modest costs. During the first two years of the NLM network, 80 institutions used the programs of one of these contractors (9).

CAI could play a major role in the cognitive aspects of educating health professionals: the acquisition of factual data and the application of that knowledge to clinical problem solving. Many implementation problems remain in the inherent limitations of the method, definition of subject matter, evaluation, and cost-effectiveness. It seems obvious, however, that while the impact of CAI on the costs of education for health professionals will probably not be large, the impact on quality may be extensive.

SUMMARY

The health professions are faced today as never before with the need to find more effective ways of acquiring a growing volume of biomedical knowledge and of addressing the urgent concerns about learning processes—namely, the continued dependence on outmoded techniques of
cognitive transfer. The author believes that greater incentives should be given for faculty and students to experiment with innovative approaches to cognitive learning while recognizing the need for increased emphasis on problem-solving skills in medical care. Proven self-learning techniques demand greater attention in curriculum and course design efforts. Finally, the author states that the process of educational planning must be viewed as continuous, dynamic, and never-ending if it is to best serve the needs of individual students, educational institutions, and the society to which both are ultimately accountable and committed to serve.

REFERENCES

(2) Ibid., p. 29.
(4) Ibid.

APRENDIZAJE TEORICO DE LAS CIENCIAS DE LA SALUD: RAZONES A FAVOR DE LA AUTOINSTRUCCIÓN (Resumen)

Las profesiones de salud se enfrentan hoy más que nunca con la necesidad de medios más eficaces para adquirir una cantidad creciente de conocimientos de biomedicina y para resolver los acuciantes problemas del proceso de aprendizaje, provenientes de la dependencia continua de técnicas anticuadas de enseñanza teórica. Según el autor, deben darse al personal docente y a los alumnos mayores incentivos para el ensayo de métodos innovadores de aprendizaje teórico, pero concediendo mayor importancia a las prácticas de solución de problemas de atención médica. Las técnicas autodidácticas conocidas exigen dedicar mayor aten-
ción a la preparación de planes de estudios y programas. Por último, el autor manifiesta que el proceso de planificación de las enseñanzas se debe considerar como un proceso continuo, dinámico y sostenido para que responda de manera óptima a las necesidades de los alumnos y las instituciones docentes, y las de la sociedad, ante la cual unos y otras son, a la postre, responsables y a la cual se han comprometido a servir.

APRENDIZAGEM COGNITIVA EM CIÊNCIAS DA SAÚDE: A FAVOR DA AUTODIDAXIA (Resumo)

Os profissionais da saúde enfrentam, hoje mais do que nunca, a necessidade de encontrar meios mais eficientes de absorver o crescente volume de conhecimentos biomédicos e resolver um problema urgente dos processos de aprendizagem, a saber: a dependência de técnicas antiquadas de transferência de conhecimentos. Na opinião do autor, deve-se incentivar mais os professores e alunos a experimentar abordagens inovadoras à aprendizagem cognitiva, reconhecendo-se ao mesmo tempo a necessidade de dar mais ênfase ao desenvolvimento de habilidades ligadas à resolução de problemas no exercício da medicina. Na elaboração de currículos e cursos, deve-se dar maior atenção a técnicas comprovadas de auto-aprendizagem. Finalmente, o autor afirma que o planejamento do ensino deve ser encarado como um processo contínuo, dinâmico e permanente para melhor atender as necessidades dos estudantes, das instituições de ensino e da sociedade, à qual tanto aqueles quanto estas devem servir e prestar contas.

L’ACQUISITION DE CONNAISSANCES DANS LES SCIENCES DE LA SANTÉ: EXEMPLE D’AUTO-INSTRUCTION (Résumé)

Les professions de la santé se heurtent plus que jamais à la nécessité de trouver des moyens plus efficaces d’acquérir un volume croissant de connaissances biomédicales et de pallier les insuffisances du processus d’étude—à savoir, la dépendance continue à l’égard de techniques démodées de transfert des connaissances. L’auteur estime qu’il faudrait inciter davantage la faculté et les étudiants à expérimenter de nouvelles méthodes d’acquisition des connaissances, tout en reconnaissant la nécessité d’insister davantage sur l’aptitude à résoudre les problèmes en matière de soins de santé. Les techniques éprouvées d’acquisition de connaissances demandent que soit accordée une plus grande attention à l’établissement des programmes d’étude et à la conception des cours. Enfin, l’auteur déclare que le processus de planification de l’enseignement doit être perçu comme continu, dynamique et permanent s’il doit répondre au mieux aux besoins des étudiants, des établissements d’enseignement et de la société envers laquelle les uns comme les autres sont responsables et qu’ils ont pour mission de servir.